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CIB Volume 7, Issue 1
Table of Contents

Letter from the Editor **December 2015**

Dear friends,

It has been another fantastic year for CIB W117 Performance Measurement in Construction and our CIB Journal for the Advancement of Performance Information and Value. The winds of change are in the air. Traditional construction management, risk management, and project management are no longer sufficient to help the industry improve, and have stymied all growth.

Over the past twenty years, traditional research has shown that it is too slow to help the industry. It takes too many academic researchers to "turn and install a lightbulb." Only someone who has been in the industry for 20+ years as a professional researcher can clearly see the repeating cycle of confusion, repeated mistakes, and incomplete literature search because academic researchers don't use the Internet, and they continue to recycle through a 10 year cycle of the same solutions that didn't work before, and will not work now.

The purpose of this journal now and over the next ten years is to find the cutting-edge ideas and to research test results and industry movement of visionary academic researchers whose solutions get "to the street" as fast as possible. We do not need researchers to do literature searches for every document in the world, find out what they all say, design a model, wait for feedback on their model from their confused peers, and then write their paper that adds nothing new. This may take years. In four years, no one will be interested in the researcher's work. We also do not need older research reviewers who have no experience in running research tests, who have no successful impact on the industry and no knowledge of a cutting edge research concepts, who make it difficult for young visionaries to get their ideas documented in conferences and journals for the sake of creating pain, giving them all the discouragement they can handle, only to have them grow up and do the same thing to the next generation. This is not my idea of adding value.

This journal is interested in the following:

1. How have the academic researchers in the Netherlands convinced the largest government organizations and the professional procurement group to go from a low bid system to utilizing expertise?
2. How did they do it so quickly?
3. What are they doing that can be used in every other country?
4. How can Saudi Arabia utilize expertise in a very controlling and reactive construction industry?
5. How can a new project management model and new procurement model reduce cost by 30%?
6. Can the academic researcher truly add value?

As a senior person in the world in the construction management research area, who has done more research tests than any other researcher in the world, I would invite all construction management

researchers to get involved. Write innovative papers. Get your papers published quickly in our journal. Get recognized for great work. Change the industry. Make an impact. Get involved in CIB W117.

Happy Holidays and a Happy New 2016.

Professor Dean Kashiwagi


Dean T. Kashiwagi


Jacob Kashiwagi


David Gastélum

Link to journal:
http://cibw117.com/journal

A Large Dutch Engineering Service Adopts the Best Value Approach

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The Best Value (BV) environment was introduced into the Netherlands in 2006. By 2008 testing was being done by a partnership of Arizona State University and Scenter (Sicco Santema, professor from Delft University). In 2010, the first significant test of the BV approach was done by the Rijkswaterstaat to deliver the $1B fast track infrastructure projects, and by 2015, the BV approach had become the "buzzword" of procurement and the professional procurement organization NEVI. However, in the delivery of professional engineering services, larger, more traditional services which were built on a system of relationships between clients and vendors, clients controlling the expert, and the importance of "billable man-hours". The transition from a traditional approach to a BV approach is very challenging. Large traditional professional organizations naturally will have more difficulty adapting to the new approach. The BV approach utilized the expertise of experts to replace the need for relationships and owner management, direction and control (MDC). It also places less value on traditional practices that have been used by professional services to get business (relationships and working together with the client in a trust based relationship). The study captures the efforts of a very successful engineering firm (the second largest in the Netherlands) as they attempt to become successful in this new approach. The Best Value team that they have put together has had outstanding results in using the BV approach to changing their paradigm.

Keywords: Professional services, Best Value, Netherlands, Royal HaskoningDHV, delivery of services

Introduction

Professional services were always selected differently from other construction services. They were identified as professional services which used engineering principles to solve and provide solutions to owner requirements. They developed a selection system called Qualification Based System or QBS, which selected designers based on the professional's past performance, professional licenses, professional relationships and technical knowledge in the firm (Child, Sullivan & Kashiwagi, 2010; D. Kashiwagi, J. Kashiwagi & Child, 2014). The QBS system resulted in a system where the owners selected the professional firm based on relationships, marketing brochures and firms' reputations. The selection process resulted in clients' selection boards deciding who was the best qualified. In many government environments, price is not a selection criteria. After the QBS was performed, a professional service is selected and price is negotiated. Oftentimes, it is a fixed percentage of the construction cost.

The QBS and other similar selection systems resulted in professional services having the following practices (Child et al, 2010; D. Kashiwagi et al, 2014; Sullivan and Michael, 2011):

1. Depending on marketing and relationships to get their work.
2. Professional services becoming more reactive to the clients' needs.
3. Strong relationships becoming the solution for engineering and design issues.
4. Design schedules becoming less important leading to design change orders and redesigns.
5. Large design services becoming more fixated on maintaining "billable man-hours" than utilizing their expertise.
6. More administrative and meeting duties than utilizing technical expertise.
7. A void of project management skills which concentrated on profit margin, efficiency, effectiveness and maximizing profit/return to the company.

These practices led to the following results (Egan, 1998; FMI / CMAA, 2004; FMI / CMAA, 2010; Sullivan & Michael, 2011; Tucker, 2003):

1. Poor customer satisfaction.
2. Clients reviewing the professional's work, and managing, directing and controlling the professional services.
3. The owners/clients had a poor perception of designers' and engineers' capability, quality of work and professionalism.
4. An inability in a large design firm to identify the expert, select the expert for a project and allow the expert to plan the project from the beginning to the end (utilizing their expertise to estimate quantities and identify the risk that other stakeholders bring to the design project Mitigating the risk by creating transparency and through a risk mitigation plan).
5. Work was procured through a marketing/relationship process called the Qualification Based System (QBS). The selection of the firm is done through an owner's selection board that decides who is the best qualified, then negotiates a contract with the selected vendor.

These design practices are in all countries and cultures (underdeveloped, developing and developed countries). The authors have been in Africa, Malaysia, China, U.S. and Europe in which the practices are observed to be the same.

The Best Value Approach has been in the Netherlands since 2007. The Rijkswaterstaat (tasked with maintaining roads and waterways in the Netherlands) delivered the "fast track projects" using the Best Value Approach (known as Best Value Procurement or BVP). The following results were realized (Van de Rijt, Witteveen, Vis & Santema, 2011):

1. Procurement transactions and costs were minimized by 50%.
2. Construction time was minimized by an average of 25%
3. 95% of all project cost and time deviations were caused by the owner/client and their professional services.

Professional services were also procured by the BVP approach. Immediately, the following problems were observed (J. Kashiwagi, Sullivan & D. Kashiwagi, 2009; Kashiwagi, 2014b):

1. The design professionals were reactive and not used to being accountable to setting a plan, identifying the deliverable to be delivered, making the assumptions that should be made utilizing their expertise, and having a risk mitigation plan that minimized the risk that they did not control.
2. The owner/client's project managers were confused and thought that the clarification period was a time to make the contractors do work to identify all the unknowns.
3. The design services faced the challenge of how to identify and utilize expertise in their own organizations.
4. Large design organizations were confused how to match their need to transform their approach from concentrating on "billable hours" to utilizing expertise.
5. The definition of an expert was in question. Years of experience, education degree and leadership position in the company may no longer be sufficient to be identified and work as an expert.

The Performance Based Studies Research Group (PBSRG) identified the following about the Dutch Best Value movement:

1. Per capita, it was the most progressive Best Value (BV) effort in the world, with most number of certified experts, the largest number of BV technology licenses, more major government clients involved in Best Value tests and the only country where the professional procurement group (NEVI) and the professional risk management and engineering group (RISNET), which includes the professional organization of the engineering and design firms, are all licensed in the BV technology from Arizona State University (ASU) and their technology licensing group AZTECH (PBSRG, 2012).
2. BV consulting groups created, which proliferate the BV practices including Scenter (led by Sicco Santema, the Best Value visionary of the Netherlands), NEVI (3rd largest professional procurement organization in the world), Best Value Europe (an organization committed to spread BV throughout Europe) and the Dutch Professional Engineering Organization which is a member of the European Professional Engineering Organization (Kashiwagi, 2014b). The groups Scenter and the European Professional Engineering Organization, are now spreading the BV approach to both Norway and Poland, translating the Dutch Best Value Procurement (BVP) book into both Norwegian and the Polish languages.
3. The largest government organizations in the Netherlands are participating with the BV effort including Rijkswaterstaat, ProRail, Netherland Rail Service, waterboards, provinces and major cities such as Rotterdam, Amsterdam, Utrecht, and Groningen (Kashiwagi, 2014b; Van de Rijt & Santema, 2013).

Problem: How to Transform Professional Services into a Performing Industry

For the BV effort to be sustainable, PBSRG was interested in three major areas: professional services, medical services and IT or ICT services. Professional service was a primary target

because the traditional delivery of professional services was an area where performance was very low and had the following characteristics (Child, Sullivan & Kashiwagi, 2010; D. Kashiwagi, J. Kashiwagi & Child, 2014; Egan, 1998; FMI / CMAA, 2004; FMI / CMAA, 2010; Sullivan & Michael, 2011; Tucker, 2003):

1. Management, direction and control were being utilized to minimize risk.
2. It is a commodity area that was being differentiated based on relationships.
3. Professional services had very poor customer satisfaction ratings.
4. The professionals are the first to touch the delivery of construction services and were identified in the Netherlands billion-dollar infrastructure project as the source of 90% of the project cost and time deviations (Van de Rijt & Santema, 2012).
5. In PBSRG construction project tests, the design services and the owner's decision making was the largest source of project cost and time deviations. The owner's representatives and the design services were indistinguishable. They were one entity and were the largest problem in the delivery of construction services (J. Kashiwagi, Sullivan & D. Kashiwagi, 2009; Kashiwagi, 2014).

To have a larger and more sustainable impact on the performance of professional services, PBSRG searched for visionaries in one of the more traditional larger professional services companies.

Methodology

The research approach was simple:

1. Identify one of the largest engineering professional services company.
2. Identify if there were visionaries who understood the BV approach in the company.
3. Assist in organizing a core team of BV experts.
4. Identify the strategic plan to transform the large organization into an organization that could utilize the BV approach to increase efficiency, effectiveness and margin/profit for their organization.

PBSRG set on the following plan to meet the research objectives:

1. Present to the Dutch professional engineering organization.
2. Identify one of the larger organizations who had visionaries.
3. Educate and train the visionaries in the BV approach.
4. Identify if they could follow the BV approach in order to give their organization the ability to utilize the BV approach.
5. Convince the core group to utilize metrics.
6. Identify if the metrics can be refined to increase the support of the rest of the organization.
7. Pick a case study which shows the success of the BV approach.

History of BV with Professional Engineering Groups

From 2011 – 2012, PBSRG started to brief professional engineering firms, including the Dutch professional engineering group (a subset of RISNET, the Dutch risk management professional group). In 2012, PBSRG was contacted by the second largest engineering and design firm in the Netherlands, Royal HaskoningDHV. Royal HaskoningDHV is an independent, international engineering and project management consultancy with over 130 years of experience. The company of professionals delivers services in the fields of aviation, buildings, energy, industry, infrastructure, maritime, mining, transport, urban and rural planning and water. Backed by expertise and experience of nearly 7,000 colleagues across the world, they work for public and private clients in more than 130 countries on five different continents (Royal HaskoningDHV, 2014). A visionary in the company, Elske Bosma, reached out to PBSRG for some guidance, and PBSRG started a relationship to assist her and her company to become Best Value experts.

In 2014, RISNET licensed the BV approach technology from ASU, and the Dutch professional engineering group, a subset of RISNET, acquired access to all the training materials. The Dutch professional engineering group under the leadership of Paul Oortwijn, started presenting the BV approach at the European Engineering Association in 2013, resulting in interest from Norway and Poland. Partnering with the Scenter group (private group which partnered with PBSRG to bring the BV effort into the Netherlands), the Dutch Best Value Procurement (BVP) book is being translated into both Norwegian and Polish languages, with the Polish book to be introduced to the Polish professional engineering group in March 2016.

Development of the Royal HaskoningDHV Best Value Effort

PBSRG had already researched how to transform a large organization to have the capability of providing the Best Value (Kashiwagi, 2015). The following approach and assumptions are mandated by a large bureaucratic organization:

1. There is no controlling any individuals in the company to change their conceptual thinking by management, direction or control (MDC) or influence.
2. To expect engineers to change was to increase the risk of failure.
3. Visionaries had to be identified by their affinity to the concepts of Best Value (BV) and Information Measurement Theory (IMT) which include logic, consistency, leadership characteristics and proactive motivation to make things better.
4. The group should start small.
5. Education is very important to identify more visionaries. However, after an initial push to educate, the education effort should be transformed into an implementation effort within the organization and marketing effort with clients.
6. People in the organization who do not understand BV are focused on amount of work (turnover and profit margin).
7. The BV core group will have to develop metrics that minimize decision making of the organization as soon as possible.
8. The BV group must have a mentor.

The following is a historical account of dates and activities of the development of the RHDHV Best Value effort led by the core team members (CTM): Elske Bosma (CTM1), Marcus van der Ven (CTM2) and Oscar Kerkhoven (CTM3) (E. Bosma, Personal Communication, December 9, 2015):

1. April 2012: Before the merger between Royal Haskoning and DHV, CTM1 starts a BVP network within DHV and at the same time CTM2 and CTM3 find each other in several Best Value efforts at Royal Haskoning.
2. June 2012: After the merger CTM1, CTM2, CTM3 and Fred Haarman meet. This was the start of the Best Value core team.
3. CTM2, as a project manager, uses BVP to improve performance of client construction projects. CTM3 combines an HR Business partner role with Best Value by facilitating and educating tender managers and key job-holders. CTM1 coordinates the internal network.
4. September 2013: The BV core team seeks contact with Dean Kashiwagi, the creator of Best Value. The BV core team also brings 2 colleagues of the higher management of RHDHV. Kashiwagi is very much interested in the BV effort of the core team.
5. December 2013: The BV core team presents their strategic plan to the executive board of RHDHV. The board approves the plan. A member of the executive board becomes the sponsor of the BV core team.
6. December 2013: As a HR business partner, CTM3 shares his insight with management about the explicit link between the Best Value Approach and the Royal HaskoningDHV strategy. CTM3 and CTM2 combine their effort to improve the Best Value tender success rate within the new company RHDHV.
7. January 2014: BV core team members CTM2 and CTM3 attend the BV Conference in Phoenix, Arizona.
8. May 2014: The BV core team invites Kashiwagi to the RHDHV's head office in Amersfoort. Over 100 employees of RHDHV attend his presentation and/or the workshops.
9. October 2014: CTM2 obtains the A+ certification (Highest BV certification).
10. October 2014: The BV core team organizes their first internal 2.5-day BV training for RHDHV project- and contract managers.
11. January 2015: The BV core team and 5 other colleagues attend the BV Conference in Phoenix, Arizona.
12. June 2015: Dean visits the RHDHV head office in Amersfoort. Approximately 80 persons of RHDHV attend his presentation and/or the workshops.
13. October 2015: CTM3 obtains the A+ certification based on an article about Best Value as a vehicle for organizational development and his effort within Royal HaskoningDHV in that field. Due to the success and positive metrics supporting RHDHV's BV effort, senior management is more and more convinced of the value of the BV approach and the way it aligns with the company strategy.
14. October 2015: CTM3 recruits 2 more persons to help develop the Best Value effort (One of the two is part of the upper management of RHDHV). Of the BV core team 6 persons of RHDHV will attend the Best Value Conference in Arizona in January 2016.
15. December 2015: With help of the others of the BV core team, CTM2 has educated over 60 colleagues (B- certification) in 2014/2015.

RHDHV Metrics

One of the objectives of the BV approach is to use metrics to minimize decision making inside and outside of the organization. The BV core team had the following objectives (Royal HaskoningDHV, 2015):

1. Show increased value of the core team activities.
2. Show that if the BV approach and the BV core team were utilized, the amount of work acquired and the success rate will increase. When the numbers become simple, policies will be set by the company that help the non-BV experts to utilize the BV core team.

Table 1 shows the core teams' metrics. Table 2 shows the metrics that minimize decision-making, and will lead to changing RHDHV policies. The RHDV core team also identified a BV expert who began to keep metrics on his own procurement projects (Table 3 and 4). PBSRG will continue to work with RHDHV and the engineering consulting professional groups in the Netherlands, Norway and Poland to assist the industry to transform itself into a Best Value industry. (Royal HaskoningDHV (2015) Best Value Performance Metrics. Unpublished raw data.)

Table 1

Royal HaskoningDHV Performance Metrics to Minimize Decision Making

Performance Criteria	2013-2015
# years BV core team	3+
# BV procurement as client PM	12
# BV tenders for engineering consultancy projects	24
# won	11 (46%)
# BV tenders in consortium for construction projects	13
# won	2 (15%)
# BV interview training key personnel	50+
# BV procurement educations	20+
# BV presentations	50+
# BV knowledge meetings	10+
# BV presentation for higher management	6
# A+ Certifications	2
# B+ Certifications	8

Table 2

Royal HaskoningDHV Performance Metrics

Performance Criteria	BV Support	No BV Support
# of Tenders	14	24
Tenders Won	6 (43%)	7 (29%)
Scored 1st or 2nd in PC Submittals	13 (93%)	14 (58%)
Risk Assessment Score	5.8	5.3
Value Added Score	6.2	6.1
Level of Expertise	7	5.8
Interview	7.4	6.5

Table 3

RHDHV Performance Metrics using BVA on Client Construction Projects (summary)

#	Performance Criteria	Results
1	**# BV projects as client PM**	10
2	**Scope in euro's**	42M
3	**% client satisfaction >8 (1-10)**	100%
4	**% running below client budget**	100%
5	**Average % below client budget**	-15%
6	**Average % cost deviation (contract value)**	3% (100% caused by client risk)
7	**% running on time**	70% (7/10) (2/3 caused by client risk)
8	**Average % schedule deviation**	6%
9	**Estimated cost efficiency**	20-30%

Table 4

Individuals Performance Metrics on Procure Company Projects

#	Project	Client Budget (euro)	Contract value (euro)	Progress	Cost Deviation	Time deviation	Estimated cost reduction contract management
1	Pumping Station Schore	2.60 M	2.40 M	100%	1%	0%	-50%
2	Pumping Station Schilthuis	0.69 M	0.68 M	95%	0%	20%	-20%
3	Ankie van Beek Ohrlaan	0.56 M	0.54 M	100%	2%	1%	-40%
4	Pumping Station Essenburgsingel	2.25 M	1.94 M	40%	0%	15%	-20%
5	TenSec 2.0	28.30 M	25.00 M	20%	2%	0%	-20%
6	INFRA1	5.40 M	4.90 M	20%	0%	1%	-30%
7	Sewage System Triangel	1.20 M	0.74 M	100%	20%	20%	-50%
8	Renovation 7 Pumping Stations	3.50 M	2.21 M	30%	0%	0%	-10%
9	Sewage System Westergouwe	1.12 M	0.90 M	40%	3%	0%	-20%
10	INFRA2	3.00 M	2.90 M	10%	0%	0%	-30%

Conclusion

The professional engineering organization in the Netherlands has been proliferating the Best Value Approach and the Information Measurement Theory (IMT) concepts. They have been successful in moving the technology into Norway and Poland. PBSRG has identified and is mentoring the second largest engineering firm in the Netherlands, Royal HaskoningDHV (RHDHV) into increasing its BV capability and utilizing metrics to minimize the decision making in their organization.

The following have been successfully achieved in this case study research which uses mixed methods to verify the changes:

1. Selected Royal HaskoningDHV as the large engineering service.
2. RHDHV selected a core team.

3. Core team educated their organization by explicitly placing BV in line with its company strategy, and using metrics to show their activity.
4. Core team refined their metrics to show their organization that the core team should be utilized to increase RHDHV's competitiveness on potential projects.
5. Identified a BV expert within the core team to compete for and run BV projects. The BV expert has been extremely successful.

The RHDHV organization has acquired BV capability. They have shown that a large engineering firm can gain the capability of the BV approach and change the paradigm of professional engineers. They will become more competitive and successful as they continue to change their paradigm. Their case study shows that a large organization whose traditional paradigm does not match the BV approach, has the capability to transform itself into the BV organization. Their success ensures that the Dutch BV effort will continue to be sustainable.

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A Procurement Method that Considers Innovation

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A challenge facing buyers in the delivery of innovative construction and facility services is to utilize expertise without increasing project risk. The traditional price-based Design-Bid-Build approach minimizes the utilization of expertise of expert construction vendors by using an owner driven specification. The non-traditional approaches such as design-build, construction management @ risk (CM@Risk), and integrated project delivery are more flexible but still have no methodology to minimize the risk caused by innovative practices. The Best Value Approach utilizing the Performance Information Procurement System (PIPS) and the Information Measurement Theory (IMT) has been tested for over 20 years with high customer satisfaction and performance. However, the use of past performance information still gave the perception of high risk when considering innovative concepts that have never been previously utilized. This research uses a case study of a hospital owner competing the risk of innovative systems with existing, proven systems. The research group had the opportunity to interject the Best Value Approach into the case study delivering the innovative service/equipment requirement, allowing them to see how the approach and created Best Value environment reacted to the expertise that uses innovation. The case study involves the delivery of cutting edge cancer technology, the proton cancer treatment equipment/system. Even though the delivered service is not standard construction, the delivery approach can be easily used in construction.

Keywords: Procurement, innovation, risk, Best Value, proton therapy

Introduction

One of the questions to the Best Value Approach has been, "Are those who have limited experience at a competitive disadvantage when using this approach?" This topic becomes more important when a buyer is moving from a price based environment where every effort is made to ensure that all bidders have exactly the same opportunity to win, to a Best Value Approach where those with expertise and experience have the competitive advantage. Performance Based Studies Research Group (PBSRG) has been searching for a potential case where the Best Value Approach can be used to identify and utilize the value of innovation or new technology.

Medical facilities in the Netherlands have begun to investigate proton therapy, a relatively new addition to a range of radiotherapy treatment modalities used to treat cancer. Currently in the Netherlands the use of proton therapy is regulated by a permit system. In February 2014, the Amsterdam Proton Therapy Center (APTC) was one of four Dutch initiatives to receive a permit to pursue Proton Therapy Treatment. APTC was founded by the Netherlands Cancer Institute (Antoni van Leeuwenhoek – AVL), the academic medical centers known as the VU University Medical Center (VUmc) and the Academic Medical Center (AMC). VUmc and AMC rank 15th and 44th in the field of medical sciences among 240 ranked European universities in the CWTS

Leiden Ranking 2014 (Amsterdam Proton Therapy Center, 2014b). Once a hospital receives a government permit, they still require funding for the construction of a new facility and proton therapy equipment as well as contracting of treatments by health care insurers. A key organization in this respect is Zorgverzekeraars Nederland (ZN), an association which all Dutch healthcare insurance companies are a member. ZN has publicly stated that they do not intend to contract with all permit holders, and that they are considering a tender to decide with which initiative to contract. In anticipation of this tender APTC predicts the cost and quality of the proton therapy equipment purchased by them, will play a pivotal role in determining if they are selected.

APTC like other hospitals is in need of cutting edge technology for the lowest cost in procuring cancer treatment equipment. Due to the rapid development of proton treatment procedures, the methods and technology used are constantly advancing and improving. Considering these conditions, APTC and similar hospitals are seeking to procure services that are innovative and upgradeable in order to remain cutting-edge and minimize the risk of their procured services losing their value over time (Proton therapy equipment costs several tens of millions of Euros).

The Oxford Dictionary of Economics refers to innovation as "The economic application of a new idea" (Black, 1997). Maranville adds by stating, "Innovation is an idea, product or technology which is perceived by the customers as new or having unique qualities," (1992). The Oslo Manual, published by the Organization for Economic Cooperation and Development (OECD), defines innovation to be the implementation of technologically new or significantly improved products or processes (2005). There are many definitions of innovation, however, similar characteristics include something new, such as a change, a better way of doing a service or action that leads to an increase in value. (Maranville, 1992; OECD, 2005; Black, 1997; Vargas-Hernandez, 2011; Townsend, 2013). Innovation is found to be very difficult as the service or product being delivered has no past performance because it is new to the industry (Edquist, Vonortas, Zabala-Ituuriagagoitia, & Edler, 2015). By definition innovation appears to carry more risk and unknown factors than procuring traditional services and products (Georghiou, Edler, Uyarra, & Yeow, 2014).

The current level that any industry has to procure innovation is still very basic in terms of standardized processes and structures. This was confirmed through a literature search performed by the authors, in which they were unable to find any defined procurement processes that had shown consensus from multiple participants in the industry to deliver innovation successfully. There are currently various theories and guidelines researchers have found through case studies (Aberg & Bengtson, 2015; Cepilovs, 2014; Dale-Clough, 2015). Industry research has also made an attempt to create procedures (Kautsch, Lichon & Whyles, 2015; Rolfstam, 2015; Yellow & Edler, 2012); however, none had shown sufficient information to prove the ability to repeatedly deliver high performance and successful innovation.

Problem

Current procurement systems do not have the ability to consistently buy the latest state-of-the-art innovation in proton treatment equipment, without increasing risk due to the two-year lead time

of construction, installation and rapid change in proton technology. A new approach will be identified, run and the results analyzed.

Proposed Solution

The APTC decided to use the BV approach to buying innovation. The BV system was selected for the following reasons:

1. The system is being heavily utilized in the Netherlands, and has shown to minimize risk by utilizing expertise.
2. The BV system has the ability to compare existing technology with future innovation that was still being developed.
3. The BV system has the ability to identify the requirement as the most state of the art equipment, without knowing what state of the art meant.
4. The BV system has the ability to minimize risk by utilizing the expertise of the vendors.
5. The process has the characteristic of minimizing the decision-making of the owner by forcing the expert vendors to show their expertise in a dominant way.
6. The BV system has the ability to compare the ability of the vendors to provide continual innovation to upgrade their installed system.
7. The BV system's use of metrics to minimize the risk of misunderstanding the proposed solution and minimize the decision making of the user/procurement team and the need to trust the vendor.
8. The BV system was determined to be the quickest and was recognized to require less expenses on the vendor's side.

Methodology

This is a case study which utilizes the action research approach. It requires an actual test, both from the client/buyer and the innovative vendors. The methodology will be to:

1. Identify a client who is attempting to procure innovation.
2. Ensure that the client had an innovative procurement agent.
3. Ensure that the stakeholders utilized BV experts.
4. Identify an innovative vendor and assist them in competing for the project.
5. Identify how the approach and process of the client allowed vendors to use innovation.
6. Identify how the vendor was innovative.
7. Identify the success of the innovative vendor.

Visionary Procurement Group/Organization

The procurement agent of APTC (Jorn Verwey), who was also the project manager, was a BV visionary. The procurement agent already believed many of the core Best Value concepts before he was introduced to the Best Value Approach (Amsterdam Proton Therapy Center, 2014b):

1. Observed that traditional approaches led to litigation, over specified parameters, long delays and strained relationships between client and vendor.
2. Understood APTC was not just looking for proton therapy equipment but the development and implementation of innovative treatment processes and strategies, while continuously reducing the cost differential of the photon therapy for patients.
3. Recognized the expertise of the vendor is a pivotal element into remaining state-of-the-art for the operational life time of the center.
4. Understood that expertise would lead to lower costs.
5. Understood the vendor's role as the expert in the project.
6. Recognized managing, directing and controlling the vendor through specifications was not optimal (Verwey, 2015).

In 2014, the procurement agent was introduced to the Best Value Approach and saw the potential value. In 2014 he attended the annual conference held by the creator of the Best Value Approach, Dr. Dean Kashiwagi and eventually received his B+ certification (understanding of the deductive logic of Information Measurement Theory (IMT) and the simplistic understanding of the Best Value Performance Information Procurement System (PIPS)). He then identified that the BV PIPS system could accomplish the following for the Amsterdam Proton Treatment Care (APTC) consortium:

1. Ensure that the APTC procured the state of the art proton treatment machine/system.
2. Deliver a vendor who would be motivated to deliver state of the art technology when it was delivered two years after being procured (the facility and delivery of the 50M Euro proton cancer treatment system takes two years to deliver).
3. Over the lifetime of the 50M Euro proton cancer care treatment machine, the system would be continually updated to be state of the art in a quickly evolving industry.

To be able to use the Best Value Approach he required approval by all three partnering procurement departments that were part of APTC. To convince the three procurement departments, the procurement visionary hired a PBSRG trained Best Value expert (Wim de Vries), who was one of only eight Best Value Experts that were A+ certified (Highest certification of Best Value from PBSRG) in the Netherlands. Wim had extensive experience in the Best Value Approach and became the focal point in answering questions and minimizing resistance from the other procurement agents and stakeholders. The BV expert was a critical piece of the ability to use such an innovative process. It became a requirement of the visionary procurement agent to have a BV expert as a part of the process. He also encouraged all competing vendors to utilize a BV expert. To ease concerns of the head of the department, who was providing procurement assistance to the project, an external legal advisor that had experience with the BV approach was also engaged. The BV visionary procurement agent understood that identifying and utilizing expertise was a change of paradigm from the traditional procurement approach. His expectation was that the approach would motivate all vendors to become visionary, to look ahead and use their expertise to identify what would be best for the client, and deliver services that are not managed, directed and controlled by the procurement agent or client.

APTC's Application of the Best Value Approach

Due to the different regulations placed on government procured services in the Netherlands, the Best Value Approach, the Performance Information Procurement System (PIPS) process was adjusted to conform to the Most Economically and Advantageous Tender (MEAT) process. Considering the slight changes made, APTC was able to follow the majority of steps from the BV PIPS process. The process remained as four phases (see figure 1) with each phase achieving the same requirements of the Best Value Approach (Kashiwagi, 2015).

Figure 1: Four Phases of the Process.

In the Preparation phase APTC's main actions included a webinar for education in two different time zones (USA and Asia), a competitive dialogue session with each vendor, and the finalization of the RFP. In creating the RFP for the scope of services the client experienced a few challenges (Verwey, 2015):

1. Users had a substantial amount of expertise on proton therapy equipment which made it difficult for them to release control to the vendors to utilize their expertise and identify the best value.
2. Client's stakeholders felt that although the vendor was the expert in the product, they were not expert in how to use the product.
3. The client's researchers and engineers found it difficult to completely refrain from adding any of their perceived technical requirements and solutions for the equipment.
4. Between the competing vendors there was a large difference in the range and field of expertise, which caused the client discomfort. The client's experts feared a vendor may not provide the features they felt to be essential to use the equipment as intended for the hospital's patients.

The procurement agent was able to keep the BV system in tact by avoiding the inclusion of minimal requirements and defining a series of aims for the vendors to accomplish with their solution. In addition to these aims additional information was provided as follows:

1. A number of 'basic requirements' reflecting the client's strategic thinking on how product use in the clinical environment. These basic requirements are to be seen as a product-selection criterion: if the vendor's solution does not provide a basic requirement then the vendor is excluded. An example is the need to be able to treat the patient from all directions (360-degree rotation). This 'basic requirement' is based on the clinical observation that this is essential for accurate treatments.
2. A definition, for each aim, of one or several 'sought performances'. This provides a map to the client's clinical use of the product. An example is the ability to 'operate the product remotely', as this is believed to increase productivity.
3. A limited list of parameters was given to the vendors to represent the client's requirements called 'What we think we want'. This set the expectation for certain key

performances which the client thought was relevant to meet their "perceived requirements." An example is the ability to treat a volume of 1 liter within 15 seconds, as this is the time a lung patient may still be able to hold his breath.

The Best Value (BV) approach applied used a multi-criteria selection process that considers the following criteria:

1. Performance Substantiation: Allows vendors to demonstrate that they understand the project and the aims and that it is going to achieve the latter.
2. Risk Assessment: Allows vendors to show capability to identify, manage and mitigate risks on behalf of the realisation of the project and aims.
3. Value Added: Allows vendors to show capability to maximize the opportunities that can add value to the project aims, over and above the tender scope.
4. Price Substantiation: Allows the vendor to make the cost structure transparent and clear and show expertise in engineering choices made in designing equipment as perceived relevant with respect to the project's aims.
5. Interview: Allows the vendors key project personnel to demonstrate that the vendor understands and can clearly and simply articulate that they can manage the project and is able to understand the aims.

Most Economic and Advantageous Tender (MEAT)

In the BV PIPS approach, the following steps are made to identify the BV vendor:

1. Each criteria is weighted (to show order of importance).
2. Each vendor's submittal is rated on the different criteria.
3. All criteria ratings are then normalized, multiplied by the weightings, and totalled up to identify the relative points for each vendor.
4. The vendor with the largest point total is identified as the Best Value.

The Dutch or Europeans commonly use a Most Economical and Advantageous Tender (MEAT) process which has been adapted for Best Value procurement (Rijt & Santema, 2011). MEAT uses a fictitious price instead of points. Instead of adding points, MEAT subtracts cost when the vendor adds value, and adds cost when the vendor does not add value in any of the criteria areas. When a vendor shows value in a criterion, the weighting and score work together to determine a value in terms of a fictitious price that lowers the vendor's actual price. It works in the following manner:

1. Each criterion is weighted (to show order of importance).
2. Each vendor's submittal is rated on the different criteria.
3. All criteria ratings are given a value. The allowed ratings for this project were 'poor', 'unsatisfactory', 'neutral', 'good' and 'excellent' (see Table 1). A 'poor' rating signified the document provided insufficient substantiation for the claim and the claims were insufficiently linked to the project's aims. An 'excellent' rating signified that the claims provided were both well substantiated and shown to be high performance in respect to the project aims. The ratings between 'poor' and 'excellent' are degrees of the two extremes

with 'neutral signifying the document provided substantiation for neither high or low performance in respect to the project aims.

4. An 'excellent' rating subtracts the total value from the fictitious price. A 'good' rating gives half of the value. Ratings under 'neutral' are negative values and increase the fictitious price.

In the MEAT process vendors are selected based upon this fictitious price (actual price minus credit due to performance shown in other performance factors). Therefore, all vendors are prioritized by their fictitious price and the vendor with the lowest fictitious price is selected as the Best Value vendor that will move into the clarification phase. The vendor's fictitious price is calculated as shown:

(Vendor price) - (Total addition credits for high ratings in selection criteria) = fictitious vendor price.

The rating system was on a scale that ranges from Poor, Unsatisfactory, Neutral, Good, and Excellent with an associated addition/subtraction to the vendor's submitted price (See Table 1). Meaning a vendor who scored "Excellent" on all of the selection criteria with a submitted price of 77 Million Euros (M EUR) would have a fictitious price of 25.6 M EUR (Amsterdam Proton Therapy Center, 2014a).

Table 1

Scoring Weights

BV Selection Criteria	**Poor**	**Unsatisfactory**	**Neutral**	**Good**	**Excellent**
Performance	+24 MEUR	+12 MEUR	0	-12 MEUR	-24 MEUR
Risk	+12 MEUR	+6 MEUR	0	-6 MEUR	-12 MEUR
Value Add	+12 MEUR	+6 MEUR	0	-6 MEUR	-12 MEUR
Price	+3.4 MEUR	+1.7 MEUR	0	-1.7 MEUR	-3.4 MEUR
Interview	The interviews were not scored, but they provide a basis for confirming the scores on of the other four criteria, whether adjusted upwards or downwards.				

Clarification Phase

After the selection is made, one vendor will proceed into the clarification phase. In the clarification phase the selected vendor will be responsible to clarify their proposed scope of services. This clarification includes (Kashiwagi, 2014):

1. A detailed and milestone schedule associated with cost and performance metrics.
2. A list of all foreseen risk with a risk mitigation plan.
3. A detailed scope of services (including what is in and out of scope).
4. Weekly Risk Report (WRR).
5. Performance metrics.

If the selected vendor is unable to fulfill the client's expectations and requirements of the scope of services, the next prioritized vendor will be invited into the clarification phase until a vendor

and their plan is found that is suitable to the client. The contractors plan with the client's requirements and required contract terms becomes the contract. After the clarification phase, the contract is awarded and the vendor will move into the execution phase to deliver the project according to the contractor's accepted plan.

It is important to note that the clarification period is a complete change of paradigm. It uses the following concepts:

1. The client is the biggest source of risk. Once the expert vendor identifies their plan, any deviations to the plan that are clearly identified in the proposed plan, are paid by the client. By utilizing their expertise, the client becomes accountable and mitigates the largest source of risk, themselves.
2. Experts should have a very clear, simple plan that is supported by a detailed plan. The plan identifies the largest potential areas of risk (expert vendor does not control).
3. The client should never make decisions, manage, direct or control the vendor on what should be done during this time. Once this is done, the client assumes all risk, if the vendor just follows their directions.
4. The vendor also exposes themselves to their biggest risk by listening to decisions and MDC from the client. Once they do this, they are in a relationship with their largest source of risk. They will not know it, until they get into a risk in the execution phase.
5. When the vendor plans together with the client, they basically give up all their BV rights and transparency that will make them successful.

The clarification phase is a change of paradigm. Simply, it is the setting up of transparency without relationships. This is the greatest mistake that has been made, and will be made in the future in the BV approach.

Identification of an Innovative Vendor

This was the first time any of the competing vendors with proton cancer care equipment had exposure to the Best Value Approach. In the first educational webinar for the project, there were nine participants, of which only three proceeded to compete for the project. Of the three, two were well known companies within the industry that had already sold their equipment to multiple hospitals. Based upon their machine's history one was perceived to be the cost leader in the industry, while the other vendor was perceived as the industry's quality leader. The third competing vendor was a new company that had not yet built, tested or installed their complete system.

This company, ProNova Solutions, approached Dr. Kashiwagi (creator of the Best Value Approach, world-wide expert in using metrics and simplification) for assistance in their attempt to win the award. ProNova Solutions claimed to Dr. Kashiwagi that even though their equipment/systems has not been tested, installed or used, in two years it would be state of the art. After educating and working with the vendor's core team for an entire day, Dr. Kashiwagi, with the assumption that everything he was told was accurate, identified this company as an innovator due to the following observations:

1. The vendor has the capability to implement new equipment and technology to enhance their proton cancer treatment equipment more quickly and continuously.
2. This new equipment and technology substantially increased value and decreased costs of their two competitors.
3. The equipment was easier to use, faster and more accurate, resulting in the capability to treat more patients in the same duration.
4. The equipment was smaller and more easily modifiable.
5. Among the three vendors they differentiated themselves by being research oriented. They were the only one with their own clinical practices and direct access to doctors and patients, with the capability to continuously improve and test their equipment and systems.
6. They were involved in ongoing research efforts to change equipment to be "state of the art."

Due to the indications of a high performing innovator, Isaac Kashiwagi, with assistance from Dr. Dean Kashiwagi, agreed to assist the vendor through the BV selection phase. During the next three months, (9 phone calls and 26 hours) Isaac Kashiwagi educated their project team and assisted in the creation of the submittal documents for the competitive dialogue, the selection phase, and the interviews. The main support was by assisting the vendor:

1. To translate their technical performance metrics into simple metrics that required no technical expertise or thinking to understand.
2. Provide meaningful metrics that identified the performance of their equipment.
3. Understand the vendor's competitive strengths and unique value to the client's requirements beyond providing them their equipment.
4. Prove to the client there is minimal risk in selecting them, even though their equipment has not yet been operationally installed nor tested.

The case study test was to identify if the Best Value (BV) approach was capable of identifying and considering the value of innovation. After identifying that the APTC was utilizing the BV approach to identify a vendor who not only provided the Best Value proton device, but also to identify a vendor who could ensure the greatest opportunity to enhance the delivered proton treatment system, PBSRG wanted to observe the reaction of the system to innovation. The optimal case study would be to maximize the capability of an innovative vendor to show innovation. PBSRG decided to participate in the case study to ensure that the amount of innovation was maximized in the case study test.
PBSRG had the opportunity to maximize the amount of innovation in the test by:

1. Supporting the vendor who did not have an existing proton cancer treatment system.
2. Supporting the vendor who had to compete with a system that did not exist.
3. Help a vendor to use metrics to describe a system as if it existed.
4. Assist a vendor to compete at a future time.
5. Assist a vendor to minimize the perception of risk of not delivering the proton system even though the proton system did not exist, and has not been implemented or used before.

If the vendor does well in the competition, it shows that the BV approach has the capability to identify and utilize expertise and innovation in the case study test.

Success of the Innovative Vendor

This innovative vendor was able to show that they were the Best Value option and were able to overcome their initial challenges by showing that they had minimal risk, provided the highest performing equipment and were able to provide the top performance in research and future innovation. This was accomplished by the use of simple, non-technical metrics and dominant facts (Pro Nova, 2015). The vendor addressed risk, was the best value, had the highest quality, and ability to be the best at being a research group and innovator.

The first step was to show that risk of not delivering would be mitigated. Even though the equipment had not yet been installed in a location, the vendor was able to minimize risk to the client by:

1. Showing all major components of their equipment were developed and tested with the only remaining part to be the integration and installation of the entire system.
2. Showing expertise and capability to integrate system components.
3. Showing that a leading research center in oncology (Oxford University) had already procured the ProNova Solutions equipment.

The vendor is able to reduce the cost of the facility (not even considered by others) that the proton system would be placed in due to a much smaller size and footprint. Due to the vendor's innovative technology and ability to decrease the size of their equipment, the vendor was able to reduce the cost of construction of their facility by an expected 23-42% (range based on the known treatment room sizes of competing vendors). Compared to their competitors which included a cost leader and the other being the quality leader their facility was estimated at €3.7M - €8.2M Euros less expensive based on known costs of making a smaller size facility (reduced volume of concrete).

The vendor has innovated in different areas of the proton system, including four main components:

1. Cyclotron and beam line, which accelerates and creates the proton beam.
2. Energy Selection System, which determines where the protons will be directed.
3. Integrated imaging system.
4. Gantry, including superconducting magnet technology: gantry is used to direct proton beam at patient under desired angle.

Through the submittals in the Best Value process, the vendor was able to show the increased value their innovation had brought in non-technical terms using simple metrics and dominant facts. Their superconducting magnet technology improved their proposed cyclotron and beam line which:

1. Decreased weight of the gantry to 25 tons. Competing models were estimated at 220 tons and 110.
2. Decreased overall individual vault size to 89 m^2. Competing models are estimated at 118 m^2 and 150m^2.
3. Cost savings on vault construction can range from 24% to 42%. Estimated between €3,651,671 and €8,184,971.

The Energy Selection System was improved due to an independent energy selection system/kicker magnet which:

1. Decreased room-switching time to less than 1 millisecond. Competing models are estimated at 15 and 30 seconds.
2. Enables an improved multi-room workflow.
3. 11 leading physicians and physicists from 8 different proton therapy centers with over 150 combined years' experience were surveyed about the impact having near instantaneous room switching would have on workflow and clinical care. Results show Physicians perceive a 95% increase in value in having this feature versus the industry standard room switch times.

PET/CBCT Scanner and imaging processes were improved. Traditionally these two are separate locations; however, the vendor has integrated both into one piece of equipment which:

1. Allows imaging patient in any treatment position and any gantry position without moving the patient. Can image 5 times faster than traditional gantry based systems.
2. Improves accuracy of treatment by reducing uncertainties and improves workflow efficiency making protons similar to photons.
3. 11 leading physicians and physicists from 8 different proton therapy centers with over 150 combined years' experience were surveyed about the impact having a bed-mounted CBCT that image at isocenter in 100% of bed positions would have on workflow and clinical care. Results indicate that physicians perceive an 80% increase in value in having this feature versus industry standard CBCT imaging capability.
4. These clinicians were also surveyed on the impact of having the ability to evaluate density with CBCT would have on clinical care. Similarly, results indicate that physicians perceive an 80% improvement in their ability to reduce treatment uncertainty.

Overall clinical performance (treatment of patient) was improved due to Beryllium degrader and achromatic magnets design which:

1. Decreased layer switching time to .5 seconds. Competing models are estimated to take 1 to 4 seconds.
2. Reduces treatment times by 1-3 minutes.
3. Increases # of patients treated by 1-3 per day.
4. 11 leading physicians and physicists from 8 different proton therapy centers with over 150 combined years' experience were surveyed about the benefits of having layer switch times that are 2 to 8 times faster than competitors. Results indicate physicians perceive an 85% increase in value versus industry standard layer switch times.

The vendor was identifying their proposal as delivering and optimizing cancer treatment care by continual research and development. In addition to the quality of the vendor's equipment, they were able to show their value in being innovative and state of the art. The vendor was not simply a manufacturer of proton therapy equipment but at their core they are a research group that could provide a partnership with APTC in developing and improving their Proton Therapy Center. The vendor is constantly innovating and optimizing cancer treatment tool/practice by verifiably integrating advanced technologies faster than any competitor. With their current equipment within the last three years the vendor has integrated the following innovative technology into their equipment:

1. Gantry including superconducting magnet technology, developed internally by the vendor in 3 years. A competing model has taken 5 years and is still not fully developed.
2. Independent energy selection system/kicker magnet and beryllium degrader and achromatic magnet design (in nozzle) was licensed from Indiana University and incorporated into the machine within a 3-year timeframe.
3. Integrated PET/CBCT scanner and imaging, PET was developed by the vendor and CBCT was acquired at the University of Salzburg technology. The vendor has signed agreement to allow distribution of technology solely to Vendor and 5 individual facilities. The vendor was able to incorporate into machine in 1 year.

The vendor's staff has built and owns their own proton treatment center:

1. The vendor currently uses their competitor's equipment in its own operational treatment center. They plan on using their own equipment in July 2016.
2. Compared to its predecessors, the vendor's proton center has treated 32% more patients in the first year, demonstrating expertise in the important initial 'ramp up' phase of the proton therapy facility.
3. Overall patient satisfaction score is 98%.
4. Using 19 active and pending clinical trials focused on advancing clinical care and improving outcomes.
5. The vendor's clinical team has clinically commissioned and opened a combined 7 proton therapy centers.
6. The vendor will also provide a partnership to a network of their own and other proton therapy research clinics and hospitals they are doing joint research with. For example, an external partner (Oxford University) is planning to utilize vendor's technology to create future state of the art technology and in doing research focused on imaging based innovation and adaptive therapy. Research will begin in 2017 upon completion of vendor's system commissioning. Oxford is recognized for their world leading position in medical sciences research. Recently recognized as a part of the Research Excellence Framework 2014, as Britain's top research University for their top quality and producing the largest volume of world leading and internationally excellent research.

Selection Matrix of Vendor's Submittals

On May 19th 2015 Pro Nova was identified as the Best Value vendor that would move on to the next phase, clarification. The scores Vendor received are shown in Table 2. The vendor was able to score Excellent on two of the four rated criteria (APTC, 2015).

Table 2

Vendor Scores

Vendor	A	ProNova	C
Vendor Price	LOW	HIGH	MED
Substantiation of Performance	Neutral	Excellent	Neutral
Risk Assessment	Neutral	Neutral	Unsatisfactory
Value Added	Neutral	Excellent	Unsatisfactory
Price Substantiation	Neutral	Neutral	Unsatisfactory
Total addition of documents	€ 0	-€ 36,000,000	€ 13,700,000
Prioritization	2	1	3

The visionary procurement agent who headed the entire venture, who had to overcome the naysayers and resistant of the client's experts identified in the beginning that no vendor would get excellent ratings (J. Verwey, personal communication, October 10, 2015). The winning proposal (supported by PBSRG) which had the most innovation, which quantified their innovation capability by using simple metrics that showed dominant value, received two excellent ratings and made the cost a non-issue. The BV system was capable of identifying and utilizing expertise to select the most innovative vendor, overriding the fact that the other two vendors had proposals that were cheaper and less risk when responding to more traditional minimum requirements of providing the equipment.

Conclusion

The case study test shows that the Best Value Approach can identify and utilize innovation. A vendor can compete using innovation in the Best Value (BV) approach. By the results of the procurement it is proposed that:

1. BV process can procure innovation in comparison with traditional solutions.
2. Innovative vendors can be successful when the Best Value process is used to buy innovation.
3. Innovative vendors may have the competitive advantage when the Best Value process is run.

The Amsterdam Proton Therapy Center (APTC) has now selected the Best Value vendor and is seeking approval from their governing boards. This research effort will continually follow the delivery of the technology and the performance of the BV vendor and client. It will also document the performance of the BV process in execution.

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Changes Required to Sustain a Best Value Environment

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The BV environment was introduced into the Netherlands in 2004. By 2008 testing was being done by a partnership between Arizona State University and Scenter (private entity led by Sicco Santema). In 2010, the $1B fast track projects were procured by the Rijkswaterstaat, using the Best Value Procurement. By 2015, instead of the BV approach being treated as just another option, NEVI, the Dutch professional procurement group (third largest procurement group in the world) designated the Best Value Procurement as one of the main stream procurement approaches, and hired a full time Director to guide their Best Value Procurement training programs. However, in three major areas: IT delivery, professional services and the medical arena, buyers and larger-traditional vendors were having difficulty adapting to the approach. The BV approach utilizes the expertise of experts to replace the need for owner management, direction and control (MDC). However, a stumbling block occurred, when a "Best Value" vendor was selected, but did not have their detailed plan as a baseline from which they could identify risk that was outside of their control, their risk mitigation plan, and a simple way to create transparency to help the client/user. This is a case study that shows how the Best Value Approach was requiring a paradigm shift with both the user and the vendor, which neither party was well-prepared for.

Keywords: Best Value, transparency, Netherlands, risk management, Rijkswaterstaat

Introduction

In the early 2000s, the Netherland construction industry was beset by a large scale case of vendor/contractor collusion (Doree, 2004). Several Dutch construction visionaries had heard the industry structure explanation from the Performance Based Studies Research Group (PBSRG, Arizona State University), and realized that the cause of the collusion was not the vendors' criminal/malicious intent but the minimization of the contractor's profit margins to an extent that threatened their sustainability. PBSRG used the Construction Industry Structure (CIS) model (Figure 1) to identify that low performance, non-transparency and collusion was the result of the owner's use of management, direction and control (MDC) to minimize the risk of non-performance. It was a form of micromanagement of the supply chain that increased the number of managers and decreased the number of expert contractors. It created an environment of MDC which increased project time and cost deviations and minimized vendor profits.

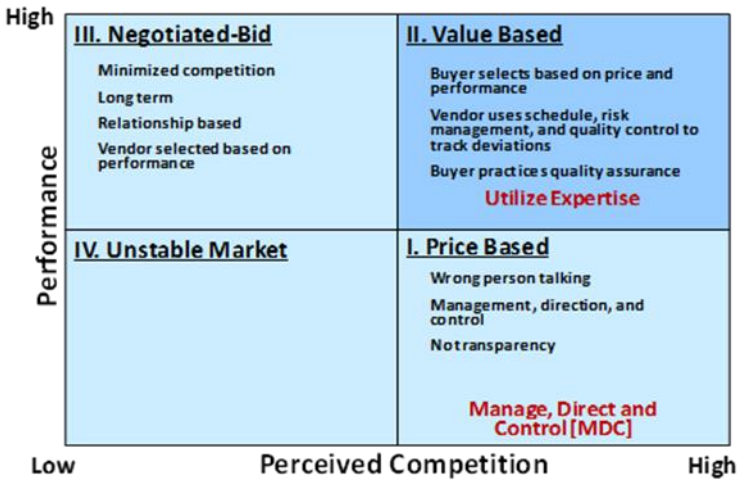

Figure 1: Construction Industry Structure (CIS) model.

In 1991, as a dissertation at Arizona State University introduced a performance based procurement system (Kashiwagi & Badger, 1991), which has since been renamed to the Performance Information Procurement System (PIPS) to differentiate it from the other performance based procurement systems that were being used (Goodridge, D. Kashiwagi, Sullivan & J. Kashiwagi, 2007). PIPS was different because of the following characteristics (Kashiwagi, 2011; Kashiwagi, 2014b):

1. It used no management, direction, and control (MDC).
2. It replaced MDC with the utilization of expertise.
3. It identified that the experts had no technical risks.
4. It defined that the only risk that experts had was the risk that they did not control.
5. The PIPS structure forced experts to create transparency to minimize the risk that they did not control.
6. It proposed that experts, who knew what they were doing, minimized project cost, and increased vendors' profit.

The Best Value Approach utilizing PIPS had three phases:

1. Selection phase.
2. Clarification phase (also called pre-award phase).
3. Execution phase.

In 2008, small procurement tests were run by Scenter, using the Best Value Approach (D. Kashiwagi & J. Kashiwagi, 2011; Koreman, 2011; Van de Rijt, Hompes & Santema, 2010) (licensed from ASU). In 2010, the first large scale test, the $1B Rijkswaterstaat "fast track" projects to widen the major roads in central Netherlands, was ran using the Best Value Approach. The BV approach was used simply because there was no way to deliver the required construction using the traditional approach in the directed 3 to 5 years (traditional Rijkswaterstaat delivery would take 12 years). At that time, the Dutch called it Best Value Procurement, or BVP, due to the name of the ASU technology called the Performance

Information Procurement System or PIPS. The results included (PBSRG, 2013; Van de Rijt & Santema, 2012; Van de Rijt, Witteveen, Vis & Santema, 2011):

1. 15 out of 16 projects were completed within three years instead of the projected 10 projects.
2. Procurement costs and transactions of the owner and the contractors was reduced by 50%.
3. The construction time on the projects was reduced by 25%.
4. It was confirmed that 90% of all cost and time deviations were caused by the owner.

The positive results led to the following:

1. NEVI, the Dutch professional procurement group, licensed the Best Value (BV) Performance Information Procurement System (PIPS) technology from Arizona State University (ASU) and started educating and certifying procurement personnel and consultants.
2. The procurement personnel focused on the selection phase or procurement part of the process. The pre-award or clarification phase was not perceived as important (even though it was highly emphasized by the founder Dr. Dean Kashiwagi).

Best Value Procurement (BVP) became a "buzzword" in the Dutch procurement. Various authors have published numerous Best Value books in the Netherlands, and the books are now being translated into the native languages of the Norwegians and the Polish people. The interest in becoming certified with a BV PIPS A+ certification and an A certification has increased. The number of Dutch experts who have attended the annual Best Value Certification Conference in Tempe, Arizona, has tripled over the last five years (Kashiwagi Solution Model, 2015). However, there are a few challenges faced by the Best Value movement. The Dutch are a consensus people and traditionally have a strong tendency towards the "trust" model. They first utilized the BVP as a selection/procurement model, and trusted the identified Best Value vendor to perform (by observation because the clarification period was not done or done improperly). Only after two or three years, did the Dutch begin to understand that the BV approach was not a trust model. The next big challenge was that the visionaries who first championed and tested BVP were procurement personnel. They did not realize that even if they eliminated MDC from the procurement role, MDC was the traditional project management model. They also did not realize that if procurement was to be successful with the BV approach, they would have to redefine the role of the procurement personnel and their function and also change the paradigm of the project manager who represented the client/owner. From hindsight, it seems very simple and clear. The Dutch would have to change:

1. Their culture of consensus, trust and assumption that everyone is an expert.
2. Minimize the decision making that procurement personnel had done for the owner for years.
3. Change the procurement function to be accountable for a procured service until final delivery.
4. Change the "silo-based" organization who passed the product "over the wall" to a transparent, efficient and effective supply chain.

5. Change the project management model from MDC to identification and utilization of expertise.

Trust-Based Model

The Dutch BV implementers were identifying expertise in the selection phase and then used a "trust" based approach in the execution phase. However, the BV approach does not utilize trust. Instead, it encourages owners/buyers of services to "not trust" the vendors. The BV approach uses a series of selection filters to identify a potential Best Value vendor, which is followed by a clarification or pre-award phase to ensure the identification and utilization of expertise. The Dutch implementers were attempting to utilize the expertise of the vendors using a "trust" model without executing the clarification phase to create transparency to mitigate risk. Most of the early implementers did not run the clarification phase due to their focus on selection and their trust of the selected vendor.

Client/Owner Decision Making

The greatest risk to the Best Value Approach is that for many years the client/owner was managing, directing, and controlling the vendors (MDC). This resulted in the vendors being:

1. More reactive.
2. Not utilizing their expertise.
3. Being silo based (acting in a win-lose, position of leverage, using the contract to control the vendor).
4. Larger vendors were already very bureaucratic. A bureaucratic client with the same bureaucracy created a non-transparent, lose-lose, reactive, relationship based environment, which the larger vendors felt very comfortable with.

After many years of the vendors experiencing the owner's price based traditional MDC environment, the biggest risk became:

1. Vendors not changing and acting in a reactive, bureaucratic approach.
2. Vendors not being able to identify and utilize their own expertise in their organization.
3. Vendors not understanding the level of expertise required to do a project.
4. Vendors who were not experts attempting to respond to clients/owners requirements as experts.

The Best Value Approach became one where the clients decided who was the best vendor, instead of the best vendor creating transparency by showing their higher level of expertise with performance metrics and lower costs. This was a huge challenge for the Dutch BV groups who did not understand the theoretical impact of decision-making and trust. The decision makers did not realize that once they decided who the Best Value was based on their own technical understanding and decision making (and not dominant performance metrics provided by the vendors), that the liability and accountability of the vendor was minimized. This increased the risk of the projects to the owner.

Problem Facing Procurement Personnel

When the BV approach was first utilized in 2008, the approach was called Best Value Procurement by the Dutch. It was utilized by procurement personnel to select the Best Value contractor (Koster-Robard, 2012; Plehn, 2011; Van der Heijden & Van de Rijt, 2011; Van Abeelen, 2012; Van Hes, 2013; Van Hulzen, 2011; Van Veenendaal & Witteveen, 2011). After selecting the Best Value vendor, procurement then turned the awarded vendor to the user's project management personnel to manage, direct, and control. The procurement personnel were in a silo, and the project management personnel were in their own silo. Both silos were making decisions and managing, directing and controlling (MDC). In many instances, the Best Value vendor reverted to the traditional reactive behavior. The visionary procurement personnel realized that if BV was to work, the traditional procurement model would have to be changed. The procurement personnel would not only be responsible for selection but also for the clarification period and the weekly risk report that tracked a project to completion. This was not easy to do because it changed the job description and responsibility of the procurement personnel. It requires a structural organizational change, and a change in responsibilities.

Project Management Model of MDC

The Dutch BV experts (procurement personnel) faced the following challenges:

1. The procurement and project management personnel are in silos.
2. The project management personnel who deliver the project and manage the delivery of the project both use a management, direction, and control (MDC) model.

The procurement personnel using Best Value Approach identifies expertise and experience using decision making and trust, then turned over the Best Value vendor to the project management group. The Best Value Approach has a structural safety catch, the clarification phase that forces the expert vendor to (Kashiwagi, 2014b):

1. Have a detailed schedule from beginning to end.
2. Simplify technical detailed schedule into a milestone schedule so that all other stakeholders can understand the project deliverables without technical expertise.
3. Have a milestone schedule integrated with a cost schedule.
4. Have milestones described by metrics that everyone could understand.
5. Ensure milestones represent the project deliverables that everyone has understood and can understand.

The clarification phase uses characteristics of experts that make it difficult for a non-expert to successfully achieve. Experts are defined by the following (Kashiwagi, 2014b):

1. Clearly identify the required deliverable in terms of metrics.
2. Identify it in terms that non-expert stakeholders can understand.
3. Work from the end deliverable to the beginning in terms of time, resources, and cost.
4. Have no technical risk.

5. They identify risk that they do not control, and mitigate the risk through transparency (simplifying the complexity so all stakeholders can see into the future and do not cause risk).
6. Experts think less, make very few decisions, and can see a project before they do it.

The clarification period is run with the procurement personnel because the results of the clarification period become a major component of the contract that is signed between the owner and the Best Value vendor. The project management personnel also participate in the clarification period because they are the owner's representative in accepting the deliverable from the Best Value expert. If the clarification period is run correctly, it integrates the owner's procurement and the project management personnel, breaking down the silos, utilizes the expertise of the Best Value vendor, minimizes decision making due to the transparency provided by the expert vendor's complete plan that includes the roles of not only the vendor but also of all stakeholders that will participate in the delivery. The clarification phase is the most critical component in ensuring that expertise is utilized to minimize project cost and maximize project value and performance.

Evolution of the Understanding of the Best Value Approach in the Netherlands

The Best Value Approach went through an evolution in the Netherlands (D. Kashiwagi & J. Kashiwagi, 2011; Van de Rijt & Santema, 2012; Kashiwagi, 2014b):

1. First, the Best Value Procurement.
2. Second, the Best Value Approach with the clarification phase.
3. Third, using the Best Value Approach utilizing metrics.
4. Lastly, the owners and vendors learning how to utilize expertise in their own and in other organizations.

The evolution of the Best Value Approach is currently changing the procurement model and the procurement function, from the selection of Best Value vendor and then tossing the vendor to project management, to the responsibility of ensuring that the Best Value vendor is capable of and delivering the Best Value deliverable that they were contracted to deliver. The Best Value expert is using the clarification period and a weekly risk report that tracks the milestone schedule to create transparency so that project management can assist in the vendor being successful. The need to trust is minimized due to the transparency, which clearly identifies roles and accountability. The evolution has taken eight years to change the paradigm, roles, and utilizing expertise to create the transparency needed.

Case Study of Hanze University of Applied Sciences

Founded in 1798, the Hanze University of Applied Sciences (Hanze UAS) in Groningen is the oldest university of applied sciences in the Netherlands. With a student population of over 26,000 and approximately 3,000 staff members, it is the largest university of applied sciences north of the Netherlands. The name Hanze UAS relates to a once driving force in terms of business and trade. The Hanze UAS is respected internationally as a knowledge institute in

which applied research and innovation are integrated in the academic curricula of the institution (Bos, 2012).

The main focus of Hanze UAS is to contribute to the large scale, interdisciplinary programs of Healthy Aging and Energy. Hanze UAS aligns the educational process and research with these two focus points. Some facts & figures about Hanze University of Applied Sciences, Groningen include (Hanze University of Applied Sciences, 2012):

1. Largest university in northern Netherlands with 26,566 students
2. 5 centers of applied research and innovation
3. 2 centers of expertise
4. More than 50 professorships, 70 degree programs and 17 master programs
5. 3,113 employees

Hanze UAS was first introduced to the BV approach in 2011. With the help of BV expert, Sjoerd Posthuma from Scenter, Hanze UAS was able to implement three projects. At the beginning of 2012, Hanze UAS decided their internal knowledge was sufficient to begin self-implementation (Bos, 2012). Since 2011 the university has awarded 7 BV proposals in both services and implementation projects totaling to more than 16 M Euros (Hanze University of Applied Sciences, 2015).

One of the first of these projects at Hanze UAS was a multi-functional printing service, which showed positive results including (See Table 1 and 2):

1. Less than 1% deviation in costs for a 1.4M Euro contract.
2. 0% deviation to schedule (includes implementation).
3. Performance metrics on quality measured and tracked by vendor.

Table 1

Multi-functional printing service performance metrics

Performance Criteria	**Results**
Start date contract	9/1/2012
Initial budget of project	€ 1,399,010
Initial Contract duration (days)	2555
Current Duration of Implementation (Days)	1125
Euros over budget	€ 9,653
% Deviation in cost	0.69%
% due to client	0.15%
% due to supplier	0.17%
% due to other	0.37%
% Deviation in schedule	0.00%

Table 2

Multi-functional printing service quality metrics

Project Performance	**2014**	**2015**
# of Hanze UAS personnel Surveyed	2500	1239
Overall Score	7.4/10	6.8/10
Quality of Equipment	7.6/10	7.54/10
Availability	7.6/10	7.32/10
Maintenance and function	6.8/10	6.4/10

Due to the previous success with Best Value, in 2012 the Hanze UAS decided to use the Best Value Approach on an IT project procuring an integrated telephone services. Unlike the printing services project, the telephone services project ran into many difficulties due to the mindset of using Best Value solely as a procurement tool.

The project was selected due to the need for a unified communications platform at Hanze UAS. The UAS wanted to unify voice and video calls, simplify web conferences, and make it easy to switch between different forms of communications. The goals for the Telephone services were:

1. Increase the customer satisfaction of users of the telephony services.
2. Realize an optimal accessibility of the organization, departments and individual users.
3. Unburden the organization Hanze UAS in non-core service activities.
4. Optimize and manage the direct and indirect costs.

Of the 27 parties, which showed interest in the project, only three turned in submittals. Of the three, Vendor A was identified as the prioritized Best Value vendor due to the fact that:

1. Vendor A had received higher scores than the competitors in 2 of the 4 selection criteria (Project Scope and Interviews), while scoring the same on the other two selection criteria (Risk Assessment/Vale Added and Planning).
2. Vendor A was one of the two vendors whose price was below the maximum budget, additionally their price was competitive.

Vendor A moved on to the clarification period in February 2013. During this time, the vendor showed multiple indicators that they could not perform all the requirements of the clarification phase (A. Bos, personal communication, March 1, 2015):

1. Award date was postponed twice. Finally, completion of clarification phase was 90 days after clarification kick-off meeting.
2. The vendor's key personnel were changed during this time.
3. Problems in the approach of the vendor were identified and not clearly resolved.
4. The client realized that the vendor had never performed the proposed approach or scope before.
5. Vendor A was unable to create a simple schedule and performance metrics for client personnel.

Despite the vendor's inability to fulfill all the clarification phase deliverables the client made the decision to proceed trusting in the vendor's expertise. By the end of 2014 during the execution of the project, the client realized that the vendor would not be able to meet the client's expectations of higher performance of an integrated communication system. Due to the incomplete clarification period which was done, the user experienced issues and increased risk throughout the execution of the project including incidents such as (A. Bos, personal communication, March 1, 2015):

1. On June 25, 2013, the interdepartmental meeting of facilities shared their worries about the organizational impact of the implementation. It is not clear to client facility stakeholders what the implementation program was and how it worked.
2. On July 3rd, 2013 the Board of Directors of Hanze UAS determined the implementation plan was not clear. Vendor A asked to work out a detailed plan which is presented on August 12th, 2013.
3. On May 2014, the implementation was initiated with accessibility of users less than before, major technical issues which result in no accessibility and increased complaints by users to 769 incidents within a period.
4. On November 2014, a survey of personnel of the Hanze UAS showed that employees were not satisfied (Table 3). Of 292 responses 60% rate Lync lower than a six (scale of 2-10), 63% totally do not agree that the attainability has improved, and 55% do not agree that their colleagues are better attainable.
5. On November 24, 2014, the Board of Directors of Hanze UAS decided to dismiss Vendor A from their expert role, but continued to use them as a supporting vendor with Hanze UAS personnel to take the lead in project implementation.
6. On January 30, 2015, it is concluded that the vendor's weekly reporting system does not have any meaning and there was a need for the client to identify a clear plan on how to finish the project.

With the project still incomplete, it resulted in the client taking on the role as the project lead and incurring increased costs and delay to the project (see Table 3 and 4).

Table 3

Telephone Services

Criteria	**Result**
Initial duration of project (implementation)	133 days
Initial budget of project	€ 4,356K
Contract duration	4 years
% Deviation in schedule	91.86%
% due to client	42%
% due to supplier	42%
% due to other	8%
% Deviation in cost	11.63%
% due to client	11.63%
% due to supplier	0%
% due to other	0%
(Hanze University of Applied Sciences, 2015).	

Table 4

Telephone Services Quality Metrics

Project Performance	**11/1/2014**	**Q2 2015**
# of Hanze UAS personnel Surveyed	292	357
Rates services with < 6	60%	-
Totally do not agree that the attainability has improved	63%	-
Totally do not agree that their colleagues are better attainable.	55%	-
# of key personnel of supplier replaced	3	-
# of mobile (smart) phones that are not used	800	-
Overall Customer Satisfaction survey Q2	-	5.6 / 10
(Hanze University of Applied Sciences, 2015).		

In reviewing the Best Value Approach of Hanze UAS on the integrated telephone project with the Best Value Approach of the procurement professionals of the Netherlands, there seems to be parallels. In learning the Best Value Approach, both the Dutch overall effort and Hanze UAS learned the following lessons concerning the clarification phase (D. Kashiwagi & J. Kashiwagi, 2011; Van de Rijt & Santema, 2012; Kashiwagi, 2014b):

1. Ensure vendor's expertise and ability to do the project instead of trusting the expertise of the vendor.
2. Verify vendor's expertise by the clarification phase deliverables (detailed schedule, performance metrics, simplified milestone schedule, defined deliverables, etc.)

3. Paradigm shift required on both the client and vendor side.

Due to this project, Hanze UAS saw the importance and evolved to use Best Value as more than just a procurement approach but a way to utilize expertise through the clarification phase and use of metrics. The vendor also learned that they had to change their paradigm to perform in the Best Value environment. The authors have since met with the vendors marketing and project management personnel, and they have realized the need to identify and utilize expertise is key in their company's BV efforts. Hanze UAS also realize that the BV effort can be controlled from the vendor side if the project management and marketing personnel are made available. Hanze UAS effort has been surprisingly successful. By taking the lessons learned from the telephone services project and implementing this shift in paradigm to the rest of their projects, the results have been dominant (Hanze University of Applied Sciences, 2015):

1. 7 outsourced projects/services
2. Over 12.3M Euros awarded with 1.51% deviation in costs (Table 4 and 5).
3. Deviation to schedule of 1.05% (Table 4).
4. University savings of 5M Euros, based on the awarded price compared to the maximum budget.
5. Decreased client costs due to utilization of expertise:
    a. Audio visual resources project, decrease in maintenance cost by 24% and budget by 17%-55% (Table 6).
    b. Travel Agency project, decrease in bookings by 52K Euros (45%) saved in travel bookings (Table 7).
    c. Printed Matter Services, Cost of management services decrease by 100% (Table 8).
6. High performance and quality measured and tracked by the vendors and not the client (Tables 4, 5, 6, 7, 8, 9 and 10).

Table 5

Overall Hanze UAS Performance Metrics with Lessons Learned

Performance Metrics	Overview
Total # of Projects	7
Initial budget of project	€ 18,696,533
Euros over budget (Million)	€ 558,992
% Deviation in schedule	13.96%
% due to client	6.32%
% due to supplier	6.17%
% due to other	1.46%
% Deviation in cost	2.99%
% due to client	2.72%
% due to supplier	0.01%
% due to other	0.26%

Table 6

Break of Hanze UAS Project Performance

Performance Metrics	VOIS – implementation Osiris Phase 1	VOIS – implementation Osiris Phase 2	Audio Visual Resources	Travel Agency	Printed Matter Services	Managed Service Provider	VOIS – implementation Osiris Phase 3
Total # of Projects (Product & Service)	Project	Project	Service	Service	Service	Service	Project
Current Duration of Implementation	119	699	940	868	852	395	273
Date of Award	1/21/13	1/21/13	3/5/13	5/16/13	6/1/13	9/1/14	1/1/15
Initial budget of project	€ 3.40M	€ .78M	€ 2.01M	€ .63M	€ 2.25M	€ 5.13M	€ 1.01M
Initial Contract duration (days)	105	678	1460	1142	1142	730	333
Days delayed	8	21	0	0	0	30	0
Euros over budget (Million)	€ 45,354	€ 114,386	€ 0	€ 0	€ 26,100	€ 0	€ 0
% Deviation in schedule	7.57%	3.10%	0.00%	0.00%	0.00%	4.11%	0.00%
% due to client	7.57%	2.10%	0.00%	0.00%	0.00%	0.00%	0.00%
% due to supplier	0.00%	1.00%	0.00%	0.00%	0.00%	0.00%	0.00%
% due to other	0.00%	0.00%	0.00%	0.00%	0.00%	4.11%	0.00%
% Deviation to Budget	13.33%	14.59%	0.00%	0.00%	1.16%	0.00%	0.00%
% due to client	0.00%	14.59%	0.00%	0.00%	1.16%	0.00%	0.00%
% due to supplier	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
% due to other	13.33%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

Table 7

Audio visual resources

Project Performance	PTH 2014 period 2	PTH 2015 period 1
Way the supplier takes care of our business needs	6.9 / 10	8.1 / 10
Availability audio visual	98.85%	98.97%
Deliveries within norm	78.80%	78.05%
Customer satisfaction	9.65	9.56
Maintenance costs	-24.26%	-24.26%
Deviation on budget	-16.97%	-55.22%

Table 8

Travel Agency

Project Performance	2015
# of travel bookings	513
Full-service booking	485
Self-service booking	28
Euros worth of bookings	€ 294,357.87
Full-service booking	€ 112,618.93
Self-service booking	€ 4,399.00
# of User Complaints	3
Full-service booking savings	€ 11,789
Self-service booking savings	€ 40,600

Table 9

Printed matter services

Project Performance	**2015**
User satisfaction survey (8 months after implementation)	7.6
Costs department management reduced	100%

Table 10

Managed Service Provider

Project Performance	2015
% of managed hired workers	88%
% of undesirable conduct	33%
Average grade rating based on external command execution	6.4
% of local externals	87%

Table 11

VOIS – Implementatie Osiris

Project Performance	06/2015	09/2015
Continuity of teaching logistics Uptime Osiris	99.75%	99.85%
Permanently meet accountability requirements	100%	100%
Operations in control	n/a	95%

Conclusion

The Best Value (BV) effort in the Netherlands has changed from a BV procurement system to a BV approach to delivering services. This has required the following paradigm shifts:

1. The Dutch culture of consensus, trust and assumption that everyone is an expert to a culture of "no trust."
2. Minimize the decision making of the procurement personnel.

3. Change the procurement function to be accountable for a procured service until final delivery.
4. Change the "silo-based" organization who passed the product "over the wall" to a transparent, efficient and effective supply chain.
5. Change the project management model from MDC to identification and utilization of expertise.
6. Use performance metrics to measure the expectation of performance, the actual performance before a change, and the performance after the implementation.

The change in paradigm must be understood by not only the owners, but by the vendors. They need to:

1. Be able to identify and utilize expertise in their own organization.
2. Be able to understand a requirement from the end to the beginning, putting in place a detailed plan utilizing a milestone schedule that identifies the costs, the deliverables, and the risk that cannot be controlled and a risk mitigation plan.
3. Be able to utilize metrics to create transparency for the non-expert stakeholders.

The Dutch Best Value (BV) effort has also identified the need to change the:

1. Traditional risk model, where risk is on every project, and can be transferred from one party to another to a model of utilizing expertise which have no technical risk and who uses transparency to minimize risk that they cannot control.
2. The project management model which needs to identify the deliverable in terms of metrics that everyone can understand, and allow the experts to plan back to the beginning to identify time, resources and costs required to deliver the project requirements.

The case study is one of the few that show the evolution of the BV PIPS delivery system in the Netherlands. It shows that paradigm shifts take time, regardless of how simple the process may seem. It also shows how huge a change the BV PIPS approach makes in the delivery of services. More documentation of tests are required to further refine the approach in the delivery of services.

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Development of a New Construction Research Model for Saudi Arabia

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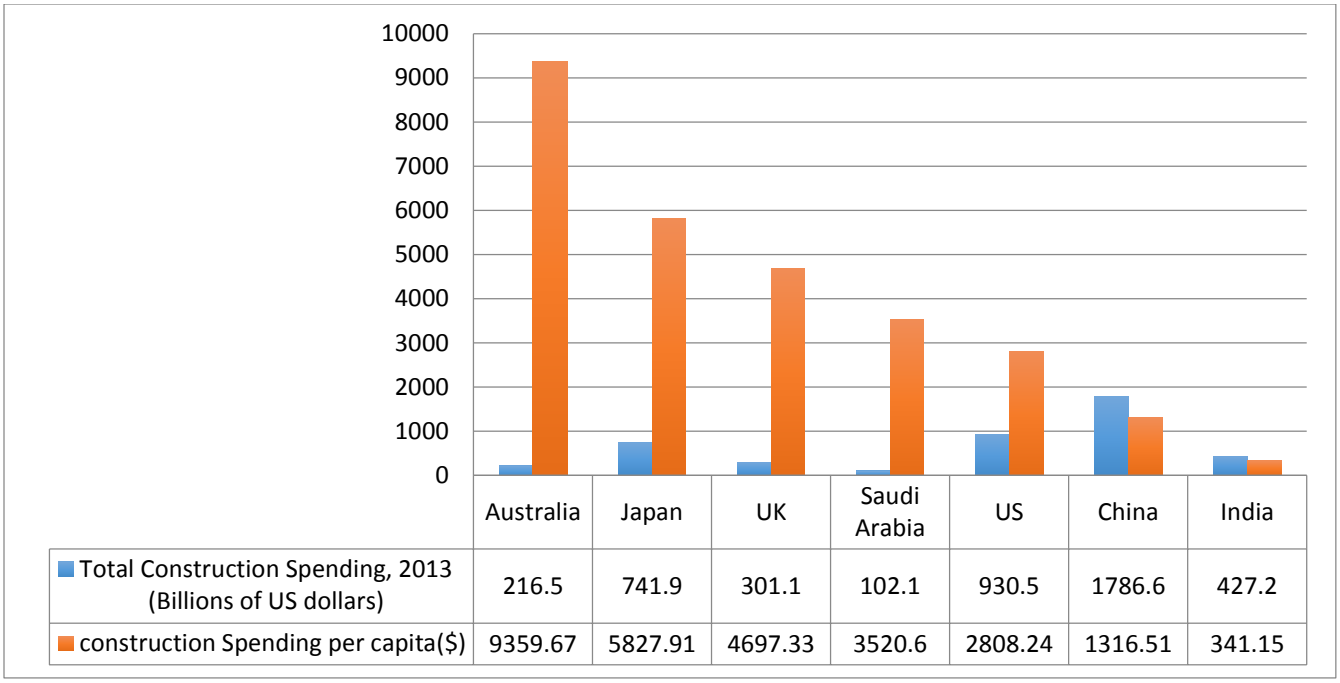
The Saudi Arabian construction industry has had poor performance for the past thirty years. There have been many publications identifying the problem and potential causes. There have been no publications identifying what the source of the problem is, how to mitigate the problem, and actual testing to validate the proposed solution. This paper discusses why this problem exists, what is a potential solution, and an action plan that mirrors the most successful (construction management, risk management, project management and procurement delivery) research and development program in the world (22 years, $16M, +1750 tests, six different countries, 31 states in the U.S. and 98% customer satisfaction). The solution proposed in this paper is unique to the strengths and weaknesses of the research and development programs at universities in the Saudi Arabian kingdom.

Keywords: Saudi Arabia, poor performance, research and development, Saudi Arabian Universities, Saudi Arabian procurement performance.

Introduction

The Saudi Arabian kingdom is an oil-based economy. It is the largest and most powerful oil producing country in the world, exports of petroleum products 988,000 barrels per day (OPEC, 2015). Saudi Arabia has been a monarchy since its beginning in 1932. Oil was discovered in March 1938. Since that time the king has attempted to bring Saudi Arabia from a nomadic based country to one of the most educated and modernized countries in the world. Saudi Arabia is the wealthiest of all developing countries and the Arab World. As a leader in the Arab world and the Middle East, Saudi Arabia has attempted to maintain the stability of a geographical area that at times has been unstable due to numerous wars by surrounding countries. The monarchy, by making decisions in the best interest of the population, has created stability in Saudi Arabia.

The construction industry in Saudi Arabia has experienced a boom during the last 30 years since the government spending on infrastructure from 2008 to 2013 was estimated at $574.7 Billion (Ventures Middle East, 2011). Prince Dr. Turki Al Saud (2015) and President of King Abdulaziz City for Science and Technology (KACST) affirmed that the building and construction sector in the Kingdom ranks second after petroleum industry in contributing to the gross domestic production (GDP). The high rate of spending has made the Saudi construction industry the largest market in the Middle East and is expected to lead much of the growth in the region through 2015 (Langdon, 2012). Saudi Arabia is also considered one of the top countries in the world regarding the spending per capita as shown in Figure 1.



	Australia	Japan	UK	Saudi Arabia	US	China	India
Total Construction Spending, 2013 (Billions of US dollars)	216.5	741.9	301.1	102.1	930.5	1786.6	427.2
construction Spending per capita($)	9359.67	5827.91	4697.33	3520.6	2808.24	1316.51	341.15

Figure 1: Total Construction Spending per capita ($) by country.

The Saudi Arabian leadership has seen a need to educate its population. There are twenty-four government universities in Saudi Arabia, 16 of them have been created in the last 10 years and at least one major university is in each region of the country. Lecturers from universities have been sent overseas to get their masters and doctorate degrees costing the Ministry of Education about $154.6 Million every year (Ministry of Higher Education, 2014). This effort is to increase the quality of university education systems and help the population adjust to the changing world around them and the modernization of the Saudi Arabian society. Returning faculties from abroad are instructed to bring back the latest advances in all technical areas.

The Saudi Arabian construction industry has had poor performance in the last 30 years. There have been many publications that have identified and documented problems in the industry:

- In 1983, it was discovered by Zain Al- Abedien that the delays were the norm for 70% of the projects taken up by the Ministry of Housing and Public Works. Six years later, Al-Sultan (1989) reported the same percentage. He reported that 70% of Saudi Arabia's public projects had time-overrun issues.
- Al-Khalil and Al-Ghafly (1999) investigated and found the average schedule delay in public utility projects in Saudi Arabia is 58%.
- Al-Ghafly (1995) surveyed the contractors and the consultants and discovered that the contractors believed that 37% of the projects suffered from delays whereas consultants agreed that 84% of the projects under their supervision suffered from delays. The researcher also reported that the estimated time overrun versus the total original time specified for a project amounted to 39%.
- In 2006, it was discovered in Eastern Province that 70% of projects experienced time overrun and the average time overrun was between 10%-30% (Assaf & Al-Hejji, 2006).

- After 4 years, a study was conducted by Al Turkey (2011) with the aim of identifying the performance of construction industry. In this study, more than 300 project managers from different sectors and disciplines in construction industry agreed that 80% of the projects were subject to overrun costs, while 97% faced time issues.

Problem

The following problems have been observed in Saudi Arabian education, research, and construction industry:

1. The Saudi Arabian construction industry has poor performance.
2. There are no solutions that have had an impact on the poor performance.
3. Research publications have identified the problems, but have not identified solutions that have resulted in increasing the construction industry performance.
4. Construction management faculty at major universities have difficulty in assisting future construction management personnel to change their approach so they can improve the future construction industry performance.
5. Construction management faculty desire to add value to the university systems and the construction industry but lack a clear model and approach.

Proposal

This paper will discuss a new approach to academic construction management research in Saudi Arabia to assist in increasing the performance of the construction industry. This research will identify the most successful approaches in the world that have had an impact on the construction industry and create a model, which can be successful, sustainable, and effective in the Saudi academic research environment. This effort will also cover the education of existing and future construction management personnel. It will also include the potential testing of research and development concepts in the construction industry. One of the requirements of this new approach is a quick turnaround of impact that results in observable improvements in the construction industry performance.

Methodology

The methodology in this research is case based, action research, and utilizes mixed methods (literature search, case study performance results, and survey questionnaires). The methodology will proceed in the following steps:

1. Identify a university group that has had success in identifying problems in the construction industry
2. Identify if the group works with the industry in performing hypothesis testing
3. Identify the success level of the university based group
4. Identify the university group's methodology

5. Create a Saudi Arabian university group/mechanism where the university group can introduce the research and development results through undergraduate and graduate education, form a database of construction performance information, do research tests, quickly publish information that will increase the performance of the construction industry and partner with established and successful research groups which have been successful in increasing industry performance.

The Need for a New Research and Development Approach

The problem identified in Saudi Arabia where the construction management university based research and development programs have not been able to help improve the construction industry may be a common problem in every country. Academic research has had minimal impact in assisting the construction industry to improve its performance (Kashiwagi et al., 2008; Adeyemi et al., 2009; Egan, 1998; Cahill, 1994; Chan, A., 2004; Cox, 2003.). Research publications of construction industry performance have identified that other countries (developed, developing and underdeveloped) may have similar issues to Saudi Arabia:

- Graham et al (2011) have proven this issue by showing that the construction related researches lack the capability to assist the construction industry. After reviewing 607-research publication from different journals, they found that the researches that are being done on construction industry are not aligned with the needs of the industry. They conclude their study by saying that "A review of literature shows that, historically, research has not played a major role in the advancement of the construction industry."
- In USA, according to NAS, N. (2009) "The U.S. construction industry does not have an industry-wide research agenda that identifies or prioritizes research areas with the most potential for improving its productivity, its competitiveness, or its efficiency."
- In Pakistan, "The construction industry does not have a professional body or organization which may provide information on the prevailing trends and demands of the industry. No research organization in the public or private sector is engaged with ascertaining the present and future needs of the industry. Lack of research and lack of constructive feedback has not let the industry to rise to its full potential. The demands and needs of the industry are then gauged by questionnaires and personal interviews that might be misleading as they are based upon a person's personal experiences and vested interests." (Khalid Huda et al, 2009)
- It has been shown that the most existing delay studies suffer from limitations regarding their contribution to solving the problems that they identify. Similar causes of delay emerge across the studies, but a great share of authors recommends no practical solutions or methods to improve the situation. (Alsehaimi et al, 2013)

In resolving this existing issue, a new or different approach is needed by university based research and development groups. A literature search shows that very few research and development centers have had impact on construction industry performance through repeated testing (Kashiwagi 2009). In 2008, TG61, a group sanctioned by the International Council for Building (CIB), performed a worldwide literature search study detecting construction innovative approaches that used performance metrics to increase performance of projects. The study

reviewed more than 4,500 papers, which were filtered down from 15 million papers. The study concluded that only 16 published papers documented actual performance increase due to hypothesis testing the use of performance information practices. The study found that 75% (12) out of the 16 papers that documented performance practices were projects performed by the Performance Based Studies Research Group (Egbu et al., 2008). This group had sufficient documentations and publications that identified the increase in performance, value and customer satisfaction in the construction industry due to concepts.

The Performance Based Studies Research Group (PBSRG) at Arizona State University proposed that one of the main causes of problems in the construction industry is the existing traditional research approach. Current academic research does not have a structure that can easily introduce change. Thus it depends heavily on literature searches and surveys of the perceptions of industry participants to identify the factors of performance and problems of the construction industry. Action research testing to determine the validity of their perceptions in "real life" industry tests is rarely done. Validation of new concepts would require action research using repeated industry tests. Therefore, the PBSRG have worked with the construction industry to repeatedly test their proposals. The research included (PBSRG, 2015):

- 1,800+ projects tested worth $6.4 Billion USD using their Best Value (BV) system.
- One of the largest contractor developers in Malaysia (which is operating in a more underdeveloped culture) is using the Best Value PIPS and IMT concepts to optimize their operations.
- 50 different clients (public & private) have participated in the testing.
- 483 Presentations, 8,600 Attendees in the U.S., Asia/Australia, Europe, and Africa.
- 175 refereed conference and journal papers on the development of IMT, PIPS/PIRMS, and research tests.
- Performed research testing in 31 states in US and 6 different countries.

PBSRG has helped the industry to overcome its problems in many countries including the United States, Canada, and Netherlands. Following are some of the documented performance metrics for this research group:

1. 98% of clients were satisfied and there was no vendor-caused cost deviation. PBSRG, 2010; Kashiwagi, 2009)
2. Vendors increased their profits up to 100% without increasing costs to the client (PBSRG, 2010; Kashiwagi, 2009).
3. A total number of 20 projects ($100M USD) have been performed at the State of Oklahoma in the United States using the BV model. The total savings from these projects has been $29M USD.
4. Arizona State University adopted the change in paradigm with the Best Value environment for its dining services and bookstore management. It has saved them $100M USD since adopting Best Value (PBSRG, 2012).
5. The results from projects in the Netherlands showed their delivery time was accelerated by 25%. Time and cost spent on transactions were reduced by 50-60% for both vendors and clients (Kashiwagi et al., 2012).

6. The formation of the W117 Performance Measurement in Construction working commission of the International Council for Research and Innovations in Building and Construction (CIB) working commission.
7. The formation of the CIB Journal for the Advancement of Performance Information and Value to proliferate the use of deductive logic and the use of performance information.
8. The results of PIPS/PIRMS testing has won the Construction Owners of America Association (COAA) Gold Award, the 2005 CoreNet H. Bruce Russell Global Innovators of the Year Award, the 2001 Tech Pono Award for Innovation in the State of Hawaii, along with numerous other awards.
9. In total, nine projects ($209 million USD) have been performed at the University of Alberta resulting in savings worth $12M USD.

PBSRG has been developing a new research and development model that has a mechanism to convince the industry to support the research. This model integrates academic research concepts into the construction industry practices to increase performance.

Characteristics of PBSRG Research and Development Model

The Performance Based Studies Research Group originator did not use the traditional literature search approach to identify the problems in the construction industry. He used personal observation to identify that a problem existed due to conflicting interests between two supply chain participants (a client and expert vendors) on a specific issue dealing with the performance of a roofing system (Kashiwagi, 1983).

The collection of performance information was used to identify which supply chain participant was accurate in their claim. The collection of performance information on the performance of the sprayed in place polyurethane foam system (SPF) identified that the client (United States Air Force (USAF)) was inaccurate and the expert vendors were accurate in their claim that the SPF roof system was a performing roof system. This conclusion was coupled with the researcher's creation of the Construction Industry Structure (CIS) model, which was created using the deductive logic of the performance information results. The deductive logic stated that when a non-expert minimizes risk using management, direction, and control, it results in low performance. When an owner utilizes expertise to minimize risk, it results in high performance.

This action research approach did not use the traditional research approach of literature search to identify the current state of the industry or the industry's perception of the problem. Neither did it seek to gain concurrence of the construction industry of the problem solution through a survey of industry experts or participants. It assumed that the problem existed because the industry participants did not understand what was transpiring (did not have the performance information and did not understand that the client or non-expert should not direct the expert vendors) and that through dominant performance information, the action research result showed the reality of the situation and the performance level (SPF roofing system was a performing system).

The researcher then attempted to identify how valuable the expert vendor's services were through a transparent system that compared different solutions' performance information. The

researcher used the multi-criteria decision making model, the Displaced Ideal Model (DIM) to determine the value and level of expertise of all competitors. The action research testing then identified which vendor was the Best Value (best value for the lowest cost). This test set the precedence for the PBSRG research approach (minimize bias/personal opinion, use performance information, minimized decision-making and observation of the solution).

Due to the approach of the research, PBSRG was faced with an immediate problem. The research results did not gain the immediate support of the industry or academic research due to a lack of validation by other researcher work in the industry. Traditional researchers became critical of the action research results (Kashiwagi, 2006; Kashiwagi, 2014; Rivera, 2014). PBSRG identified that to be successful in getting their results recognized and utilized by the industry, a new approach would have to be used. PBSRG would have to simultaneously and continuously conduct:

1. Theoretical development research.
2. Prototype testing.
3. Implementation testing.
4. Keep performance metrics on the action research results.
5. Find a source of publication that would get around the resistance from traditional researchers.

PBSRG assumed that their success would result from a preponderance of test results, continual action research testing, and the optimization of construction industry practices and publication in the industry. This approach is identified by this research as a different approach from the traditional validation by peer review. Another approach of PBSRG research was to make things simple. The objective was to show that the construction industry problem was not delivering on time, minimal project cost deviation and with customer satisfaction. PBSRG results showed:

- Dominant test results, 1800+ test with 98% customer satisfaction and minimal vendor caused time and cost deviation.
- Clients were the source of the majority of project cost and time deviations.
- Simple deductive logic called Information Measurement Theory that explained the action research test results.
- A compilation of publications that supported the action research test results.
- Integration of industry and academic research by using industry tests for all action tests.

PBSRG's approach to research required a new business model. Repeated action research tests, continual improvement of successful concepts, and the development of dominant and simple logic required a new funding model. PBSRG did not compete for government grants (Rivera, 2013; Kashiwagi, 2013; PBSRG, 2015). All research grants were sole sourced from construction industry clients who understood the new paradigm and who requested to run tests utilizing the PBSRG concepts through action research. PBSRG did not do any research outside of its area of expertise. Construction industry partners gravitated to the research due to the following dominant results (Kashiwagi, 2015):

1. The reduction of project cost from 5 to 50%.
2. The reduction in procurement duration and transactions by all parties by 50%.
3. The increase in expert vendor profit.
4. Expert vendor project time and deviation cost of less than 1%.
5. The minimization of client management and direction by 90%.

PBSRG also required a source of publication for the research results. In 2010, the CIB awarded PBSRG with a working commission, W117 Performance Measurement in Construction. Along with the working group, W117 was awarded the Journal of the Advancement of Performance Information and Value. PBSRG's ability to integrate the theoretical development, the prototype testing and the implementation of the Best Value technology increased the impact and speed of action research testing and publication to the industry. PBSRG (the only construction management research group) also went beyond the borders of the construction industry, to run action research in all industries (personal services, professional services, engineering and architecture, information, communication and technology (ICT) and medical services and equipment).

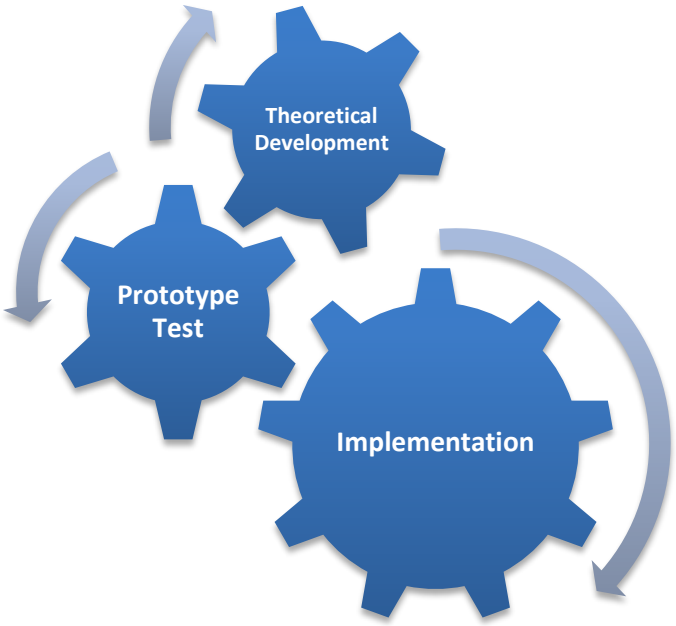


Figure 2: *PBSRG Research Model*

As it is shown in Figure 2, this approach ensured rapid impact and continual conceptual development in the delivery of services in the construction industry. Theoretical development immediately impacts the implementation of the technology. The validation of the developed concepts would not be by academic research peer review in journal publications, but by action research test results and sustainability of the research effort. If the research efforts do not lead to industry implementation, the action research objective of improving the industry performance is not validated. The research sustainability results include (PBSRG, 2015):

1. Longest running construction management (CM) research group: 23 years.

2. Highest funded CM research group studying the optimization of delivered performance: $16M.
3. Most research tests: 1,800 delivering $6.4B of services.
4. Most countries running tests: 6.
5. Most states with research tests: 31.
6. Other dominant results: changed the delivery of services in the Netherlands in five years, changed the delivery system in the largest university (Arizona State University with 85,000 students) in the U.S.
7. Most licensed technology developed at Arizona State University with 44 licenses.
8. Research publications: 384.

Theoretical Development (IMT, BV PIPS/PIRMS)

The theoretical development of the BV technology took a totally different approach than any research effort. The following assumptions are made:

1. Logic must start from a foundation of natural laws and not industry technical knowledge.
2. The logic must be non-technical in nature.
3. No concepts for solutions will be taken from industry participants or experts. The assumption was that the problem of the performance of the delivery of services has been poor for so long, the industry's traditional approaches were not optimal and even flawed.
4. The solution must be simple (non-complex). The assumption of the researchers is that complexity is created by non-experts, and can never lead to improvement of the industry performance.

The PBSRG action research result requirement was simplicity, clearly identifying where industry participants were not following the developed processes. The theoretical result of the PBSRG research was the Information Measurement Theory (IMT), the Kashiwagi Solution Model (KSM), the Construction Industry Structure (CIS), the Performance Based Procurement System (PIPS) and the Performance Information Risk Management System (PIRMS). The IMT consists of the following concepts (see Figure 3):

- All natural laws that explain the change from one state to another, exist at all times.
- All event start from unique initial conditions and unique end with unique final conditions.
- These unique initial and final conditions are always related.
- All events have only one outcome.
- Randomness does not exist.
- The expert understands the initial conditions, predicts the final conditions, and monitors the performance from the beginning to the end.
- The expert minimizes their scope and utilizes transparency to minimize risk that they do not control.
- The expert does quality control and risk management, and the owner/buyer does quality assurance (ensures that the expert contractor is doing their quality control and risk management).

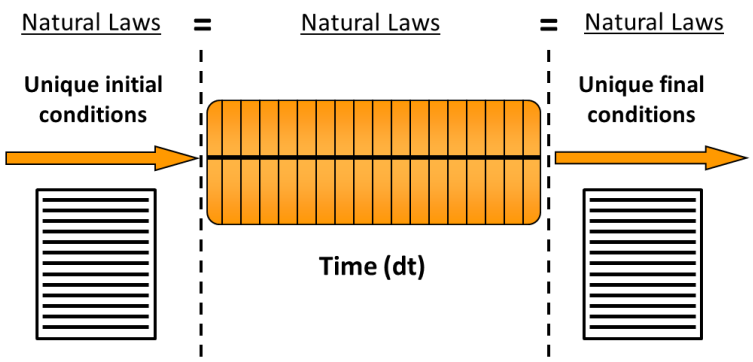


Figure 3: Event Chart (Kashiwagi, 2015)

By applying the IMT concepts in action research, the following became obvious:

- Expertise can be utilized to lower project cost and increase project quality.
- When the buyers manage and direct the expert vendor, the expertise of the vendor will not be utilized, the value of the expertise will decrease and the cost will increase.
- When the expectation of a buyer is created, and expertise is not utilized, the project risk is increased.
- Project risk is the difference between expectation and reality that is set by the initial conditions.
- A transparent environment assists expert and not expert vendors perform.
- Transparency minimizes decision making and confusion.

The theoretical development of IMT led to the development of the Construction Industry Structure (CIS). The CIS is a visual of the construction industry and identifies that poor performance is created by the use of direction and control by non-experts.

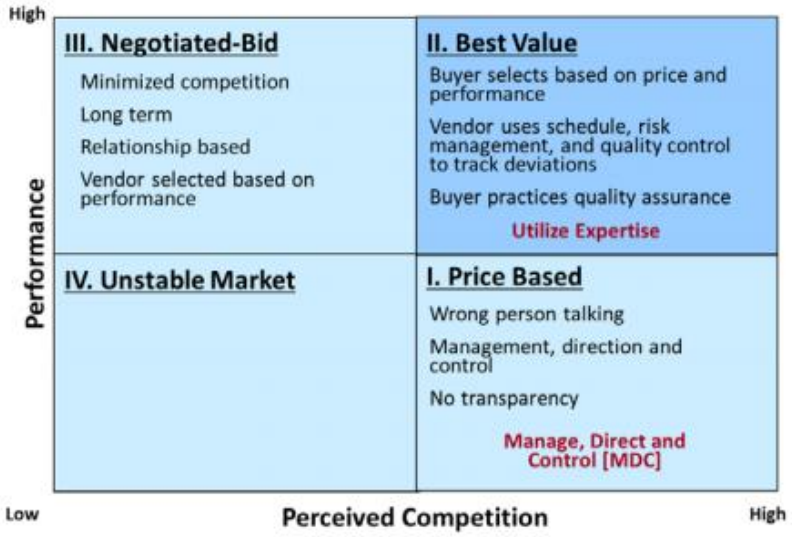


Figure 4: Construction Industry Structure (Kashiwagi, 2014).

The understanding of IMT and the CIS led to the Best Value Approach and technology (Figure 5 and 6). Various clients prototype tested the Performance Information Procurement System (PIPS) and then over a longer period of time a couple of clients attempted to implement the system into their organization. Figure 5 shows the three phases of the PIPS and Figure 6 shows the submittals and the process in more detail. The simultaneous development of the theoretical development, prototype tests and the implementation of Best Value into the buyer's structure has made the PBSRG research of great value to those who are seeking to improve their construction performance.

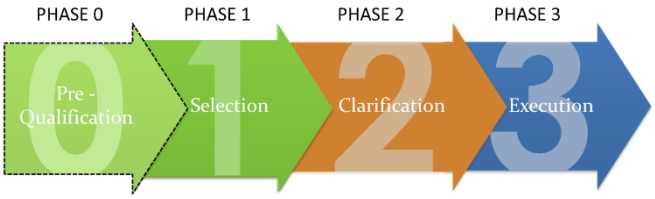


Figure 5: Performance Information Procurement System (Kashiwagi, 2015)

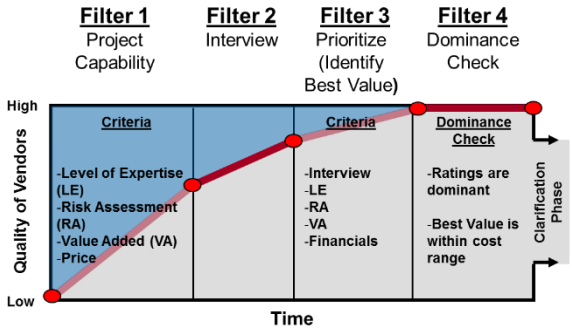


Figure 6: PIPS Filters (Kashiwagi, 2015)

Potential Solution for Saudi Construction Industry

The construction industry structure (CIS) provides an insight into the present structure of the Saudi Arabian construction industry. The following characteristics of the Saudi construction industry propose that it occupies the price-based environment:

- Change orders, time extensions, cost overrun, and stakeholder's dissatisfaction.
- No accountability for deviations (blaming environment).
- More detailed specifications given to the contractors in bidding stage.
- Need for decision-making. This practice is not efficient and causes risks.
- Award to the lowest price using minimum specifications.
- Lack of contractor preplanning before contract award.
- Lack of local skilled contractor base in critical subcontractor areas.

PBSRG has identified the similar problems in the construction industries in Finland, the Netherland, Botswana, Canada, and United States and Malaysia. Tests conducted by PBSRG have minimized project cost and time deviations, increased customer satisfaction, increased

vendor's profits and minimized project costs. Therefore, the authors wanted to create a group of researchers and setup an implementation plan in order to proliferate the "Best Value" Technology into Saudi Arabia construction industry.

Implementation Plan

The authors set up a plan for implementing the successful PBSRG research model and the Best Value in Saudi Arabia to have impact on Saudi construction industry. The plan will contain the following objectives:

1. Design a Saudi Arabian academic research program called Saudi research group (PBSRG-SRG) under PBSRG mentoring.
2. Learn the expertise of PBSRG in conducting the Best Value research.
3. Learn the theoretical development concept of PBSRG model and its implication.
4. Learn the PBSRG research approach that have improved the construction industry practice and improved its performance.
5. Obtain Master of Science (MS) degrees and Doctorate (PhD) degrees, writing theses and dissertations in the Best Value (BV) research program. Those students will learn the PBSRG approach and conduct research with the aim of implementing the BV research and development in Saudi Arabia.
6. Educate the Saudi academic research units and government agencies by giving them presentations and invite them to visit PBSRG at ASU.
7. Create a database of construction industry performance for worldwide construction industry including Saudi Arabia.
8. Run tests in Saudi Arabia with visionary government owners and vendors.

One of the authors from PBSRG spent two years with the Royal Saudi Air Force (1987-1988). He realized that the challenges in doing research and development in Saudi Arabia with the country being rapidly transformed from a nomadic culture and thinking to a proactive, modern day society. The key to assisting the Saudi research and development effort was to partner or joint venture with the Saudi universities, and slowly change the research model. It is important to realize that PBSRG is not a traditional research and development group.

Saudi Research Group (SRG)

Under the mentorship of PBSRG, a Saudi Research Group (SRG) has been formed. SRG members have been mentored and educated. SRG members have successfully presented the PBSRG efforts to both academic organizations and the construction industry in Saudi Arabia and have gained interests in bringing the PBSRG Best Value technology to Saudi Arabia. The following list includes a brief summary of their accomplishments to date:

- The group started in 2013 with the first PhD student.
- They have obtained 6 scholarships from different Saudi universities and government agencies since 2014.

- SRG has developed a database of 300 references on worldwide construction industry performance. Reconfirmed that PBSRG is the only research group in the world performing repeated action research tests.
- Mentored weekly by BV PIPS experts in the research approach, the theoretical logic and research testing.
- Learning from other PBSRG research groups such as Dutch Best Value participants and the Leadership Society of Arizona.
- Identified a potential test of applying innovative concepts with a client in Saudi Arabian construction industry and will start in the fall of 2015.
- Through tuition funding from the Saudi universities, the SRG has brought $160K to Arizona State University.

Conclusion

The Saudi Arabian construction industry has suffered from non-performance and inefficiencies for the past 30 years. Saudi Arabian research efforts to improve the poor performance have not been successful. The Saudi lecturers have organized the Saudi Research Group (SRG) to identify a potential solution to the poor performance.

The SRG did a literature search to identify successful research efforts that have integrated the academic research efforts and industry experts and improved the industry performance. The literature search identified the Performance Based Research Group (PBSRG) as the only effective research group to do theoretical development and repeated action research to do prototype testing and implementation of the Best Value technology. The SRG have set as an objective to modify the PBSRG research operational model, partner with the PBSRG, and set up a Saudi Arabian PBSRG in the Saudi university environment. Currently, the SRG is being mentored by PBSRG, and is planning to partner with PBSRG, run tests and do theoretical development, then break away from PBSRG and become a Saudi branch of PBSRG.

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Factors Causing Construction Litigation in Saudi Arabia

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The problem of litigation and disputes in the construction sector is a major impediment to a country's development goals. The purpose of this paper is to investigate the problem of high legal costs and long delays that arise due to litigation involving project owners, designers, contractors and other construction parties worldwide and in Saudi Arabia, as well as give recommendation according to the outcomes of this research. The causes of litigious behavior in Saudi Arabia and around the world were identified and documented; also the differences in litigation of the Saudi Arabian construction industry as compared to other countries were identified. Preliminary investigations revealed that there is some level of similarity in the nature of the causes. Thus, these causes were grouped into three main categories, which are expectation factors, communications factors and documentation factors. Further research based on existing literature showed that the practices used to minimize litigation in the construction industry were investigated. The following delivery processes were researched: Design-Build (DB) Delivery Method, Alliance Contracting, Construction Manager at Risk (CMAR), Best Value Model (BVM), Integrated Project Delivery (IPD), Public-Private Partnerships (PPP) and the Best Value Performance Information Procurement System (BV PIPS). Many of these delivery methods were found to have issues, which means the methods by observation do not seem to be the ideal solution to minimize litigation in the construction industry. The only delivery method found to have no litigation issues was the BV PIPS approach.

Keywords: Litigation, construction industry, Saudi Arabia, risks.

Introduction

Saudi Arabia is one of the largest exporters of oil and gas in the world. Consequently, the Saudi economy has experienced a boom, especially in the construction sector, which has seen a remarkable increase in activity from 1995 to 2015. Key trends in the Saudi construction sector include an increased government emphasis on expanding national infrastructure, such as roads, seaports, and airports. There is also an increased government focus on residential housing projects and buildings to address the shortage occasioned by an increasing population. Moreover, Saudi Arabia is experiencing a huge demand for construction services as evidenced by the dramatic increase in the demand for building materials and the number of new and ongoing projects in the country. Recently, the president of the Saudi Law Training Center, Majid Garoub (Hussin, 2014), stressed the need for high-quality engineering and legal aspects in construction projects in order to deal with the massive legal issues facing the sector in the Gulf region. Garoub warned that, if the litigation problem were not addressed, it could hamper economic development and government administration. The growing trail of contract litigations before the courts, may disrupt the judiciary sector and related services, such as transportation, health, education, and municipal services. Despite the opportunities presented by the recent trends in Saudi's construction sector, there are various challenges that must be resolved. Major problems facing construction projects in Saudi Arabia include complex conflicts arising due to different

construction methods and different contract specifications, among other issues, that lead to litigation. Litigation is problematic because it delays the completion of projects. A construction project is acknowledged as successful when completed on time, within the budget, and in accordance with specified quality specifications (Chan 2001). The purpose of this study was to examine the problems of the high legal cost and long delays that arise due to litigations involving construction projects in Saudi Arabia, to identify the causes of litigious behavior as compared to other countries, and to give recommendations to help the Saudi construction industry to improve.

Litigation in the Construction Industry

Litigation in construction projects may cause disputes with varying impact all over the world. For instance, litigation can lead to a cascade of financial consequences for the contractors and project owners. The parties may wind up in court. In other cases, calculating the impact of damages resulting from litigations may not be easy because, sometimes, contractor's costs or part of their compensation portion may be tied to multiple projects. Overall, the impact of litigations can include complex damage calculations that can result in various economic damages, including disruptions, relocation costs, compensation delays, escalation damages, extra work, acceleration, and even contractor termination. The cost impact of litigations includes both direct and indirect costs. Indirect costs include those spent in dispute avoidance, such as costs arising from project rework, cost to reputation, costs due to inefficiencies or delays, and firm organizational costs. Direct costs are the costs directly involved in the litigations, including court interventions and costs associated with alternative dispute resolution (ADR).

The legal environment influences construction projects in multiple ways. It has been found that the construction industry has the reputation of being adversarial and, paradoxically, a leader in both dispute occurrences and dispute resolution systems (McGeorge et al., 2007). The inability to complete construction projects on time and within budget is a major concern. This is especially important given that the construction industry is complex and comprised of a large number of parties, such as contractors, owners, consultants, and regulators (Enshassi, Mohamed, & Abushaban, 2009). Construction conflicts and litigation affect the interests of many stakeholders and reduce profits. Preliminary investigation shows that stakeholders have become increasingly dissatisfied with the legal methods of construction conflict resolution (Mitkus and Mitkus, 2014). Litigation may involve a wide range of issues, including contractor conduct such as allegations of bad faith, fraud, and deceit. Litigations may also involve allegations of material variations contrary to agreed terms of the contract as established in the procurement law, licensing, subcontracting, payments, or even the selection of other construction professionals, such as engineers and architects. Jaffer, Tharim, and Shuib, (2011) classified these factors of conflicts in construction projects into three categories: behavioral factors, contractual problems and technical problems.

Problem

Currently, over 10,000 projects in the Gulf Region are involved in legal disputes (Hussin, 2014). The primary problem associated with litigations in Saudi Arabia's construction sector is the high

legal cost and the time it takes to settle claims and disputes. Studies show that legal disputes in the construction sector in the Middle East take over a year (14.6 months) to resolve, an increase of 62%, compared to statistic referred to in 2012 (Sambidge, 2013). The Middle East also experiences disputes of high value, averaging $65 million (Sambidge, 2013). In Saudi construction industry, the following issues with disputes are identified:

- Experts confirmed that the value of the issues construction contracts (in both public and private contractual disputes) amounted to, was more than $800 million, noting that the size of these contracts is estimated to be 40% of the state budget (Alnomci, 2012).
- At a time when the Kingdom of Saudi Arabia is considered one of the biggest construction project markets in the Middle East, economic statistics estimated the projects that are still stalled are worth $167 million, while the projects that have been cancelled have been estimated to have a value of $196 billion, (Thunayyan, 2013).
- Saudi commercial disputes in the courts has increased in 2014 to 70% of which 80% constitute the construction sector and engineering disputes.
- Construction projects and contract for engineering conflicts accounted for 40% of the overall budget for Saudi Arabia. Also, judicial value of contracts to resolve disputes in engineering projects in Saudi Arabia amounted to $3 billion (Alnomci, 2012).
- Judicial value of contracts to resolve disputes in engineering projects in Saudi Arabia amounted to $7 billion (Abaas, 2015).

Research Questions

In order to achieve the aim of this study, the following research questions were proposed:

- What are the causes of disputes in construction industry?
- What are the characteristics of these causes of disputes?
- What are the potential solutions used to minimize disputes?
- What is the performance analysis of these solutions?

Methodology

The research method in this study was based mainly on a literature review of litigious behavior in construction projects all over the world. The methodology involves identifying and documenting the causes of litigious behavior in the construction industry worldwide. The literature search was performed on causes of litigation in the construction industry and included the following steps:

1. Identify and document the causes of litigious behavior.
2. Identify the differences between the causes of litigation in Saudi Arabia and other countries.
3. Identify causes of litigation in different construction delivery methods.

The first purpose of this literature search is to show the causes of construction litigation in Saudi Arabia and in the rest of the world, second, to identify if these causes also occur in the major construction delivery systems. The writer used different academic resources for this literature

search. The three major databases used by the researcher were ABI/Inform, EI Compendex, and Google Scholar.

Existing Causes of Litigious Behavior in Construction Projects

The researcher investigated the litigious behavior in the construction industry in different countries. The researcher then compared the main causes of litigation between these countries. In Saudi Arabia, one of the most insightful studies on the litigious behavior in Saudi Arabia (Mahamid, 2014), identified the main causes of micro (direct) level and macro (indirect) level disputes in residential building in Saudi Arabia. According to Mahamid, the top direct causes of disputes include delays in the progress of payments by owners, change orders, unrealistic duration of construction projects, labor inefficiency, and poor quality of completed construction work. Accordingly, the main indirect root causes of legal disputes are either poor or lack of sufficient communication between construction parties, inadequate experience on the part of the contractor, poor planning and project scheduling by the contractor, inaccurate estimation practices, and cash glitches during the construction phase (Mahamid, 2014). Indirect causes of legal disputes in Saudi construction projects include mistakes in design, qualifications of subcontractors, inspection delays, and violation of contract conditions. Further analysis of the documented causes of litigious behavior shows a common underlying problem: a lack of transparency in the delivery of construction projects.

On the other hand, In the United States, the main causes of litigious behavior in the construction sector include delays, project disruptions, and scheduling disputes (Genberg, Riggs, & Abraham, 2014). Another study on litigation in the United States was about the defects in the design and construction projects, which are usually associated with the contracting process. Other causes of litigious behavior include terminations, claims over the scope of construction projects, and compliance disputes that may or may not involve state, federal, and local regulations and laws (Genberg et al., 2014).

In Korea, the main causes of litigations include: differing site conditions, obstruction by local people, design errors and omissions, change order evaluations, double meaning in specifications, and excessive quantity of work (Acharya and Lee, 2006). Whereas, in the United Kingdom, construction litigations and claims arise due to claims over plans and specifications, disputes over drawing and submittals, change orders, differing site conditions, construction defects, and subcontractor substitution (Klinger, 2009). Moreover, other studies have been conducted regarding identifying the causes of dispute in construction industries in different countries in the worlds as it is shown in Table 1.

Table 1

Comparison of the main causes of litigation in different countries

Cause	Country	References
1. Late payments by owners 2. Change orders 3. Unrealistic duration of construction projects 4. Labor inefficiency 5. Poor quality 6. Lack of sufficient communication 7. Inadequate experience of the contractor 8. Poor planning by the contractor 9. Inaccurate estimation practices	Saudi Arabia	(Mahamid, 2014)
1. Change orders 2. The owner applies penalty on contractor without conducting investigation of the delay reason 3. Lack of clarity in the contracts conditions 4. Site conditions	Saudi Arabia	(Ghamdi, 2008)
1. Lack of clarity in the drafting of contracts 2. Changing key people's responsibility 3. Increase in the number of vendors	Saudi Arabia	(Abbas, 2005)
1. Disputes over drawing and submittals 2. Change orders 3. Differing site conditions 4. Construction defects 5. Plans and specifications	UK	(Klinger, 2009)
1. Change the scope of work 2. Change of condition	UK	(Hewitt, 1991)
1. Deferring site conditions 2. Errors and omissions in design 3. Double meaning in specifications 4. Excessive quantity of work 5. Obstruction by local people 6. Change order	Korea	(Acharya and Lee, 2006)
1. Communications 2. Access to construction site 3. Access to materials 4. Changes of scope 5. Site conditions	Australia	(Waldron, 2006)
1. Change orders 2. Design issues 3. Quality issues	USA	(Killian, 2003)
1. Delays and disruptions on project 2. Design issues 3. Change of project scope 4. Termination claims 5. Compliance disputes	USA	(Genberg et al., 2014)
1. Lack of communication 2. Changes of site conditions 3. Change in the scope of work 4. Lack of predictability 5. Unrealistic expectations 6. Design issues 7. Contract documents	Hong Kong	(Kumaraswamy, 1997)

1. Misunderstanding between the stakeholders 2. Lack of predictability	Netherlands	(Sykes, 1996)
1. Change the scope of work 2. Change in site conditions	Netherlands	(Heath, Hills, & Berry, 1994)

It is clearly seen that change orders and changing the scope of work are common litigation factors in most of the identified studies. These factors occur because each party is in a silo and cannot see the other stakeholder's performance, and once they have an issue of not meeting their expectations, the change order will be issued and they will likely have conflict. In Saudi Arabia, the construction industry is suffering from changing orders and lack of clarity in the contracts conditions issues. In addition, the literature research found only two major differences between the causes of litigation in Saudi Arabia and the rest of the world. They are the following:

1. Changing key personnel responsibilities.
2. Clients applying penalties on contractor without conducting investigation of the reason for the delays.

All of these factors shown in Table 1 create disputes and a litigation environment. In addition, most of the countries have common factors that cause litigation.

Discussion and Analysis

A critical analysis reveals some level of similarity in the nature of the causes as it is shown in Table 2. Overall, most of these causes could be categorized into three main categories, which are:

- Communication related factors.
- Expectation related factors.
- Documentation related factors.

Communication problems are prevalent in the construction industry due to its dynamic and fragmented nature. For instance, many stakeholders frequently operate in changing sets of relationships that are contractually binding. According to Hoezen, Reymen, and Dewulf (2006), the problem of communication relates to the nature of information processing, feedback, trust, and satisfaction with communication. The absence of these attributes can lead to conflicts and disputes, which lead to disruptions and delays. Poor communication can also lead to claims related to compliance, project scope, and termination claims, even if the parties agree to terminate building contracts (Aiyewalehinmi, 2013).

Table 2

Common causes of disputes in the construction industry

Cause Factor	Group	References
• Change orders / scope • Change in site conditions • Compliance disputes	Expectation issues	(Mahamid, 2014), (Al-Ghamdi, 2007), (Klinger, 2009), (Hewitt, 1991), (Acharya and Lee, 2006), (Waldron, 2006),(Killian, 2003), (Genberg, Riggs, & Abraham, 2014), (Kumaraswamy, 1997), (Heath, Hills, & Berry, 1994)
• Lack of communication • Increase the number of vendors • Obstruction by local people • Changing key people's responsibility • The owner applying penalty on contractor without conducting investigation of the delay reason	Communication issues	(Mahamid, 2014), (Abbas, 2005), (Waldron, 2006), (Acharya and Lee, 2006), (Kumaraswamy, 1997), (Ghamdi, 2008)
• Inaccurate estimation practices • Lack of clarity in the contract's conditions • Lack of clarity in the drafting of contracts • Plans and specifications • Errors and omissions in design • Design issues • Design and construction disputes • Design issues • Contract documents	Documentation issues	(Mahamid, 2014), (Ghamdi, 2008) (Abbas, 2005), (Klinger, 2009), (Acharya and Lee, 2006), (Killian, 2003), (Genberg, Riggs, & Abraham, 2014), (Kumaraswamy, 1997)

Preliminary research shows that many factors influence communication, including the type and organization of the construction process. Transparency is inversely proportional to a lack of communication. Therefore, solutions that enhance transparency have the potential to improve communication in the sector. Transparency ensures openness and accuracy of information.

The second category is the expectation or misunderstanding, according to Mane and Pimplikar (2012), a dispute is defined as a misunderstanding between two parties. Consequently, one of the greatest challenges facing the construction sector is how to resolve misunderstandings or disputes. This is especially important because expectations can cause delays in payments by contractors, hence creating cash problems. Expectations can also affect the project planning process, leading to excessive work or change orders, which trigger litigations. Transparency and project misunderstandings are inversely proportional. Increasing transparency can help minimize misunderstandings because it creates an environment that facilitates communication and a culture of teamwork.

Documentation is the third category of disputes caused. In an ideal world, design and documentation provided for construction projects should be complete and unambiguous. However, contractors often receive incomplete and erroneous project documentation that takes time to resolve, hence causing delays or eliciting protracted legal processes. According to Tilley, Wyatt, and Mohamed (2004), the problem relates to the increase in documentation regarding registers for a massive number of architectural drawings and other documentation that increase

up to the end of the project. Documentation is important; however, its massive increase in construction projects may create conflicts among parties, leading to delays or litigations such as those associated with change orders, design errors, and other forms of disruptions. Increasing transparency can resolve problems arising due to increased documentation. Transparency would ensure that designers and contractors do not need to produce multiple documents. In addition, the construction industry involves extensive use of expertise at various levels. This expertise ranges from managerial skills to technical craft skills. Failure to utilize expertise can lead to deeper problems, with legal implications and consequences to the project completion. For instance, failure to use expertise may lead designers or architects to perform tasks of which they are not competent, causing an excessive quantity of work, obstruction of the project by local communities, or different forms of project claims. According to Sambasivan and Soon (2007), contractors should never take on jobs in which they do not have sufficient skills.

Litigious Behavior in Construction Delivery Systems

In the construction industry, there are efforts to address this problem by focusing on project delivery methods and practices that have become entrenched in transparency, accountability, and good governance. Recently, there has been increased scholarly interest in approaches such as Design Build (DB), Construction Manager at Risk (CM@R), Integrated Project Delivery (IPD), Alliance Contracting, Private-Public Partnerships (PPP), and Best Value Method (BVM). In this section, existing literature is reviewed in order to identify if dispute factors exist in the identified delivery methods. The main objective to examine their flaws in terms of solving the problem of costly disputes and litigations in construction projects.

Design Build (DB)

In the DB delivery method, the contractor and architect serve as a single entity hired by the project owner in order to deliver a complete project. A single point of contact fosters improved communication, accelerates the delivery of projects, and minimizes adversarial roles. The DB approach suits highly sensitive construction projects with smaller user groups and minimal need for user reviews. With regard to solving litigious situations, this approach has elicited intense scholarly attention. Garner, Richardson, and Castro-Lacouture (2008) noted that DB represents the Best Value selection delivery of construction projects in terms of providing an owner with a single source of accountability, which eliminates lengthy litigious behavior. However, a lack of expertise and experience among participating firms may hamper these advantages and trigger conflicts of interest leading to litigations. Another potential cause of construction disputes using the DB method relates to its sophistication in that, if the project owners do not have full comprehension of the project concepts and scope, it may cause owner-instigated litigations. More importantly, DB does not allow checks and balances between architect and contractor, which may lead to conflicts and potential disputes. In a related study, Friedlander (n.d.) argued that the existence of a team comprised of a designer and contractor raises unique legal problems regarding their specific relationships, including questions of who serves as the owner and who becomes the subcontractor and whether the entity is a joint venture, a limited company, or a corporation. Further research showed that DB fails the transparency test due to potential conflicts

in the interpretation of the client's requirements, unclear responsibilities, and lack of confidence (Lam, Chan, & Chan, 2012).

Construction Manager at Risk (CM@R)

In CM@R, the construction manager (CM) and the design team work together to develop and estimate designs. The project owner can select a fee-based firm before completing design and bidding documents, based on experience. Cunningham (2005) established that, although the CM@R approach enhances transparency because of the open costs and fees, previous studies have established that adversarial relationships may develop if there is little collaboration between the CM@R firm and the designer on one hand, and the CM@R firm and the Commissioning Authority on the other hand. Jeelani, Al-Dosary, and Karthikeyan (2012) have established the same problem with CM@R, which may lead to complex conflicts and litigations that affect project delivery.

Integrated Project Delivery (IPD)

The use of IPD is based on the premise that it emboldens a collaborative process that exploits efficiency in the design and construction phases of projects (Cleves & Gallo, 2012). That is, IPD reduces conflicts and related litigations due to facilitation of early stakeholder participation, shared goals, and reduced exposure to liability (AIA California Council, 2007). O'Connor and Benson (2009) established that collaboration arrangements designed to enhance cooperation and eliminate litigious behavior in projects fail because of lack of trust (p. 11). The problem is that nearly 60% of alliances fail due to high dependency on familiarity and trust as opposed to contract terms, which also opens new avenues for litigations in the event of breaches. In a related study, Akintan and Morledge (2013) admitted that, although IPD increases information and knowledge sharing, it may not necessarily guarantee transparency and project success.

Alliance Contracting

One of the solutions proposed to eliminate or minimize conflicts, disputes and litigations involved in construction projects is the use of a model that emphasizes the principles of alliance contracting. The impetus of a strategic alliance is that it promises improved cooperation between parties in the construction industry, which can likely lead to reduced litigious behavior. Hampson and Kwok (1997) identified the potential pitfalls of alliance contracting include the lack of the relevant attributes that serve to facilitate transparency, such as the lack of commitment, poor cooperation and lack of communication.

Best Value Method (BVM)

The BVM emphasizes assessing various alternatives and selecting the solution that meets the best value over long-term project management. It has been defined as a process where quality and price factors influence the evaluation process in order to enhance the value and long-term performance of construction (Scott, Molenaar, Gransberg, & Smith, 2006). Although the BVM is a robust solution for enhancing successful completion of projects, it suffers certain limitations that may lead to lack of transparency and trigger litigious behavior. Some of the challenges attributed to this approach include the perception of favoritism when project teams consider

factors other than the confines of ordinary responsibility (Scott et al., 2006). The perception of favoritism may cause conflicts that later transform into litigations. In addition, bidder qualification in the BVM may tend to favor larger and experienced companies. This could be problematic because it can create conflicts among construction stakeholders, leading to adversarial relationships. More importantly, the subjectivity of performance evaluations in this approach may lead to dishonesty and lack of transparency in the bidding process. The common notion in existing literature is that BVM is most successful for projects that are less complex.

Private-Public Partnerships (PPP)

Growing evidence in recent years suggested that PPP could enhance partnerships and reduce cases of construction disputes and litigations. The idea is that PPP encourages good governance, accountability, and transparency. According to Ribeiro and Dantas (n.d.), although PPP promises benefits in terms of enhancing successful completion of projects in the construction sector, international experiences have shown various issues can affect the implementation of trust. The problem could be attributed to differences in the priority criteria used to manage stakeholder expectations and need for public and private sectors (Takim, 2009). In a recent study, Fombad (2014) demonstrated that PPPs in developing countries suffer from three main transparency and accountability issues: (a) complexity of legislation and policies, (b) transparency, and (c) monitoring of PPPs. Other issues related to transparency include nondisclosure, procurement irregularities, and corruption due to involvement of state agents with deep-rooted irregularities.

Best Value PIPS/PIRMS (Procurement Information Performance System/Performance Information Risk Management System)

The Performance Based Studies Research Group (PBSRG) at Arizona State University has been developing an approach that integrates into construction industry performance. This approach is called Best Value PIPS/PIRMS (Mselle et al., 2009). PBSRG has overcome industry problems in its prior applications in the United States, Canada, the Netherlands, and other countries. The following are some of the performance metrics with regards to Best Value PIPS/PIRMS implementations:

1. 98% of clients were satisfied and there was no vendor-caused cost deviation (PBSRG, 2010; Kashiwagi, 2009).
2. Vendors increased their profits up to 100% without increasing costs to the client (PBSRG, 2010; Kashiwagi, 2009).
3. 1,800+ projects tested worth $6.4Billion USD (PBSRG, 2015)
4. Arizona State University adopted the change in paradigm with the Best Value environment for its dining services and bookstore management. It has saved them $100 million since adopting Best Value (PBSRG, 2012).
5. The results from projects in the Netherlands showed their delivery time was accelerated by 25%. Time and cost spent on transactions were reduced by 50-60% for both vendors and clients (Kashiwagi et al., 2012).

Overall, the only delivery method system in construction industry that shows dominant results and has helped construction industry to improve its performance is PIPS\PIRMS. On the other

hand, the studies showed issues with DB, CM@R, BVM, IPD and Alliance Contracting. All of the issues that have been identified in literature in construction delivery system are related to the three identified categories that have been presented in this paper which are expectation factors, communication factors and documentation factors as it is shown in Table 4.

Table 3

Summary of issues in construction delivery systems

Type of delivery method	Issues of dispute	Reference
Design Build	• Poor communication between architect and contractor creating room for conflict • Sophisticated approach; Owner must have clear idea of project concept/scope • Inexperience • Contentions on responsibilities • Unclear clients requirements	Garner *et al*., 2008 Friedlander, n.d Lam *et al.*, 2012
Construction Manager at Risk	• Little collaboration between designer and CM@R firm during design phase • Little collaboration between Commissioning Authority and the CM@R firm	Jeelan *et al.*, 2005
Integrated Project Delivery	• Over reliance on trust and familiarity	O'Connor *et al.*, 2009
Alliance Contracting	• Lack of commitment • Independent problem solving	Hampson and Kwok, 1997
Best Value Approach	• Perceptions of favoritism • Subjectivity of performance evaluations	Scott *et al.*, 2006
Public and Private Partnerships	• Differences in priority criteria, needs and expectations between private and public stakeholders • No-disclosure • Corruption • Procurement irregularities	Takim, 2009 Fombad, 2014
PIPS/PIRMS	• No Issues were found	

Table 4

Classification of issues based on its nature

Issue	Type of contract	Communication	Expectation	Documentation
Poor communication between architect and contractor	DB	X		
Sophisticated approach; Owner must have clear idea of project concept/scope			X	
Contentions on responsibilities			X	
Unclear clients requirements			X	
Little collaboration between designer and CM@R firm during design phase	Construction Manager at Risk	X		
Little collaboration between Commissioning Authority and the CM@R firm		X		
Over reliance on trust and familiarity	Integrated project delivery	X		

Lack of commitment	Alliance Contracting	X		
Independent problem solving		X		
Perceptions of favoritism Subjectivity of performance evaluations	Best Value Approach	X	X	
Differences in priority criteria, needs and expectations between private and public stakeholders	Public and Private Partnerships		X	
No-disclosure			X	
Corruption		X		
Procurement irregularities				X

Conclusion

Litigation is a worldwide construction industry issue. Due to the critical role that the construction industry plays in the Kingdom of Saudi Arabia's economic development, this has become a major concern for the country. Research shows that the value of the issues construction contracts in both public and private contractual disputes amounted to more than 800 million, noting that the size of these contracts is estimated to be 40% of the state budget (Alnomci, 2012).

The objective of this study was to identify the causes of litigation in the construction industry. A literature search of 3 academic databases and 90 publications identified that the major causes of litigation were due to:

1. Change orders
2. Scope of work changes
3. Design issues
4. Changes of site conditions and lack of clarity of contract conditions

The literature research found only two major differences between the causes of litigation in Saudi Arabia and the rest of the world:

1. Changing key personal responsibilities
2. Clients applying penalties on contractor without conducting investigation of the reason for the delays.

After further investigation into the causes of litigation in the world, it was identified that the reason for legal disputes could be categorized into three major issues:

1. Inaccurate expectations
2. Miscommunication
3. Incorrect documentation

The literature research investigated the efforts to address these problems, which is the major construction delivery systems. Seven types of delivery methods were investigated (DB, CM@R, BVM, IPD, Alliance Contracting, PPPs and BV PIPS/PIRMS). The results showed that every delivery method was shown to have issues in one of these categories (inaccurate expectations,

miscommunication, and incorrect documentation), except the BV PIPS/PIRMS. None of the identified issues causing legal disputes was found to occur in the BV PIPS/PIRMS method.

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Major Factors Causing Construction Delays in Mecca

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Delays are a major cause for concern in the construction industry in Saudi Arabia. This paper identifies the main causes of delay in infrastructure projects in Mecca, Saudi Arabia, and compares these with projects around the country and other Gulf countries. Data was obtained from 49 infrastructure projects undertaken by the owner and were analyzed quantitatively to understand the causes and severity of delay. 10 risk factors were identified and were grouped into four categories. Average delay in infrastructure projects in Mecca was found to be 39% of the estimated projects schedules. The most severe cause of delay was found to be the land acquisition factor. This highlights the critical land ownership and acquisition issues that are prevailing in the city. Additionally, other factors that contribute to delay include contractors' lack of expertise, haphazard underground utilities (line services), and re-designing. It is concluded that the majority of project delays were caused from the owner's side as compared to contractors, consultants, and other project's stakeholders. This finding matched with the research findings of the Gulf Countries Construction (GCC) industry's literature. This study fills an important practice and research gap for improving the efficiency in delivering infrastructure projects in the holy city of Mecca and Gulf countries at large.

Keywords: Delay, construction industry, Saudi Arabia, Risks, Roads and bridges.

Introduction

The Kingdom of Saudi Arabia is experiencing a rapid growth in infrastructure, both in urban and rural areas. The government of Saudi Arabia is progressively allocating huge amount of resources and money to develop its infrastructure all over the country. The economic position of the country has driven the government to invest in construction projects. Between 2008 and 2013, the government spent close to $574.7 B on construction projects (Ventures Middle East, 2011). This high rate of spending has led many in the world to recognize the Saudi construction industry as the largest construction market in the Middle East. Looking ahead, the construction industry analysts around the world expect this growth to advance even more (Langdon, 2012). From the past three decades, all construction institutions in this region have agreed upon the fact that this industry is faced with the grave issue of inefficiencies, non-performance, and the lack of an analysis on construction delays. Al-Ghafly (1995) surveyed the contractors and consultants of major construction projects. His findings showed that around 37% of construction projects were believed to be delayed by the contractors, and 84% of all the projects which were under the supervision of the consultants had gone through serious delays. The researchers also reported that the average estimated time overrun amounted to 39% of the contractual time period. To support these claims, a study was conducted by Al Turkey (2011) with the aim of identifying the performance of the construction industry. It was found that more than 300 project managers from different sectors and disciplines in the construction industry agreed that 80% of the projects were subject to cost overruns, while 97% of the projects faced delay in project completion.

Contractors in Saudi Arabia estimate the total value of delayed public projects at nearly $146.6 B (Abdul-Ghafour, 2011). Mecca Al-Mukarramah is regarded as the holiest site in Islam and is the center of the annual Islamic pilgrimage. This place holds a special position for the followers of the Muslim religion all over the world and it receives over 20 million pilgrims during Umrah season alone (Mohammed, 2014). The high volume of religious devotees and tourists in this city has led to the enormous infrastructure development in Mecca. The expansion of the Holy Mosque has cost the government $10.6 B in just a span of 6 years (2010 to 2015). This enormous cost of development was to develop the 6000 square meter (sq.mt.) area around the holy mosque (Qssas, 2014). This indeed illustrates the high cost of construction and development in this famous city. Furthermore, land ownership is one of the major challenges that are faced by the developing authorities. Land rates around the central area of Mecca were around $80,000/SM during 2008 (Al Thaqafi, 2008). This figure rose to $133,000/SM during 2010 (CW Staff, 2010) and to $400,000/SM during 2013 (Arab News, 2013). Consequently, the Saudi government spent over $8.8 billion on land acquisition between 2009 and 2010 (Al Mufadhli, 2011).

Problem

In view of the large scale investment and the need for fast paced development, cost and time overruns are a serious issue. Research findings indicate that around 70% of the construction projects in Saudi Arabia have faced delays. Zain Al-Abedien (1983) found that delays were a concern for over 70% of all the projects undertaken by the Ministry of Housing and Public Works. Al-Sultan (1989) reported the same percentage of delays in construction projects even after six years. Al-Khalil and Al-Ghafly (1999) in their investigation found that 72% of the total projects undertaken were delayed during this period. This trend continued even during 2006, it was found in the Eastern Province that 70% of projects faced time overruns by 10% to 30% of the estimated project schedule (Assaf & Al-Hejji, 2006). Projects in Mecca (Western province) are not an exception to these delays. With over 5 years of intensive work experience as a project manager for public infrastructure projects, the main researcher and project manager in Mecca believes that delays are a major hindrance during execution of public projects. While very limited research has been done which analyzes the root cause of delays, it is a challenge for the industry professionals (Elawi, 2015). They are aiming to solve these issues to enhance the project delivery mechanisms.

Research Aim and Objectives

This paper identifies and examines the causes of delay in the construction of infrastructure (roads and bridges) projects in the Mecca province of Saudi Arabia. The objectives are to:

1. Identify construction performance and causes of delays in Gulf Countries Construction (GCC) industry.
2. Determine the performance of 49 infrastructure projects.
3. Identify the causes of delay and the parties responsible for each of them as per the owners' perspective.
4. Compare the analyzed delay factors and cases findings with other studies from Saudi and Gulf Countries Construction (GCC) industry.

Research Methodology

This study uses a quantitative approach to analyze delay factors and will be conducted in three phases; a literature review, an analysis of the collected data and a comparison of the delay factors and findings of this case study with other related literature. It was found that all previous studies analyzing the delay factors in Saudi and Gulf countries construction industry were completely based on literature reviews. Most researchers tend to conduct a survey to assess the causal impact, severity and frequency of delay factors. However, in this study, the authors will identify the delay causes based on a real time quantitative performance analysis of all the infrastructure projects under consideration. After that, these delay factors will be evaluated by their frequency of occurrence on 49 projects and the severity will be measured in terms of percentages. By assigning these delay factors to the responsible stakeholders, the root cause for the majority of delays and the responsible party will be determined.

The research method for this study is a detailed analysis and quantitative comparison of delay factors for 49 infrastructure projects in the Mecca province. One of the researchers has been working as a construction project manager for the Saudi Arabian government for past 5 years. (Elawi, 2015) His responsibility is to manage and oversee the infrastructure (roads and bridges) projects in Mecca located at the Western province of Saudi Arabia. This study is limited to the constructions taking place only in the Mecca province mainly because of the familiarity and expertise of the main researcher in this 1,200 square kilometer area. (Elawi, 2015) Moreover, all of the cases in consideration (49 in total) are either bridge or road projects. The reason for selecting these projects is because of the demand to construct and develop the infrastructure in this region to support the millions of devotees that come for their pilgrimage for Hajj and Umrah. The second stage will focus on analyzing the case study findings; the authors intend to analyze a total of 49 construction projects in Mecca province. The aim of this comprehensive analysis is to determine the major risk factors that affect the project's performance and the stakeholder responsible for causing those risks (i.e. client, contractor, consultant, or other stakeholders). The data for these construction projects was obtained from the owner and it contains the following information:

1. Total cost of the project
2. Planned vs. actual start and completion date
3. Factors that caused delay in those projects

In the third stage, the authors will compare the risk factors with other similar research studies carried out in the Saudi construction industry and the Gulf States construction industries in order to find out whether or not the risk factors in the author's data are similar to other local studies in the industry.

GCC Literature Review

While reviewing literature that has described various causes and effects of delays in Saudi and other Gulf Countries' Construction industries, the severity of the situation was realized. The definition of delay in construction industry is the time overrun in the projects' planned schedule

that was agreed upon by all the stakeholders of the project. For the client/owner, time delay causes loss of revenue. This is due to the absence or delay in revenue generation from the proposed construction after completion. For a contractor, delay causes cost overruns due to compensation of wages for prolonged time, excess hire charges for plant and equipment, material and space utilization, loss or damage of construction materials, and inflation factors (Assaf and Al-Hejji, 2006). Any construction project's lifecycle can be broadly classified into three categories; conceptualization/pre-construction phase, design, and the construction phase. Most of the causes for delays happen during the construction phase because various unforeseen risks are continuously involved (Chan and Kumaraswamy, 1997). Various delay factors could be categorized based on the direct and indirect consequences upon the financial budget of the project. Delays could be also categorized into excusable and inexcusable delays. Inexcusable delays are the ones caused exclusively by the vendor, sub-contractors, or suppliers. There is no compensation to the contractor in this case and the contractor is obliged to proceed with their job or pay for the damages to the client as liquidated damages. If liquidated damages are not included in the contract, compensations could be made to the contractor as actual damages.

The first type of excusable delays is the non-compensable, which are caused by other stakeholders or risks out of the client or contractor control such as unexpected acts by the government, a fire, or unusual weather. Usually, the vendor in these cases does not have the right for financial compensation but he has the right to time extensions. The second type of excusable delays is compensable, which is caused by the actions or act of the client/owner or client's agents such as design changes or late release of drawings. In these cases, the vendor receives compensation from the owner as indirect costs for the extra overhead costs (Gardezia et. al., 2014). In addition, there are two groups of causes of delay in the construction industry that could be categorized into internal and external causes (Ahmed et. al., 2003). Internal causes of delay are caused from the three main stakeholders (clients, contractors, and consultants) in the construction projects; whereas, the external causes for delay are out of the control of the owners, contractors, and consultants. These external causes could be:

1. Natural disasters
2. Shortage of building materials in the market
3. Unavailability of proper equipment in the market
4. Adjustments in government's laws and regulations

Similarly, various other studies have been performed in GCC countries with an aim to determine the causes of delay on construction projects (Mahamid, 2013; Assaf and Al-Hejji, 2006; Assaf, 1995; Al-Khalil and Al-Ghafly, 1999; Alnuamimi and Al Mohsin, 2013; Fraidi and Al-Sayegh, 2006; Koushki et. al., 2005; Hassan et. al., 2014; Albogamy et. al., 2012; Al-Kharashi and Skitmore, 2009). The top ranked causes of delay in the previous 10 studies with their frequencies are shown in Table 1. Contractor lack of experience received the highest rank as it was among the most frequent causes of delay for all of the 10 studies. The second most frequent delay factor was the financial constraints by the owner. This factor was documented in 9 studies. Documented in 6 studies, the most frequent delay factors included ineffective planning and scheduling by a contractor, poor site management and supervision by a contractor, and delay in performing inspection and approval by a consultant. 5 studies indicated facing unidentified design errors/changes and slow decision-making by owners were problematic. Change orders

and type of project bidding and award (lowest bidder) are ranked fifth as they occurred in 4 studies. Subsequently, Table 2 shows the responsible parties of the identified causes of delay in GCC studies by showing the percentages of the causes of delay. Owner related causes were the highest as they were responsible for almost 50% of the time extensions. Contractor related causes were ranked the second since contractors were responsible for 36% of the time extensions causes.

Table 1

Top ranked causes of delays in the GCC studies.

	Risk Factor	Frequency	%	Related to
1	Contractor experience	10	16.3 %	Contractor
2	Financial constraints by the owner	9	14.7 %	Owner
3	Ineffective planning and scheduling by contractor	6	9.8%	Contractor
4	Delay in performing inspection and approval by consultant	6	9.8 %	Consultant
5	Poor site management and supervision by contractor	6	9.8%	Contractor
6	Design errors/changes	5	8.2 %	Owner
7	Slow decision making by owner	5	8.2 %	Owner
8	Type of project bidding and award (lowest bidder)	4	6.5 %	Owner
9	Change orders	4	6.5 %	Owner
10	Materials in market	3	5 %	Other
11	Difficulties in obtaining work permits	3	5 %	Owner
	latoT	60		

Table 2

Responsibility percentages of the causes for each party For GCC Studies.

	Group of Risk	%	Frequency
1	Owner related	49.2	30
2	Contractor related	36	22
3	Consultant related	9.8	6
4	Other	5	3
		100%	61

Performance of Mecca Projects

The main aim of this study is to identify the causes of delay and the responsible party for these causes according to the owner's perspective in road and bridge projects in the Mecca province. The collected data of the 49 case studies include the project type and the contract cost for each project. The total value of the projects into consideration is $ 937,914,590.97. Time extension percentage out of the original contract duration is identified for every project and the average delay percentage for all the projects is 38.88%. The causes of delay in the studied projects were identified according the owners' perspective and the main causes are land acquisition, contractors' lack of expertise, line services, re-designing, clashes with other Ministries, design conflicts between owners, re-study the design because of valleys, variation in estimated quantities between the design and construction phases, differences in opinions from the Ministry of Traffic, deliberate delay in construction by the general contractor and changing consultants

during project execution. Table 3 shows the ranking of the identified causes of delay in the studied projects based on the frequency of occurrence of each cause. Land acquisition got the highest rank as it is the main cause of delay for 15 projects with an average of 35% time extension for the effected projects. The second is the contractors' lack of expertise as this cause accrued in 12 cases with an average of 56% time extension for the affected projects. Facing unidentified line services (underground utilities) in the design rank third in severity as it occurred in 9 cases with an average of 48% time extension of the effected projects. Re-designing ranked fourth in severity of delay as it occurred in 8 projects with an average of 49% time extension of the effected projects.

Table 3

Ranking the Risk factors for the research case studies

	Risk Factor	Frequency	% Delay	Related to
1	Land acquisition	15	35%	Owner
2	Contractor' lack of expertise	12	56%	Contractor
3	Re-designing	10	45%	Owner
4	Line services (Utilities and underground services)	9	48%	Owner
5	Clashes with other Ministries	5	22%	Other
6	Design conflicts between owners	2	20%	Other
7	Variation in estimated quantities between designer and GC (General Contractor)	2	28%	Owner
8	Differences in opinions from the Ministry of Traffic	1	12%	Other
9	Deliberate delay in construction by the GC	1	22%	Contractor
10	Change of consultant during project execution	1	39%	Consultant

Four delay factors are related to the owners as shown in Table 4. Land acquisition is the most frequent and severe cause of delay that affects the projects in Mecca. This factor is related to the owners as they are the responsible party for preparing the project site before beginning construction. Assaf (1996) stated that "more than two-thirds of the total cost of some public projects in Mecca may be held in legal battles between land owners." Land ownership issues are long in duration and must be resolved legally which affect the assigned projects in time extensions and an extra expense to the owner adds to the original cost of the projects. The factor of line services and underground utilities is also related to the owner as he is the responsible party for knowing all the existing line services within the project site before starting construction. This issue needs more coordination with other agencies to inform the contractor about all the line services to avoid any time delays. Redesign issues are also related to the owner as all the projects were design-bid-build and the owner gives the contractor a full design before the beginning of construction.

Three delay factors are related to contractors. Lack of expertise in the contractors' managers and technical staff caused a massive time extensions in Mecca projects. Delays caused by other governmental agencies are categorized as anoother. Miscommunication and lack of coordination with other agencies considerably affected the project in Mecca to be complete on time is the third delay factor. Mecca is continuously witnessing unprecedented construction development by different government organizations and direct co-ordination between these organizations is weak and projects are often mismatched (Assaf, 1996).

Table 4

Categorizing the Risk Factors for each party

No.	Risk Factors	Category (related to)
1	Land acquisition	OWNER
2	Line services	
3	Re-designing	
4	Variation in estimated quantities	
1	Contractors' lack of expertise	CONTRACTOR
2	Deliberate delay in construction by the GC	
1	Lack of expertise	CONSULTANT
1	Differences in opinions from the Ministry of Traffic	OTHER STAKEHOLDERS (local public, land owners, etc.)
2	Clashes with other Ministries	
3	Miscommunication between various stakeholders	

Table 5

Responsibility percentages of the causes for each party

	Categories	%	No. of Projects (out of 49 projects)
1.	Owner related	53	26
2.	Contractor related	27	13
3.	Consultant related	1	1
4.	Other Stakeholders	19	9

Table 5 shows the percentage of delays caused by respective parties among the 49 infrastructure projects that were in consideration. Owner related delays turned out to be the highest as they were responsible for 53% of project delays, i.e. 26 out of 49 projects were delayed due to the owner. This is similar to the GCC studies as owner related causes were the highest with almost 50% occurrence. Contractor related causes were ranked the second as contractors were responsible for 27% project delays affecting 13 projects out of the 49 into consideration. This is also similar to the GCC studies as contractors were responsible for 36% of the time extension causes. Causes of delays that results from miscommunication and lack of coordination with other agencies affected 9 projects and responsible for 19% of the time extensions in the 49 cases.

Comparison of Mecca Projects and other Studies in the GCC Construction Industry

The final stage of this study was to compare the obtained results from the Mecca projects with the GCC studies and evaluate the similarities and differences in them. Table 6 shows a comparison between the top four causes of delays in the 49 case studies and the GCC studies. Land acquisition is the most frequent cause in the case studies and it is only mentioned in one GCC study. This is due to the special situation in Mecca land ownership, as mentioned earlier and the type of case studies (roads and bridges). Contractor' lack of expertise is mentioned in all the GCC studies which highlights the issue of having inexperienced contractors in the GCC and

not using efficient selection systems to hire expert contractors. Re-designing and line services were mentioned in half of the GCC studies (5 papers). It was found that almost all of the delay factors (except Land acquisition) and their ranking were the same as analyzed in the GCC studies.

Table 6

Comparison between the Major Risks Factors for the Research Case studies and GCC Studies

Major Risk factors for the research case studies	1 Albogamy 2012 KSA	2 Mahamid 2013 KSA	3 Assaf 2006 KSA	4 Assaf 1995 KSA	5 Al-Khalil 1999 KSA	6 Al-Kharashi 2009 KSA	7 Alnuamimi 2013 Oman	8 Fraidi 2006 UAE	9 Koushki 2005 KUW	10 Hassan 2014 BAH	Freq.
1. Land acquisition										√	1
2. Contractor' lack of expertise	√	√	√	√	√	√	√	√	√	√	10
3. Re-designing	√			√				√	√	√	5
4. Line services		√			√	√	√			√	5

Conclusion

Increasing need for infrastructure development aided by sufficient capital reserves of the Kingdom of Saudi Arabia has led to a tremendous growth in the construction industry. This growth is being decelerated by the significant impacts of construction delay. In this study of delay factors analysis for infrastructure projects (roads and bridges) in the Mecca province of Saudi Arabia, it was realized that the major cause for delay was attributed to the owner's. Among 10 different delay factors that were categorized under owners, contractors, consultants, and other stakeholders, it was found that 'land acquisitions' caused the majority of delay in infrastructure projects. The average time overrun for 49 infrastructure projects in the Mecca province was found to be 39% of the estimated project schedule. Delay factors that contributed for the majority of time overrun were; land acquisition, contractor' lack of expertise, re-designing, and line services (haphazard underground utilities). The severest among these was found to be the issue of land acquisition which contributed to majority of the time delay in infrastructure projects in the Mecca province. This is mainly due to the historical, religious, and topographical features of this special province in Saudi Arabia. Delays owing to the owners were found to be the highest as they were responsible for 53% of the time delays (26 out of 49 projects). Contractors were responsible for 27% project delays among the 49 projects. This was followed by miscommunication between various stakeholders (19%). This finding matched with the studies done in the Gulf Countries Construction (GCC) industry. In the analysis of the GCC studies, it is found that owners were responsible for causing almost 50% of the delay and contractors caused 36% of the delay.

Delivery of projects depends on the efforts of different parties and they contribute to projects delay differently. Further research should be applied to investigate how the parties' roles in the project's process can be coordinated and effectively employed to enhance processes and avoid parties from causing risks that affect the projects' completion times. Similar research can be performed in other project types to investigate the root causes of project delays with evaluating the effect and involvement of project parties to the delays. For example, the problem of owners' managerial activities and their involvement need to be reconsidered and investigated to reduce their liability. The authors also recommend further research should be applied to implement strategies used by other countries to actively and consistently prevent land ownership conflicts by developing an adequate institutional framework that organize this major issue and reduce land acquisition disputes. In addition, the contractors' lack of experience is a major issue in all GCC industries and better prequalification and selection systems should be developed and implemented to hire experts who do not have technical risks.

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Research Program to Sustain the FM Professional

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Arizona State University has been involved in identifying the future Facility Manager (FM) paradigm which results in a sustainable FM profession. The $16M, 20-year international research program has identified, created and tested out a solution to the almost impossible task of replacing the aging FM professionals. The research has identified the future FM as one who is leadership based and leads the entire supply chain from inside the organization. This paper will cover the three year results of finding the future FM by accessing the top 10% of ASU's 85,000 students through Barrett's Honors Program, 7th – 10th graders through the Barrett's Summer Honors Program, and culminating this year in placing the education in one of the top private schools in the state of Hawaii for high school students, testing the approach on 116 Brazilian engineering undergraduate students and getting approval for testing a 14 week program in the Tempe High School. The model is proposed as a prototype for future FM professionals and how the FM professional can become sustainable.

Keywords: Facility management, leadership education, IFMA, Best Value, construction management.

Introduction

Traditionally, facility managers have been engineers, construction managers or technical construction/facility personnel. They have been educated in engineering, architecture, management, business or construction/facility management. Many have come up through the ranks of facility management. They are usually technically oriented, responsible for one of the technical areas in maintaining a facility. The International Facility Management Association (IFMA) has created a profession and professional path by ensuring that facility management personnel are trained in all the technical areas of facility management (Earn must-have FMP credential!, n.d.). With the proliferation of green/sustainability products and systems, the number of technical areas have expanded. It becomes more difficult for FMs to be the expert in all areas of facility management. The expansion of products, systems and new materials and the constant effort of reducing costs and improving quality have resulted in an environment where the FM is trying to survive by being more educated, knowing more and attempting to manage, direct and control the services that are required to maintain a facility.

There is another challenge facing the FM community. The International Facility Management Association (IFMA) has identified that a large group of FMs in upper level management/leadership roles are in the twilight of their career and that there is a perceived shortage of FMs who can fill their leadership/management positions once they retire (Hightower & Highsmith, 2013; Sullivan, Georgoulis and Lines, 2010). However, there are troubling signs in the FM profession (Kashiwagi, Turnbull, Gunnoe and Rivera, 2015):

1. The FM function is being outsourced by facility owners to real estate management based firms.
2. FM services are being procured at the lowest cost.
3. There is a movement in the IFMA chapters where FM vendors of services instead of FM professionals are more active and are taking leadership roles.
4. A large percentage of IFMA chapter members are FM vendors of services.
5. There are few university programs that offer FM undergraduate and graduate education and have done significant FM research. The only one identified is at Arizona State University (Hurtado, Sullivan, Okamura & Kashiwagi, 2014).
6. One of the major activities of the IFMA chapters is to network and help find jobs for unemployed FM personnel. Leadership/management jobs are not plentiful.

This is being caused by:

1. FMs are being viewed as a cost of doing business and not a core expertise of their organization.
2. FM and FM services are being viewed as a commodity technical service that can be acquired for the lowest price.
3. FM is being observed as a "non-value added" cost by the organizations.

FM leaders are faced with the following issues:

1. The technical materials/systems, political/regulatory constraints and FM requirements are changing faster than the education and certification programs can be developed and implemented.
2. FMs who desire to lead the FM efforts in the future, do not have the time to become the expert in every technical area.
3. Administration and human resource issues have become a larger part of an FM's responsibilities.
4. Forced to hire experts to assist the FM do the FM's job, so the FM's actual value is diminished.
5. The facility owners do not understand FM. If the FM's skills remain technical in nature, they are a target for cost reduction and outsourcing.
6. Once outsourced, the major emphasis of FM services is lower prices. The physical distance from the facility owner is "farther" and their influence is "less" and their emphasis is "cost". The outsourced FM is a FM who utilizes their expertise less, who emphasizes low price and has fewer benefits associated with their job position.

The Traditional FM Leader is not the FM of the Future

Many in the FM community are distracted by the obvious fact that the FM professionals are getting older and there is a lack of younger FMs who can have the knowledge and experience to take their place. They are concerned that this situation will end the profession of the FM because there are not enough knowledgeable, experienced FMs ready to take their place (Hightower & Highsmith, 2013; Sullivan, Georgoulis and Lines, 2010). Logic and observation of the current

job and education situation proposes a different perspective. The traditional FM of today (technical based, expert who is employed by a facility owner and manages, directs and controls a facility) may be unsustainable in a quickly changing, increasingly technically complex and competitive environment.

The need for this traditional FM is diminishing over time. This is observable as the FM function is being outsourced to real estate based vendors. The problem that the FM is facing, is the FM must change in the following ways to add value to the facility owner:

1. Must become physically closer to the facility owner (FO).
2. Must talk the language of the FO (value and facility capability, cost, time).
3. FM expertise must increase value provided by showing dominant metrics in terms of decreased cost, decreased time and increased capability for the organization.
4. Must decrease overhead costs associated with FM technical services.
5. The successful FM leader of the future is a totally different type of person.

Proposed Solution of the FM Leaders of the Future

The FM leader of the future must have the following characteristics:

1. Create dominant value for the facility owner in terms of lower costs, increased facility capability and quality of life for the facility's core operations.
2. Communicate in non-technical terms to the facility owner.
3. Value must be understood by the facility owner (capability of facility/organization, cost, time).
4. Must utilize FM expertise to cut costs and increase value. There is no other way to increase value while cutting cost.
5. Must be a professional to be recognized by the facility owner.

The FM leader must observe and accept the reality that the FM leadership function is being outsourced, that FM services are being procured based on the lowest price and facility owners view FM functions as a cost.

By observation, the Industry Structure model (Figure 1) identifies the following:

1. The difference between low and high performance, is that when management, direction and control (MDC) is utilized along with minimum standards, the result is low performance.
2. High performance (high value) requires the "utilization of expertise."
3. The movement from low performance (where the expert FM uses MDC to minimize risk) to high performance and value can only be done by utilizing expertise.
4. The FM being the technical expert to the FM being a leader and utilizing expertise is a paradigm shift.

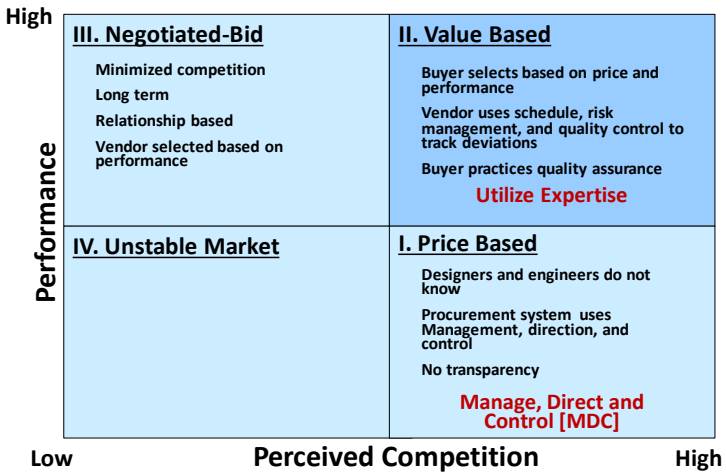

Figure 1: New FM Paradigm Requires Change

By observation and logic of the Industry Structure model, as shown in Figure 1, the FM Leader of the Future must be leadership based instead of management based (MDC). This is resisted by today's traditional FM for the following reasons:

1. It is easier to try to MDC than it is to lead and utilize experts to create value.
2. The traditional FM is the technical expert.
3. MDC is reinforced by education and certification programs.

In the new paradigm, there are three major roles: the new FM leader, the expert vendor and the FM technical expert. All other roles will be minimized. In the new environment, the new FM will identify and align expertise and the expert vendors will create transparency to minimize risk. Risk will be defined as risk that the technical expert does not control, and experts will minimize risk (risk mitigation) that they do not control by creating transparency (not MDC).

Challenges for IFMA

The challenge for IFMA and their membership is to add another area of certification, the FM leader certification. The FM leader must transition from being the traditional expert to a totally different paradigm. The IFMA leadership, the IFMA foundation, the IFMA membership are professionals who are from the traditional model, teaching that the FM is the technical expert. The industry will still need the technical expert (more on the supply side). IFMA Foundation's current effort is to sustain the FM technical expert pool. IFMA must also find a supply of leadership based profession and to find people who want to become the FM of the Future. The FM leadership model of the Future will be a different role in ten years, requiring a leadership based FM who utilizes the entire supply chain and who creates value for the organization. The characteristics of today's traditional FM leader include:

1. Technical expert with technical interests and communications.
2. Detail oriented.
3. MDC.

4. Form relationships based on trust.
5. Work together to solve problems.
6. Thinking and decision making.
7. High stress.
8. Non-changing (do what their predecessors did).
9. Reactive, cost-cutting to survive.

Research results now shows that this traditional FM management model has increased stress and risk in the changing environment that is highly competitive and cost driven. Research shows that all forms of management models (project management, risk management and micromanagement) results in low performance and higher cost and risk in a cost driven environment. The new FM leadership role of the future will have the following characteristics:

1. Leadership-based, non-technical.
2. Vision at 30K feet. Looking at dominant ways to improve value and quality, while minimizing cost.
3. Not interested in technical details. That is the responsibility of FM technical experts.
4. Transparent environment which makes every participant accountable.
5. Form relationships based on performance and value instead of trust.
6. Allows FM technical experts to take responsibility and accountability for solving problems.
7. Allows FM technical experts to create transparency which minimizes the need for the FM to think and make decisions. The mantra of the FM Leader of the Future is "don't make me think. It is not a good thing."
8. Low stress but very exciting.
9. Always changing.
10. Proactive, always allowing change.

This future leadership based FM model is not technically based. It requires leaders and individuals who have a leadership approach and structure to their job. It requires individuals who can utilize the capability of the entire supply chain of FM technical experts and who can integrate their efforts.

Performance Based Studies Research Group (PBSRG) at Arizona State University (ASU)

PBSRG was started by IFMA Fellow, Dean Kashiwagi (Educator of the Year in 2009 and Fellow in 2012), to transform the role of the FM manager from a management, direction and control (MDC) role to a leadership role which would replace MDC with the utilization of the FM technical experts in the supply chain. It was members of the local Phoenix IFMA chapter that assisted finding the opportunities for the first tests. They also became sounding boards for the continual changing concepts.

Metrics that describe PBSRG include (PBSRG, 2015; Duren & Doree, 2008; State of Hawaii, 2002):

1. Longest running construction management (CM), facility management (FM), project management (PM), risk management (RM), research group in the world (23 years).
2. Highest funded research group studying CM, FM, PM and RM ($16M).
3. Conducted procurement tests (1,800) delivering $6B of services in six countries and 31 different states in the U.S.
4. Changed the delivery of services from the traditional to a futuristic FM model in the largest university in the U.S. (ASU) and the most forward thinking country, the Netherlands (Kashiwagi, 2013; Van de Rijt & Santema, 2012).
5. Issued the most intellectually property licenses at ASU (45) (ASU Technology Transfer, 2015).
6. Created Information Measurement Theory (IMT), the Performance Information Procurement System (PIPS), and the Kashiwagi Solution Model (KSM) (Kashiwagi, 2014a; Kashiwagi, 2014b).
7. Client customer satisfaction at 95% of services delivered.
8. Increased FM/PM capability 10 times by utilizing expertise (Smithwick, Schultz, Sullivan & Kashiwagi, 2013; Arizona Department of Environmental Quality, 2015).
9. Published approximately 300 journal and conference papers.

Over the 23 years of research, PBSRG objectives have been to identify the FM leadership model and practices of the future. The objective was to transform the traditional FM manager of today to the FM Leader of the Future. For 23 years, PBSRG has identified that FM Leader of the Future must be a utilizers of FM technical expertise and an integrator of the supply chain. This is defined by an FM leader who is:

1. Leadership based and not management and technical based (Best Value technology).
2. Not a technical FM expert, but a utilizer of FM technical expertise. When an FM leader is the technical expert, they will MDC. They focus on cutting cost. They treat the expert vendors like a separate silo with a "win-lose" relationship.
3. Identifies risk as what is not in the control of the expert.
4. Utilizing expertise and encouraging the vendor to create transparency to minimize risk using the language of metrics.
5. Minimizes cost and increases quality and facility capability at the same time.
6. Brings dominant value that minimizes the need for the facility owner to think or make decisions.

The FM professional of the future is the FM who is leadership based and who is an expert in Best Value technology. The Best Value technology defines the role of a leader as a professional career and job description (Kashiwagi, 2014a). The 20+ years of research was to prove that the FM of the future could make a dominant value contribution while cutting cost. The research was kept alive by calling it the Best Value technology and not the FM of the future, simply because the traditional FM would have identified the research as abrasive and counterproductive to the strengthening of the traditional FM model.

In 1992, PBSRG along with a few visionary FMs in the IFMA Greater Phoenix Chapter, made the following assumptions about facility managers and their leadership-based environment (Kashiwagi, Turnbull, Gunnoe and Rivera, 2015):

1. An increase in complexity.
2. An increase in the number of new systems, products and materials.
3. Owner organizations would increase the political, legal, regulatory and human resource requirements of the FM.
4. The other organizations in the company that the FM was working in would become silos, resisting any attempt by the traditional FM to create efficiency and get the best technical solutions.
5. If the FM continued to be a technical expert, they would be viewed as a cost and a problem, and not an essential core function of the owner, and if possible would be outsourced.
6. The impact of a FM professional working for the owner would decrease unless he could get closer to and more integrated in the core operations of the organization by bringing dominant change (not the technical operations of the facility).

PBSRG research identified a potential sustainable "FM of the future" model and its increased role in the facility owner's operations. PBSRG began looking for FM visionaries who understood this future model. It quickly realized that:

1. Most FMs were not willing to change their paradigm.
2. The majority of FMs were technical based and thinking about how the new model would affect their job and their business and not capable or interested in helping the profession.
3. Most FMs did not know how to change their paradigm. They thought it was someone else's job to change their paradigm.
4. Most FMs did not have the depth of experience in complex FM roles to realize that the FM of the future was a leader and an integrator of expert services.
5. Most FMs were going to attempt to survive and die in the traditional model of being the technical expert.
6. Many FMs were discontinued by their owner and worked as outsourced services or found a government job.
7. Many FMs knew that the value in FM is leadership, but could not parlay that into an actual professional career or operational model.

PBSRG realized that to help the FM professional community, it would be required to do the following research:

1. To clearly define the FM Leader of the Future Model.
2. Ensure that the FM of the uture could bring dominant value.
3. Find a method and source of young students who would be the "FM Leader of the Future."
4. Create an educational program for the "FM Leader of the Future."

PBSRG then made a startling discovery. If they found a visionary student who would qualify as the FM Leader of the Future, they could also be a visionary leader and executive in any profession or industry. The educational and professional opportunity would not be controlled by the constraints of the FM community. These visionaries would follow opportunities. If the opportunity to be a visionary FM was not there, they could easily find another opportunity. The FM community would have to provide FM opportunities to keep the visionary FM of the future.

Therefore, the education program did not have to identify the FM of the future as the end product, but a leadership based person who can utilize and align expertise to create dominant value.

FM Leader of the Future Research Program

PBSRG was faced the following challenges in designing and testing the new research proposal:

1. They understood they would receive no support from the university engineering or management programs. These programs saw little value in any research that did not bring large government grants in their core technical area of engineering and were not open to "out of the box" and huge changes in paradigm. The business school approach to business was so steeped in MDC; it would take 20 years to get any type of support from the WP Cary School of Business at Arizona State University.
2. In 2010, IFMA Foundation and Research and education group was still emphasizing technical core competencies and had limited funding and did know how to fit in this research approach. Many saw this effort as a competing effort that would compete with their limited funding.
3. The current construction management students were not quick enough to understand and embrace the new model.
4. PBSRG would have to find its own funding, create the education, find leadership based students and continue its successful research at the same time.

In 2010, the PBSRG visionaries, made a calculated and bold move. They planned to do the following:

1. Continue to do their research testing of the FM Leader of the Future model (Best Value technology).
2. Increase the number of IFMA presentations and also presentations to PMI, NIGP and ISM chapters to find visionaries who could validate through testing the capability of the FM of the future.
3. Gain access to more visionary students.
4. Create a FM of the future education program. Develop a dominant education program that would be so successful that it would not be stopped by the university bureaucracy.
5. Attempt to gain access to students even before they reached the university level.

Best Value Technology is the FM of the Future Model

The FM of the future model is defined as an FM with the following characteristics:

1. Leadership based instead of technical-based.
2. Not the expert, but a utilizer of expertise of experts.
3. Replaces the MDC of the traditional FM with the utilization of expertise of experts.

The results of over 20 years of testing (1,800 tests delivering $6B of services) include (PBSRG, 2015):

1. 98% customer satisfaction.
2. Minimize cost by 5 – 50%.

Dominant case studies in the 20 years include:

1. The reshaping of the delivery of services at Arizona State University (Kashiwagi, 2013; Kashiwagi, 2014b).
2. The changing of the delivery of services in the country of the Netherlands, starting with a $1B infrastructure test and resulting in the 2012 Dutch Sourcing Award (DSA) (Van de Rijt & Santema, 2012).
3. The delivery of the housing facilities at the University of Utah for the 2002 Winter Olympics (Kashiwagi & Byfield, 2002).
4. The test at Harvard University that resulted in the 2005 Corenet Global Innovation of the Year Award (Kadzis, 2005).

Access to Visionary Students and the Education Program for Leadership-Based Students

PBSRG research resolved the access to visionary students and development of the educational program in one step. IT took the Best Value technology research to the ASU Barrett's Honors College. The Barrett's Honors College at Arizona State University is a program of innovation and impact. It was identified by the New York Times as the "gold standard" of honors education and the Best Value in today's university education systems (Bruni, 2015). Students come to ASU to participate in the honors program and pay an additional $1,000 per year to take additional honors designated classes outside of their core concentration. Honors classes aim to broaden students' worldview and help them innovate and impact society (Barrett Honors College, 2015). The majority of the honors students are in the top 1 - 5 percent of the ASU students and number around 8,000 students annually (~10% of the ASU students) (Barrett Facts and Figures, 2015). In 2008, honors students were given the opportunity to take a Best Value education that did the following:

1. Taught a new way of learning that exchanges the learning of massive amounts of technical information to a process based on logic and observation of natural laws.
2. Taught students to quickly learn almost everything, without knowing almost anything.
3. Emphasized the acceptance of what someone observes with minimal thinking and a minimized need for decision making.
4. Mimicked the characteristics of the new age leaders.

The following concepts are taught in the leadership and deductive logic class:

1. All events happen only one way.
2. There is no such thing as randomness or chance in reality.
3. Everything can be predicted if you have enough information.
4. Everything is subject to laws of nature.

5. The concept of influence or control is not accurate. When people attempt to influence or control others, their risk increases, and many times the results are contrary to what was expected.
6. People who can see into the future are experts in their area.
7. We can create an environment that helps the "blind" or inexperienced people see.
8. Everyone is in a silo, and by understanding reality, they can remove themselves from the silo and understand all things.

As a result of the course, students become much more logical in their thinking. In the span of one semester, students can understand seemingly complex concepts that are outside of their degree concentration. They become leadership oriented. They understand themselves, their families, their peers, their teachers, and their industry in a new light. The instructors document significant changes that the students make in their personal life as a result of the class. If the leadership approach can have significant results that are easily observed, the instructors propose that the logic can be used to create value and change paradigms of people. The following have been significant documented results of the class:

1. A student taking antidepressants for 3.5 years, stopped taking medication, stopped receiving counseling, and became proactive, stabilized, and is now planning on graduate school in counseling (Student #1 Presentation (Video File)).
2. An alcoholic engineering student, identified his genetic disposition to being an alcoholic, ceased drinking, and changed his outlook on life (Student #2 Interview (Video file)).
3. A Navajo student who hated her life and her mother, became transparent, happy, and a successful nursing graduate (Student #3 Presentation (Video file)).
4. A student on the suicide watch list, became confident with himself, happy, productive, and needs no further counseling (Student #4 Presentation (Video file)).
5. An emotionally unstable, depressed single mother with two kids, changed her entire life and became a top graduate from the school of construction management. She received multiple offers from construction management firms and a full scholarship offer from the George Washington Law School (Student #5 Interview (Video file)).

The move to expose the Barrett's Honors College 8,000 students to the FM leader of the future model has resulted in the following:

1. The class went from exposing 25 students to 175 students a semester (PBSRG, 2015).
2. The instructors are the highest rated (5.0 and 4.8 out of 5.0 points) instructors at ASU (instructors with over 50 ratings) on Rate My Professor (Rate My Professor, 2015).
3. The class registration closes within 15 minutes of early registration for honors students.
4. Students wait for up to 2 to 3 semesters to get into the class.
5. It has become one of the favorite honors classes at ASU for engineering, business and liberal arts students.

PBSRG/ASU has also accessed potential FM leaders of the future through the following programs:

1. ASU Barrett's Summer Honor's Program for 7th, 8th and 9th grade students.
2. Tempe School District, Tempe, AZ.
3. St Louis High School, Honolulu, Hawaii.
4. 2016 BSMP Program (116 undergraduate engineering students).

Barrett's Summer Honors Program is run every summer to attract the highest performing students to Arizona State University. For the past three summers, two research assistants (PhD students in the CM/FM area of study) have been teaching in the program. Their performance in conveying the leadership concepts and acceptance by the young students has been amazing. They have scored the same or higher in all the metrics against very experienced professors (PBSRG, 2015; Rivera, 2014).

These results have caught the attention of the ASU coordinator of relations with high schools in the Tempe AZ school district. The leadership education is now being taught for an 11-week period to the Tempe High School on a trial basis to identify if the success from the Barrett's Honors Program can carry over to the High School. If successful, it will be placed in every high school in the Tempe School District (S. Pachuta, personal communication, September 09, 2015).

For the first time, the college honors class "Leadership and Deductive Logic" is being taught at St Louis High School (SLS), a private high school in Honolulu, Hawaii that produced the 2014 Heisman Trophy Winner Marcus Mariotta. The school is testing the "Leadership and Deductive Logic class." PBSRG transferred the curriculum and trained the SLS teachers. The preliminary results have been very encouraging (Arizona Science and Technology Enterprises, 2015).

In the summer of 2015, 116 undergraduate engineering students, who were studying under the BSMP scholarship program of the Brazilian government, did a two-month internship program at PBSRG/ASU. The program was one of the most successful academic engagements by the PBSRG. In a two-month duration, the Brazilian students not only gained an understanding of the leadership technology, but participated in research documentation of research tests that were ongoing in PBSRG. The Brazilian students matched the performance of the ASU honors program in the understanding of the logic (PBSRG, 2015).

PBSRG over the past 20 years has developed a FM based undergraduate and graduate (masters and PhD program). The undergraduate program is the construction management program that is connected to a master's program (known as a 4+1 program). The undergraduates are serviced by the local Phoenix FM chapter and have their own student chapter. The graduate program is developing FM research capability. The FM targeted students are mentored through their education by three professors (FM Fellow/Educator of the Year, Educator of the Year, FM researcher), an FM coordinator, and six FM based graduate/undergraduate students. It is the deepest staffed undergraduate/graduate/research program in the U.S.

Conclusion

PBSRG has identified that the FM role has been changing and will be different in the near future. It will be more of a leadership-based role, requiring a different type of FM Leader. It will be a

high level leadership based professional, and not one requiring years of technical experience and training. The FM Leader of the Future will be required to:

1. Utilize expertise instead of being the expert.
2. Integrate many different expert services.
3. Utilize expert services which dominantly improve the value of FM knowledge while reducing cost.
4. Align the expert services to minimize overhead, administrative and management costs.
5. Lead the entire supply chain instead of managing, directing and controlling internal workforces.

The traditional FM role is being outsourced and the number of slots will be minimized. However the number of FM Leaders of the Future slots will increase. The system to replenish the FM profession has to be different than in the past. It not only has to target the FM technical expert, but also the FM Leader of the Future. It must use different methods, different incentives and target a different type of individual.

1. PBSRG over the past 20 years has developed a pipeline for future FMs. The pipeline includes:
2. A feeder program that attracts high performance high school students.
3. A FM based undergraduate and graduate education program.
4. A research program that continues to help the FM professionals increase their value.
5. Integrated education and research program.

The authors recommend that the IFMA organization not only target students who will be technically oriented for FM work, but also the FM Leader of the Future who will sustain the professionalism of the FM community.

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The Cause of Collusion in the IT and Construction Industries

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In 2002, the Dutch construction industry encountered a problem with collusion. They had a very difficult time understanding the solution to the problem. The visionary Dutch government officials approached the Performance Based Studies Research Group (PBSRG) at Arizona State University to solve the problem. PBSRG introduced the Construction Industry Structure (CIS) and explained that collusion environment is created by the client and not the contractors. Meeting resistance from Dutch researchers, PBSRG created a new research approach upon which the Dutch BV effort flourished. Instead of consensus, PBSRG used simplistic logic, identified visionaries who could understand, and ran tests without years of theoretical discussion. The simplicity of the explanations and the results of repeated testing identified that the problem of collusion was non-technical. It was a problem with the delivery of services. The same problem came up in the ICT industry. PBSRG took the same approach to resolve the problem. Find Dutch visionary partners, educate them, run tests, and document the test and minimization of problems.

Keywords: IT industry, performance, supply chain issues, large organization, Best Value

Collusion in the Dutch Construction Industry

In the early 2000s collusion was identified in the Dutch Construction industry. The cause of the collusion was identified as contractor greed (Doree, 2004; D. Kashiwagi & J. Kashiwagi, 2011). In response to these allegations the government moved to penalize the guilty parties but discovered that the penalized amounts would be greater than the profit generated by the colluding vendors. In order to maintain stability in the industry a few scapegoats were identified and penalized, while the rest of the industry was persuaded to build a case against the scapegoats by providing information on the collusion. Those who volunteered information were promised to be exonerated. Kashiwagi proposed that the cause of collusion was the owners and not the contractors. In the price based environment, the owners used management, direction and control (MDC) of the contractors to minimize risk. The MDC is inefficient, ineffective and causes non-transparency. It minimized the profit margins of the contractors and forced them to collude to survive.

Construction Industry Structure (CIS)

The CIS model was created as a part of a dissertation in 1991 (Kashiwagi, 1991). The source of low performance was identified as an owner generated problem and not a vendor generated problem (Figure 1).

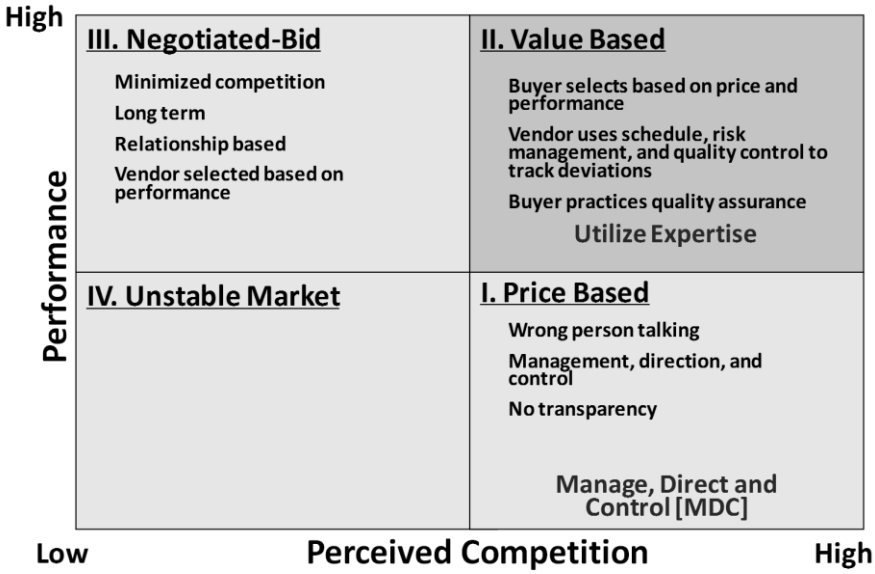

Figure 1: Construction Industry Structure (CIS) model. (Information Measurement Theory by Dean Kashiwagi, 2014a, Tempe: Ksm-inc.)

The CIS identifies that the major difference between low performance and high performance is caused by the owner's use decision-making, and attempt to manage, direct and control (MDC) the vendor's actions to minimize risk, instead of utilizing expertise. The results of this practice include (Kashiwagi, 2014a):

1. Poor performance
2. Higher costs
3. Inefficiency
4. Decision making
5. Need for relationships to be formed to solve problems
6. Low perceived value for expertise
7. Commodity practices
8. Non-transparency (an environment where the source of the problem is not easily identifiable).

It is in the priced based environment where collusion occurs. Collusion occurs when there is non-transparency, where profit margins are low, and contractors collude to survive. The concepts of the CIS was being presented in CIB conferences in Trinidad, Tel Aviv and Singapore, and eventually led to meeting a fellow CIB member (George Ang, Ministry of Housing). George Ang then brought Dr. Dean Kashiwagi into the The Hague, Netherlands to present to the various ministries in 2004 (Ang, 2011).

Kashiwagi realized that there was a problem in the Dutch construction industry and in the construction management academic research community. The problem was simple; the explanation was simple and easily observable. However, no one wanted to help solve the problem using simple solutions. Kashiwagi tried to reach out and gain consensus. It did not work. Finally, he found a visionary in the supply chain area (Sicco Santema and the consulting

group Scenter) (Van de Rijt, 2011). Five years later, the CIS model and Best Value Approach are understood by everyone.

Kashiwagi realized it was not a paradigm issue only with the industry, but also with the research community. The research community was too slow, too cumbersome, and caused more problems than solutions. By observation and logic, this would lead to silos. A new research approach would have to be used to bypass the bureaucracy of the academics who became far too comfortable with documenting what other academics were saying, instead of knowing what was actually happening. Kashiwagi identified the traditional academic research community as colluding partners (no different from the industry), accepting only what they felt comfortable with, and rejecting anything that came from somewhere else or that they were uncomfortable with because it may have conflicted with their previous academic documentation. A new approach to academic research was needed.

New Academic Research Approach

In 2004, PBSRG decided to use a totally new research approach. Unlike other researchers, who utilized government grants and publications in peer reviewed journals to be promoted and tenured, Dr. Kashiwagi decided to create a different research approach. It included:

1. Using a deductive logic based approach, using mixed methods to identify the research data and reach his conclusions.
2. Instead of using extensive literature search to identify what the industry and other academic researchers were practicing, he assumed that the industry was wrong, and their perceptions were inaccurate, and using their concepts would be a waste of time and resources.
3. Instead of using an inductive approach, he used a deductive approach, simplifying by using natural laws and common sense that minimized the need to discuss or make decisions. Even though, this was against the academic research model, and he was told that he was not a good researcher and his research had no value, he pursued this course. (reference)
4. He used natural laws that can be observed, that are commonly accepted and used simple concepts that minimized the need to discuss with peers or get peer reviewed for validation.
5. He identified industry experts who understood and agreed to test his concepts.
6. Ran repeated testing, analyzing the hypothesis and modifying the hypothesis through test results.
7. PBSRG did simultaneous research on non-traditional theoretical concepts, prototype testing of the proposed concepts and implementation into organizations.

The new research approach allowed PBSRG to use models that were simple, accurate, and easy to understand by the industry. PBSRG assumed that the academic community would not come up with a solution of the collusion, and used its multiple industry test results and simple explanations to bypass the rest of the academic community. By 2005, PBSRG had successfully tested the CIS concepts and the Best Value Approach with multiple International Facility

Management Association owners in the Phoenix metropolitan area, the State of Hawaii, United Airlines maintenance site in San Francisco, the Federal Aviation Administration, and the State of Utah.

At this time, the construction management academic research experts in the Netherlands did not come to consensus about the cause of the contractor collusion, the CIS model, and CIS explanation of collusion. It seemed too simple. Most academics perceived that the vendors were at fault, that the Dutch construction management researchers felt that the Dutch culture was different from the American culture and the CIS solution was not accurate. Only one academic research source, Dr. Dean Kashiwagi from PBSRG/ASU, the author of the CIS model and the creator of the BV approach, proposed that it was the owners and not the vendors who were at fault. He used deductive logic, common sense, and case study test results in the United States to validate his proposal.

An effort was made by Dr. Kashiwagi to involve more Dutch researchers, but his insistence to run industry tests without the consensus of all the Dutch researchers was unsuccessful. Instead of staying with the traditional, Dr. Kashiwagi, began applying PBSRG's unique research approach defined and discussed in the previous paragraph. Bypassing further discussion and consensus of the Dutch Construction Management academic researchers in the Netherlands, Dr. Kashiwagi, went right to the industry (Hijmens, Rikkswaterstaat and Scenter) and formed partnerships to test out the CIS concepts (Van de Rijt, Hompes & Santema, 2010; Koreman, 2011). A lead Dutch visionary in one of the major construction companies (Marc Gillissen), multiple visionaries in the Rijkswaterstaat, and a visionary professor in marketing and supply chain at Delft University (Sicco Santema) accepted the CIS model explanation and the Best Value Performance Information Procurement System (BV PIPS) as a solution to change the environment of the delivery of construction services resulting in the following actions (D. Kashiwagi & J. Kashiwagi, 2011):

1. Heijmans Construction licensed the Best Value Performance Information Procurement System (BV PIPS) from ASU.
2. Rijkswaterstaat was also licensed with the BV PIPS technology from ASU.
3. Scenter (private consulting company led by the visionary Sicco Santema) and the Delft University were licensed with the technology.
4. Scenter was educated and trained by PBSRG. They ran small successful BV PIPS tests in 2008-2009 (Van de Rijt, Hompes & Santema, 2010).
5. Rijkswaterstaat ran a huge test by procuring $1B "fast track" infrastructure projects using BV PIPS (called Best Value Procurement or BVP) assisted by Scenter and PBSRG. (Van de Rijt, 2011)
6. The fast track project results using the CIS and BV concepts minimized procurement transactions and costs for all parties by 50% (owner and competing contractors), contractors reduced construction time by 25%, and test results confirmed the CIS model of utilizing expertise to minimize risk is accurate and 90% of all project cost and time deviations are actually caused by the owner. (Van de Rijt, Witteveen, Vis & Santema, 2011).
7. As a result of the "fast track" project test results, NEVI (the third largest organization of professional procurement personnel in the world) licensed the BV PIPS technology from

Arizona State University (ASU) through AZTech and has begun to educate and certify all procurement personnel in BVP and the CIS and the underlying logic of the BV PIPS approach which is called Information Measurement Theory or IMT (PBSRG, 2012, AZTech, 2012). The BV PIPS approach, which moves the paradigm from the price based MDC environment, to the utilization of expertise environment is now one of the major thrusts of NEVI. They have recently hired a new Director of BVP education and are expanding their offerings to assist all stakeholders in understanding of the BV PIPS approach. (Jeroen van de Rijt, email dated 11/11/2015 from Jeroen van de Rijt to Dean Kashiwagi).

8. The RISNET organization comprising of risk managers and professional engineering groups also licensed the technology from ASU.

Results of the New "Non-traditional" Research Approach

The history of documented changes within the Dutch procurement as a direct result of the implementation of the CIS and BV paradigms along with dominant project successes have validated the CIS model and its concepts. The CIS model and the BV PIPS or Best Value Procurement (BVP) is now accepted and used as a mainstream model in the procurement of services in the Netherlands. The traditional academic research model of performing a literature search of existing concepts, proposal of a theoretical solution based on the literature search, survey of industry experts to identify which industry characteristics are most influential in the collusion, and presentation in academic journals to seek consensus in the academic world was not used due to the extensive time requirement and impracticality quickly solving and assisting the construction industry with its collusion problem.

The traditional research process would be too lengthy, would not assist the industry in a timely manner, and would utilize opinions of industry and academic personnel that were "a part of the existing problem." Instead, the PBSRG deductive logic approach in the Netherlands and elsewhere has resulted in the following:

1. Twenty-two (22) years of research testing, $16M of research funding, 1,800 tests, 98% customer satisfaction delivering $6B of services (PBSRG, 2015).
2. The most licensed technology (45 licenses) developed at ASU, one of the top innovative research universities among universities in the United States without a medical school.
3. Two five-year longitudinal studies which identified the client and their representatives as the largest source of project cost and time deviations. Vendors create minimal risk when transparency allows the identification of the sources of risk (D. Kashiwagi & I. Kashiwagi, 2014).
4. The PBSRG proposed concepts and research testing results were audited by both the State of Hawaii Legislative group and by a dissertation from one of the most prestigious universities in the Netherlands, the University of Twentee. (Duren & Doree, 2008; Rijt & Santema, 2013; State of Hawaii Report, 2002) PBSRG is the only research program to be officially audited and the results published by third parties. Due to research partners' investment into the PBSRG research coming from the organizations' operational funds, PBSRG research results are audited continually.

5. 250 journal and conference publications showing that management, direction and control (MDC) results in poor performance. (PBSRG, 2015).
6. Validated the CIS or IS model, and identified that the paradigm must be changed to deliver higher quality construction services (Kashiwagi, 2014b).
7. CIB W117 committee on the Use of Performance Information in the Construction Industry, who is one of the major sponsors of the PBSRG testing, has done research work in seven different countries and 32 different states in the United States validating the same concepts.

This new approach of simplistic explanations backed by test data resulted in the industry cooperating with the academic research. Owners are now desiring to utilize the expertise of expert vendors to lower costs and increase value. They have moved from the management, direction, and control (MDC) model to utilizing expertise. This has been accepted by NEVI (Dutch professional procurement group), by RISNET (risk management group) and the Dutch professional engineering group. The new approach has also fueled efforts by Sicco Santema, the Best Value visionary, to partner with Delft University to bring the new academic research approach to the Netherlands. This has bypassed the efforts of the traditional construction management groups.

The authors are proposing that what has been going on in the Dutch construction industry, is also going on in every other industry. Through the efforts of NEVI, the Best Value Approach is reaching every industry, including the information, communication technology (ICT) industry. When collusion charges came up against a major ICT vendor, the authors quickly identified the collusion as caused in major part by the owners who were buying ICT.

Collusion in the ICT or IT Dutch Industry

The delivery of services in the IT (information technology) or ICT (Information, Communication Technology) industry is perceived as being non-performing. The following has been documented on the nonperformance of the ICT industry:

1. ICT non-performance is estimated as high as 75% (D. Kashiwagi & I. Kashiwagi, 2014).
2. Major consulting company claims that the projects are too complex, and the complexity is causing the nonperformance. (Standish, 2013)
3. New project management model, the agile approach, which maximizes communication and documentation, movement in smaller increments of time, and works from beginning to end instead of from the end to the beginning (Scrum Alliance, 2013).
4. Dutch government inquiry is held to identify the source of the ICT industry nonperformance and the large amount of resources being wasted on ICT projects. The result of the inquiry shed no more understanding of the problem (Tweede Kamer, 2014).

One of the larger Dutch ICT industry partners was identified as being in collusion with Dutch government officials. (Zembla, 2014) Even though the company has not been convicted of crime of collusion, the company was cast in a poor light. At the same time, PBSRG was notified of

another large government client was having problems with another major ICT vendor on a Best Value project.

Past research results showed that the client/owner was/is the biggest source of risk in the delivery of construction services. Because the source of risk is not technical (client/buyer using MDC to deliver projects and minimize risk), the authors propose that the problem is not a technical problem (complexity of the technology, lack of technical expertise, or complexity of the requirement). The authors propose that the CIS or IS, identifies that poor performance and collusion is caused by the client attempting to manage, direct and control (MDC) projects to minimize risk. The authors propose that the client is creating an environment, which is:

1. Nontransparent, confusing and based on relationships.
2. Does not utilize expertise.
3. Filled with decision making from non-experts.
4. Resulting in inefficiency, ineffectiveness, and poor performance.
5. Not understanding what risk is and how to utilize expertise because experts have no risk.
6. The areas of risk management and project management have to be redefined and new paradigms must be utilized to increase the performance of the ICT industry.

This research takes the following simplistic path. It has been identified that collusion is caused by the owners attempting to minimize non-performance by making decisions and attempting to manage, direct, and control the expert vendor. The research will first gain access into the Dutch ICT industry to attempt to identify if an ICT vendor can have high performance in the Dutch ICT industry by utilizing expertise instead of using management, direction, and control (MDC). The research will then select large traditional ICT vendors who will have more difficulty changing from the non-transparent, inefficient, and bureaucratic environment to a Best Value environment, and identify if they have interest in the BV approach, and how they are attempting to change from a MDC environment to a BV approach. The following steps will be taken:

1. The researchers will search and identify an ICT vendor that does not utilize MDC to deliver their service. Their performance will be identified.
2. If the performance is dominantly higher than the industry performance of 25% success, the authors will investigate if the problem of MDC is in the ICT industry.
3. Identify a large traditional ICT vendor and identify if they have a bureaucratic or MDC environment.
4. Identify if the large traditional ICT vendor has a performing project or a BV project.
5. Analyze the project to identify what made the project different.
6. Analyze the owner/client of the performing project and identify what they did differently.
7. Also, identify if the client/owner visionary is facing resistance from MDC personnel in his own organization.
8. Identify an effort with a large ICT vendor responding to BV project request that resulted in the client using decision-making and MDC to eliminate the vendor's BV effort.
9. Identify the difference between the price based and BV environments, and identify the difficulty for a large ICT vendor to change into a BV oriented vendor.
10. Analyze the results of the case studies to see if the environment delivering ICT services is in the price-based arena resulting in low performance.

Research Case Studies

The first case study is to identify a high performance ICT provider in the Netherlands who is utilizing expertise to have high performance. Schuberg Philis (SBP) is one of the ICT companies in the Netherlands that is known for their high performance and unique company structure (D. Kashiwagi & I. Kashiwagi, 2014). After studying SBP it was confirmed that SBP was an expert company that delivered high performance (See Table 1):

Table 1

Schuberg Philis Overall Performance Line

#	Criteria	Metrics
1	Total # of projects in last 10 years	991
2	# of large projects (€150K- € 3.3 Million)	47 (72)**
3	% of large projects on time	89.36%
4	% of large projects on budget	95.74%
5	% of large projects customers satisfied	93.62%
6	Highest customer satisfaction 7 years in a row (Market Average)*	8.9 (6.9)*
7	Recommended by customers by year	100% 5 years in a row
8	Business Process Availability past 4 years	99.994%

* Market average was taken from 2014 Giarte Report
**72 projects existed however; documentation older than 6 years was discarded and not available.
Source: Schuberg Philis Audit on Project Metrics 2009-2014 by Sandeep Panday, 2014: Schuberg Philis.

The following are documentation on Schuberg Philis:

1. They are the top rated ICT vendor in the ICT infrastructure area (in every category measured).
2. They have a project performance of 89.36% on time, 95.74% on budget, and 93.62% customers satisfied on 47 large projects in the last six years.
3. Of the six most critical ICT providers that support financial vital infrastructures as stated by DNB (same function as Federal Reserve Bank); they are the only vendor with 100% customer recommendation for outsourcing.
4. In the last four years, their business process uptime performance is 99.994.
5. Their customer satisfaction rating was 8.9 in 2013 – highest in the IT market for 7 years in a row, 2 full points above the market average (6.9).

Some unique characteristics about their organizations is that (D. Kashiwagi & I. Kashiwagi, 2014):

1. They have no MDC.
2. They have very high performance.
3. The authors conclude that Schuberg Philis is a BV company that delivers high performance.
4. They prove that if a vendor is BV oriented (no MDC), they will deliver very high performance.

The authors conclude that Schuberg Philis (SP) is an expert vendor who utilizes expertise in the Dutch ICT industry. Their operations are in a BV environment. If ICT vendors mimicked SP's operations, the need to collude would disappear. By deductive logic, the authors propose that the low performance in the Dutch ICT industry is caused by owners using MDC. This is identified by the Industry Structure (IS) model as the price based environment. IS identifies larger, traditional organizations or vendors, are more likely to be bureaucratic, inefficient and in the price based environment. Using deductive logic and observation that the large ICT vendors are having difficulty changing their paradigm, the Dutch ICT industry is in the price-based environment (identified by organizations using MDC to minimize risk, no transparency, inefficient and wasteful, and allows collusion). The authors will identify large traditional ICT vendors and show that even if their operations are in the MDC or bureaucratic environment, they are seeking to gain the capability of using the BV approach. If the large traditional vendors are having difficulty in making the transformation, it validates the idea that it is the price based paradigm and not the malicious intent of the ICT vendor that is causing the perceived collusion. This will logically show that the collusion is being caused by the price-based environment, which is controlled by the owner and not the ICT vendors.

Case Study of Large Traditional ICT Vendor

One very large traditional ICT Vendor was accused of being in collusion. When questioned by the research team, they had no understanding why collusion occurs. In their efforts to change the public perception and mentality of the company, the vendor began to investigate the Best Value Approach. As the BV approach stressed "win-win" relationships and utilization of expertise to deliver high performance and low costs, the vendor formed a BV core group to achieve these results. The BV core group discovered that some of their experts within the company were already thinking and acting with the BV approach. An example of this was identified was the vendor's BV performing project at the Port of Rotterdam.

The project was investigated to identify its level of performance. Five key participants on the buyer's side were interviewed and the status of the project was reviewed. Findings include (Port of Rotterdam project participants, personal communication, June 6, 2015):

1. The owner/client's procurement manager utilizes BVP as the procurement approach.
2. The client PM faces resistance from his own organization.
3. BV approach required a change in paradigm from MDC to utilizing expertise on both the buyer and vendor side. This required both the vendor and buyer to go through a learning curve changing their paradigm.
4. The paradigm shift had been a big challenge to the project for both the vendor and the buyer.
5. The project is successful, and the project team identifies the project as a success.

Table 2

Sample analysis of data Table explicitness

#	Criteria (10 is strongly agree, 5 is don't know, 1 is strongly disagree)	Results
1	The owners' inability to utilize expertise of expert vendors is a source of risk and poor performance.	8.2
2	Unlike Schuberg Philis, which was already practicing a BV approach, many larger traditional companies (using MDC and reactive behavior) have a very difficult time changing to the BV approach.	7.6
3	Owners also have difficulty changing from the MDC approach to the Best Value Approach.	8.2
4	Until larger vendors change their approach, the industry will not have the momentum to change paradigms.	6.2
5	Large owners would have a difficult time changing the traditional buyers and project managers' paradigm.	5.8
6	The owner have a difficult time implementing a clarification period.	5
7	The implementation of a clarification period would tremendously increase the project performance.	9.4
8	A clear plan which includes the functions of all the stakeholders would increase the performance of the project.	8.2
9	The Best Value Approach changes the project management, risk management and the definition of risk (what the vendor does not control).	8.6
10	Decision making is reduced if the expert's plan is utilized.	8
11	The Best Value Approach is the optimal approach to increase project value and performance.	8.4
12	The expert vendor can utilize the Best Value Approach even if the selection methodology was a more traditional relationship award, if it implements a clarification period, a weekly risk report, and creates transparency.	6.6
13	Rate the vendor's performance (1 is unacceptable, 5 is average and 10 is outstanding).	8.4
14	What would the performance be under the traditional approach?	5.6
15	Was the performance delivered by the BV vendor higher than would have been delivered under the traditional approach (MDC)	4 out of 5 (yes)
16	Is the traditional PM model (MDC) accepting of the BV approach?	5 out of 5 (no)
17	Did the PMs have to change their paradigm to do BV?	3 out of 5 (yes)

The following observations are made on the responses of the owner's team:

1. The owner's team understood that their weakness was to utilize the vendor's expertise, instead of MDC the vendor.
2. They were undecided about the ability of their large organization to change.
3. Then in question 5, they identify that they do not know if their project managers can change their paradigm.
4. They did not understand the clarification period (key period where the vendor lays out a detailed plan from beginning to end of what will be delivered).
5. Even if they did not understand the clarification period, they agreed that to have a good clarification period would increase performance.
6. They also rated the vendor's performance under the BV effort as much better than under the traditional approach of MDC.
7. They all agreed that the traditional price based MDC environment was not accepting of the BV model.

This case study proposes the following:

1. The owner's visionary, who was the procurement manager, faced great resistance during the BV test from stakeholders in their own organization.
2. Some of the stakeholders attempted to remove the visionary BV expert from the project.
3. At the end of the project, the stakeholders would now do the BV effort again, even if they opposed it at the start of the project.
4. The owner's traditional ICT environment is a MDC, price based, non-transparent environment.
5. The owner's test team realized that the BV environment delivers higher performance.
6. The client has to change their paradigm to use more of the BV approach.
7. The large traditional owner and vendor is having a difficult time changing their paradigm.

By observation, both the large owner's organization and the large ICT vendor is having difficulty changing the paradigm from a price based to a Best Value paradigm. This confirms that the vendor, which is being accused of collusion, is in the price-based environment and will need to change its paradigm to avoid the possibility of collusion.

Case Study of Large Traditional ICT Vendor Submitting on a BV Effort

This large traditional ICT vendor also attempted to win a Best Value project. Being coached by an A+ BV certified expert and PBSRG, the vendor understood the BV process and knew they would require experts in order to compete and secure the subject project. The ICT vendor put their best experts on the project; one of their best project managers and best technical experts on Oracle. In responding to the request for proposal of the buyer they attempted to show how they could provide a high expertise in relation to the buyer's project objectives. In one of the three two-page documents, some of their main substantiations of their expertise include (personal communication, July 7, 2015). The following sections are directly from the ICT vendor's submittal:

"(Objective 1 & 4): The key personnel of the supplier are an experienced project leader Transition and an experienced service delivery manager, which contributes to the objective of unburdening with regards to system management and a risk-free and effective transition. The project leader Transition has successfully:

1. *Brought 2 ERP* (Enterprise Resource Planning) *environments to system management through a transition in the past 4 years. The results were:*
    a. *Deviation regarding time and budget 0% (Fixed Price projects)*
    b. *Average project budget €5.1 million*
    c. *Customer satisfaction 8*
    d. *On average more than 10 interfaces and 20% custom work*
2. *Taken care of 3 ERP implementations in the past 7 years, including decharge. The results were:*
    a. *All 3 > 3 million*
    b. *Deviation regarding time and budget less than 5%*

   c. *Customer satisfaction 8*
3. *Implemented information security 1 time at a government agency so client and supplier are compliant to the information security policy (BIR).*
   a. *Deviation regarding time and budget 0% (Fixed Price Project)*
   b. *Budget 70 days*
   c. *Supplier received discharge*

The service delivery manager was responsible at two EBS & BI (E-Business Suite & Business Intelligence) *clients for 3.5 years for the delivered services (FAB, TAB and TB) and achieved the following results:*

1. *Client 1:*
   a. *System management budget €325,000 per year*
   b. *Customer satisfaction: 8*
   c. *17 EBS modules, 16 interfaces and 164 custom work components*
2. *Client 2:*
   a. *System management budget €1,860,000 per year*
   b. *Customer satisfaction 8*
   c. *22 EBS modules, 12 interfaces and 157 custom work components*
   d. *Score of 8.4 for availability and 7.1 for performance EBS platform*
   e. *Availability 99.98% (24/7)*

(Objective 5): Provider allocates a certified experienced information security specialist on the project that has a proven track record in meeting the compliance of managed systems. This contributes to the objective of fulfilling all requirements regarding the protection of personal data and information security. Supplier allocates an information security specialist:

1. *Certified CISSP (associate)*
2. *Who ensures the information security policy for 55 ERP contracts (34 EBS, 21 SAP) and performs 6 compliancy checks every month.*
3. *Finds an average of 1 customer security incident per month and manages it.*
4. *Supplier has been audited by an external party and holds the certificates ISO/IEC 27001 (Information Security for all types of organizations). 130 system management contracts are part of the certification. The system management contract of Buyer will also fall under this.*

*(Objective 1 & 3): Supplier achieves an availability of the production environments of at least 99.8%, 24*7 (excluding agreed maintenance slots), this contributes to the objectives of Buyer for continuous availability, availability outside regular office hours and makes working from home possible. Supplier achieved this high availability in 2014 at three similar clients with EBS/BI system management contracts:*

1. *Average availability production 99.95%*
2. *Average number of managed interfaces 17*
3. *Average number of users 1750*

(Objective 2) Supplier achieves the desired service levels from the SLA from day 1, this contributes to the effective cooperation with Buyer and in particular with Functional System Management. Performances of the supplier in 2014 are:

1. *Handled a total of 1294 technical EBS client notifications for 34 system management contracts*
2. *Achieved SLA response time in 91%*
3. *Achieved SLA resolution time in 92%*
4. *Achieved SLA resolution time for 14 technical EBS client notifications with priority "Very high" in 100%"*

The results of this submittal shocked the IT vendor as they had thought they had provided sufficient information to reflect their expertise to this project. However, the client/buyer rated them with a neutral rating of six on a scale 2 to 10 in their claims of expertise for the following reasons:

1. Good linking support to performance targets; Applicant thus demonstrates in principle to achieve all project objectives.
2. Applicant shows experienced people, which are more likely to have done ERP transitions and less frequently EBS transitions.
3. Many quantitative substantiation of the claims which the question is how verifiable (and dominant) are these numbers? Performance support is limited in relation to the actual Buyer proposed approach. This makes Vendor less clearly understand the mission.
4. Conclusion: Vendor provides a relevant achievement underpinning; here, however, shows no (dominant) added value that justifies a higher score than neutral.

The subject vendor did not make it to the shortlist. From observation, the owner's selection committee made a decision to eliminate the subject vendor (this is against the rules of the BV PIPS procurement system). The PBSRG researcher (Kashiwagi is also the creator of BV PIPS and industry expert) who analyzed this case and who understands the BV approach, comes to the following conclusions:

1. The subject vendor should have received a 10 rating based on their performance metrics supporting their expertise.
2. The owner made a decision, which goes against the BV approach and the selection phase rules.
3. If owner's representatives continue to do this, they are resisting the change to the BV paradigm of utilizing expertise and minimizing MDC.

Case Study of another Large Traditional ICT Vendor Winning a BV Effort

In the initial development phase of the Best Value Approach another large IT vendor began competing and investigating the approach. The Vendor bid and won a telephone/communications integration project. However, due to the buyers and Vendors inexperience with Best Value and the current maturity of the BV approach in the Netherlands key elements of the process were overlooked such as the clarification phase. The project ended in failure with the Vendor was

unable to deliver the client's expectations and the project reverting to a traditional paradigm of the owner making decisions and utilizing management, direction, and control (MDC).

Table 3

Vendor BV core team bid results

Involvement of BV Team	% to next phase interviews	% to next phase: clarification/won	Involvement of BV Team
BV team part of bid team	100%	56%	BV team part of bid team
BV team support role	67%	25%	BV team support role
BV team not involved	36%	18%	BV team not involved

Since then, the Vendor has become more involved and educated in the BV effort and has formed a BV core group within their organization. The BV core group has become knowledgeable and successful in winning project bids and educating company individuals to deliver high performance, some key indicator of success includes (See Table 3) (personal communication, October, 29, 2015):

1. +/- 10 members (solution consultants, bid manager, project managers).
2. Internal training sessions (since 2013 63 training sessions, > 600 participants).
3. 100% success rate in going to the interview phase of project bids when BV team is part of bid team, 67% when BV team is in a support role (less active role), and 36% when BV team is not involved at any level.
4. 56% success rate in winning bids, 25% when BV team is in a support role, and 18% when BV team is not involved at any level.
5. Vendor is expanding their effort from the sales/marketing group to the project management group and are observing that level of expertise has diminished due to long period of owner's MDC approach to ICT services.

Conclusion

The problems in the ICT industry are the same problems that were faced in the construction industry. This research resulted in three case studies. In the first case study the following was observed and documented:

1. A high performance vendor was identified who does not use management, direction, and control (MDC) in the delivery of their service by using expertise. Their performance is the best in the Dutch industry. It shows that if a vendor has a Best Value environment, they will perform to a very high level.
2. The high performance ICT vendor has no performance issues. Their performance is dominantly better than the other large traditional ICT vendors.
3. The study of their performance shows that they are in the BV environment. A bank study identified the most impactful ICT vendors in the Netherlands. The high performance vendor is one of the vendors.

Two of the other large ICT vendors who are trying to gain the capability to deliver performance were approached. Both vendor environments were in the price based environment (bureaucratic, difficulty identifying expertise, and difficulty in meeting the requirements of a BV effort). Both large ICT vendors were engaged in a BV effort, and both clients had problems in implementing the BV environment due to a lack of understanding of the BV paradigm. In both cases the clients were facing the resistance of traditional approaches to delivering projects. Both clients showed that there must be a paradigm shift in not only the vendor's approach but the client's approach. Both large ICT vendors have visionaries who realized the importance of changing the project management and risk management paradigms.

The research shows that the CIS model can be utilized in the Information Communications Technology (ICT) industry. It also validates that the largest source of risk is the owner's decision-making, and their use of management, direction, and control (MDC) to minimize risk and deliver performance. The authors propose that the use of expertise will reduce project cost and increase vendor profit.

The ICT industry is in the price-based environment where the owners are attempting to manage, direct, and control (MDC) the vendor to minimize project cost and risk. The ICT industry is facing the same issues as the construction industry. The results of this study propose that the owners can increase project value and minimize project cost by utilizing expertise. By observation of both industries and the case study results over 20 years in multiple countries and cultures, the changing of the environments from a price-based environment to a BV environment requires experts who think differently (see into the future before they do a project, identify the project requirements in simple terms that all stakeholders can understand, identify everyone's role in the delivery of the service, and minimize the risk of the project by creating transparency and not MDC to assist everyone to see into the future to minimize risk).

The ICT case studies have shown that resistant stakeholders resist because they do not understand the future outcomes, and will cooperate if they can see the future outcomes. This is the requirement of the expert, to simplify and create transparency so that all stakeholders can see the future outcomes. This environment requires a new project management approach and a new risk management approach, both of which the Dutch Best Value effort is working to develop. This research has also validated through deductive logic and mixed methods the Industry Structure model. It has identified that the owner/buyers have created an environment, which is conducive to collusion through their MDC based procurement systems. The Dutch ICT industry collusion case is no different from the Dutch construction collusion case. The research also shows that the BV model has worked in both industries and can assist vendors in the Dutch ICT industry to improve.

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The Development of the Best Value Approach in the State of Minnesota

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Owners in the State of Minnesota have a ten-year history of implementing the Best Value (BV) approach utilizing the Performance Information Procurement System (PIPS) with the Performance Based Studies Research Group (PBSRG) at Arizona State University (ASU). The University of Minnesota started testing and implementing in 2005. Other users quickly followed. By 2015, over 400 projects valued at approximately $500M had been delivered using the Best Value process. The results of the BV test projects validated the industry structure analysis concepts and results from another longitudinal study performed by the U.S. Army Medical Command (MEDCOM). The paper also discusses the modifications in the BV approach during the ten-year development. The research conclusions include the following: identified the owner and owner's representatives as the major source of project risk (time and cost deviation); the identification of professional designers as a source of risk; contractors selected by the BV approach was the smallest source of project risk; and a paradigm shift is required to optimize the delivery of construction services. This paper concludes with a case study on a large construction renovation project with the Best Value minimizing project cost by the contractor thinking in the best interest of the client.

Keywords: Best Value, Minnesota, delivery of services, source of risk, minimizing cost

Introduction

The University of Minnesota brought the Performance Based Studies Research Group (PBSRG) and the Best Value Approach to the State of Minnesota in 2005. Michael Perkins, associate vice-president of capital projects and a civil engineer, became interested in the approach a couple of years after Dr. Kashiwagi had presented to some procurement personnel at the University of Minnesota (UM) in 2003.

Perkins realized that the current method utilized by the University of Minnesota was not optimal. His objectives included (Perkins, personal communication, October 14, 2015):

1. Bring the latest approaches and technology in delivering construction to the University.
2. Create efficiency in his own organization.
3. Make the University personnel accountable.
4. Hire performing contractors who would increase value and performance and minimize change orders.

Michael Perkins clearly believed that the traditional process of telling the contractors what to do and awarding to the lowest price was detrimental to the University. This tendency increased cost, caused performance issues, and decreased the accountability of the University's staff.

The State of Minnesota BV tests were preceded by the Federal Aviation Administration Western Region (Goodridge, 2007; Kashiwagi, 2011), State of Hawaii, University of Hawaii and State of Hawaii DOT (waterproofing, roofing, painting and DOT repaving) (Kashiwagi et al., 2001; Kashiwagi et al., 2002) and State of Utah (large vertical construction projects) (Kashiwagi et al., 2002) BV testing. Simultaneously to the State of Minnesota, Harvard University (Kadzis, 2005) and the U.S. Army Medical Command was also (Kashiwagi et al., 2009) testing the BV concepts on procurement, risk and project management. However, the Core of Engineers procurement group out of Huntsville, Alabama ran the BV operation, and continued to clash with the MEDCOM visionary Nathan Chong (Chong, personal communication, August 27, 2015). The effort was more of a test in the shift in the paradigm of traditional project management and led to the term PIRMS or Performance Information Risk Management System.

Up until this time, BV testing by previous research partners had focused primarily on the procurement or selection of the Best Value contractor. Past performance information was the most critical component of the BV system. The name for the Best Value Approach at that time was "Best Value Procurement" (Kashiwagi, 2010). During the selection phase, great care was made to identify risk and the method to mitigate the risk. The vendors were requested to also identify how they were adding value to the project. The interview was key to confirming the high past performance. If the vendor did not perform, their past performance counted up to 50% of their future performance rating. The Best Value Procurement (BVP) system was based on (Kashiwagi, 2011):

1. Vendor past performance database kept by the owner.
2. Dominant high performance capability of the Best Value vendor's key project managers to act like experts.
3. Trust model between the user's project managers and the vendor's project managers.
4. Minimized need for the client/user's representative to have a detailed, definitive scope of work for the vendors.
5. The client announcing their budget to the vendors.
6. No formal cost control for the Best Value vendor. If the vendor showed outstanding performance, they were hired at their requested price.
7. A multi-criteria decision making model (Zeleny's Displaced Ideal Model (DIM) (1982)) was used to identify the value of each piece of information by multiplying the normalized relative value of each vendor's number by the information factor

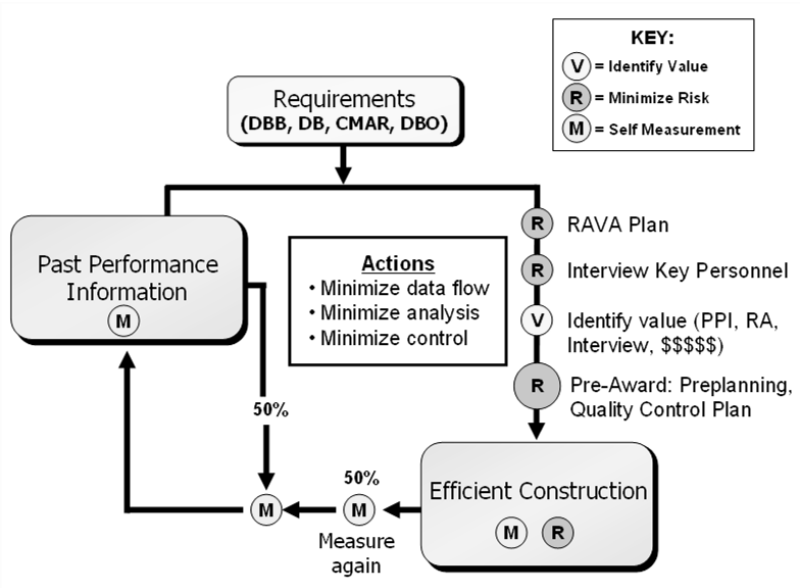

Figure 1: Best Value Procurement Closed Loop System.

Except the large vertical projects at the State of Utah ($50M 2002 Olympic Village construction and a $17M Southern Utah University Recreational Facility), all the other projects had very few detailed drawings and specifications.

Transformation to a "No Trust" BV Approach

The results were dominantly better than anything that had been recorded in the construction industry (98% customer satisfaction, on-time, on budget) (PBSRG, 2015). The early visionaries in the BV testing program realized that there were major flaws in the traditional system to deliver construction:

1. It took too long for the professionals working for the client to design solutions.
2. The professionals were not always the most knowledgeable of construction methods.
3. The expert vendors' (construction contractors) expertise was not being utilized.
4. When the designers identified the scope of the project, their scope was not detailed enough to get competitive bids from experts (did not provide the best quality, minimize change orders and minimize project cost increases and time delays).
5. The low price award was not working on a consistent basis to increase the contractor's quality.
6. The owners could not consistently get contractors to be accountable.

The BV research effort results of the "Best Value Procurement", prior to the State of Minnesota tests, resulted in much higher performance than the traditional delivery systems, but was not totally successful in overcoming some of the major flaws of the industry identified above.

Lessons learned from the project tests before the State of Minnesota (Kashiwagi, 2015b):

1. The Displaced Ideal Model (DIM) which was being used to identify the Best Value contractor was too complex for the construction industry stakeholder and contractors to understand. Industry stakeholders called it a black box which was being controlled by ASU.
2. The greatest risk of the BV approach was political risk. Political risk, and poor performance results, stopped the BV efforts of every visionary BV expert. Political risk was caused by owners' representatives not understanding the value of expert contractors.
3. The majority of the construction industry personnel were reactive and inexperienced.
4. Many project managers who represented owners in the government sector did not understand how to identify high quality. They used subjective minimum standards that required a high degree of management, direction and control from government project managers.
5. Technical people (engineers, project managers) gravitate toward technical details which direct a contractor on how to do work, technical information based on minimum standards and decision making based on the "subjective" minimum standards. Very few technical experts understood how the minimum standards were derived.

It was clear that a paradigm shift needed to be made in the development of the Best Value Approach to minimize these issues. To clearly differentiate the Best Value Approach which addressed these issues, PBSRG and the creator of the Best Value Approach model, renamed the approach with the new name of the Performance Information Procurement System (PIPS) to differentiate it from all other Best Value processes which used the more traditional practices of management, direction and control, but was using the name of the Best Value Procurement process. During the State of Minnesota tests (2005-2015) the Best Value PIPS process was transformed from a procurement centered process to an approach that optimized procurement, project management and risk management (Michael et al., 2008, Kashiwagi, 2015b).

Transformation of BV PIPS Required a Unique Research Approach

PBSRG is a research center based at ASU which does not request or utilize government research funding for its Best Value research ($16M over 20 years). It allowed PBSRG to not have links with existing traditional processes, but to use an entirely different approach to solving problems. PBSRG can immediately identify and test "disruptive" practices without having to coordinate with traditional practitioners. It allowed PBSRG to identify current practices as inaccurate and inefficient. All funding was spent on research testing. If PBSRG could not find research partners who wanted to test the hypothesis, PBSRG would have to shut down its research. Unlike other research centers, it has the following objectives and developments (Rivera, 2014; Kashiwagi, 2015a; Kashiwagi, 2015b; PBSRG, 2015):

1. Use deductive logic, common sense and simplicity to solve industry problems instead of the more traditional inductive approaches.
2. Use mixed methods research focusing on simple solutions based on (commonly acceptable) natural laws and humanistic concepts using case studies, survey results and

results of testing outside of engineering (psychology, psychiatry, education, business and government studies).

3. Proposes the problem of poor construction service performance was not a technical problem but a humanistic problem caused by human beings who are attempting to use detailed technical knowledge and data skills to solve a humanistic and societal problem.
4. Identified that a significant breakthrough in understanding in construction, facilities, project and risk management was the Construction Industry Structure model (changed to Industry Structure (IS) model when it was discovered that the problem was not construction industry specific).
5. Created a new deductive logic based theory called the Information Measurement Theory (IMT) as the foundation of the IS model. IMT identifies that no one can control or influence another human being, that with sufficient information the actions of human beings can be predicted and human beings can only do what they understand. IMT identifies thinking, decision making and managing, directing and controlling (MDC) in any form as the major source of construction nonperformance and project deviations.
6. Identified multi-criteria decision making (MCD) models such as Analytic Hierarchy Process (AHP) and the Displace Ideal Model (DIM) as academic analysis tools only useful within academia. They are useful to help academic researchers understand human decision making, however, would not be suitable for use in test projects done within government procurement. PBSRG identified that these complex mathematics tools will never be sustainable and consistently used by government agencies, private organizations or vendors to select Best Value vendors or individuals. This was dominantly shown in the State of Hawaii tests, where the use of the DIM (the simpler and the easier to explain and use of the MCD models) was a major contention of those fighting against transparency, vendor accountability, performance metrics and fairness. It was identified by industry as a "black box" that was being manipulated by Arizona State University (Kashiwagi, 2011; Kashiwagi, 2014). Research project results identified that public procurement requires transparency which is simple and easy to understand. This is what the authors identify as a natural law (there are no exceptions) that is deductive based on observation during research testing.
7. The only academic research group in construction, project and risk management that utilizes a college honors class (Barrett's Honors Program), high school classes (St. Louis School, Honolulu, Hawaii, Tempe High School, Tempe, AZ), industry experts and families to collect information and validate simple concepts of human nature (requires less thinking and decision making), physical natural laws (such as gravity) and human behavior which were used as the foundation of the construction management research.

The material was so innovative, that the university licensed the BV approach research material as intellectual property. It is the most licensed academic based research technology developed in the construction management area.

PBSRG is the only research center in construction management which has experienced the following (PBSRG, 2015):

1. Continuous funding for 20 years, $16M funding with 1,800 tests delivering $6B of services.
2. Repeated hypothesis testing where the hypothesis are continually modified based on lessons learned.
3. Had research results audited by another university and by a U.S. state legislature (Department of Commerce and Consumer Affairs, 2002, State of Hawaii, 2002).
4. Had a research proposal rejected by the National Science Foundation (NSF) in 2004 for lack of research value and then received funding from Harvard University to run the tests, with the test results at Harvard winning the 2005 Corenet Global Innovation of the Year award. (Kadzis, 2005)
5. Changed a procurement approach of the largest university in the U.S., and delivered $1.7B worth of services with the change, saving the university millions of dollars (Michael et al., 2008).
6. Changed the procurement approach of a country (Netherlands) in seven years, overriding years of traditional concepts taught in the country's universities. Changed the approach of the group NEVI (third largest procurement group in the world) to go from the traditional to accepting the Best Value PIPS approach which changes the paradigm of procurement using IMT and CIS concepts. (Kashiwagi et al., 2013, Van de Rijt et al., 2012)
7. Has performed testing in six different countries and 32 different states in the United States (PBSRG, 2015).

PBSRG is constantly being challenged by younger researchers, or researchers at more traditional construction management schools who are silo based and only accept concepts that are published in peer reviewed journals. These researchers do not have an understanding or knowledge of the BV literature. The BV approach is based on the IMT and IS which has not changed theoretically over the past 20 years. However, the application and implementation has made tremendous strides. The advent of the internet has now created a transparent environment which now places premium value on the speed at which researchers can get their technology to the marketplace. PBSRG has taken the approach that peer reviewed journals are too slow, and too bureaucratic to have any impact on the industry it is trying to help.

Timeline of Best Value Research Clients

The large number of tests (400) over ten years, allowed PBSRG to accomplish what may have been too costly and time consuming if traditional research practices were required. Traditional research is more consensus based; utilizing surveys, statistical analysis and changing processes and systems only after the industry has agreed to the changes. PBSRG, using the IS model, identified that management, direction and control were inefficient and ineffective, and that the utilization of expertise was the only way to minimize project cost and increase value. PBSRG proposed the following to the industry:

1. The owner is the biggest source of risk and cost on the project.
2. The more detailed contracts are, the more inefficient and costly the services will become.
3. The more contracts are used to enforce the project requirements, the higher will be the project cost.

4. When contractors are experts, they have the expertise to have a plan and can do risk management and quality control while tracking project cost and time deviation.
5. Standards are subjective, have no relationship with actual performance, and are very difficult to enforce.
6. The current delivery systems for construction are broken, allowing non-experts to do poor quality work.
7. Contractors and manufacturers are treating the minimum standards as maximums and are driving the delivered performance down as low as they can.
8. Using technical people as construction managers to represent the owner is a broken system that creates confusion and makes all parties reactive to protect their own interests.

All research partners in the State of Minnesota were selected because they accepted these observations and identified them as accurate based on their experience. The research tests tested these observations. There was no need to have discussions and gain a consensus on these concepts. If they did not agree with these concepts, they did not partner with PBSRG to run tests. This approach made the research testing efficient and quick. Many peer reviewers resist the notion that the metrics are valid because of the preponderance of test results. What the traditional research community has to accept is that this is the only research that has been audited multiple times (Duren et al., 2008; State of Hawaii, 2002; Department of Commerce and Consumer Affairs, 2002).

The timeline and major results of the BV testing in the State of Minnesota is presented below (Table 1) along with the significant results of the projects:

- 2004 – University of Minnesota's first contact: Michael Perkins, Associate Vice President of the CPPM of University of Minnesota at that time, attended a Best Value conference at ASU.
- 2005 – University of Minnesota: Michael Perkins decided to pilot the PIPS Best Value program in testing the PIPS structure. The first tests were implemented in the mechanical, electrical and roofing areas of construction. The projects became bigger as time went on, and developed into new capital improvement projects (CIP) (Sullivan et al. Perkins et al. 2007; Sullivan et al., 2008).
- 2007 – BV becomes a law in Minnesota to procure construction. The University of Minnesota was not bound by the state statute, and therefore, was able to implement the BV approach ahead of the change of law. The unions used the PBSRG documentation (13 years of testing) and the University of Minnesota test results to pass the bill. This freed up all other government organizations to test the Best Value model. The only requirement of the law was to be trained in the BV approach, and the number of tests were limited for the first few years. The union legal representatives and lobbyists were interested in getting the Best Value Procurement approved for construction because of the perception of the deterioration of the subcontractor craft capability and their perception that the move would ensure that the training that the unions were doing would maintain its value and market share with signatory (union) contractors.
- 2008 – City of Roseville: The City of Roseville tested BV procurement out on a complex, state of the art, ice rink project. The City of Roseville wanted a "state of the art" power

generation source for their ice rink. They ended up procuring a hydro-electric power generation system that was very efficient. (Smithwick, Sullivan and Kashiwagi, 2014)

- 2009 – City of Rochester: Led by Richard Freese, the city moved from the priced-based system, to the BV PIPS system, procuring large vertical construction projects, professional services, IT systems and DOT projects. (Kashiwagi, 2014)
- 2009 - Olmstead County: Application of one BV project. (Kashiwagi, 2014)
- 2009 - Rochester Public School: Tests of BV PIPS on a school renovation and upgrade project. Used the triple prime concept, then moved to a general contracting approach. Their experiences led to the proposal to either return to triple prime contracting or utilize a mechanical and electrical level of expertise, risk and value added documents. The Rochester School district identified along with other users that the primary source of risk was their nonperforming design work. (Kashiwagi, 2014)
- 2010 Independent School District (ISD) 287 announced the largest test of Best Value in Minnesota (up to this time) with the construction of the North education center in Plymouth, MN. (Rosemeyer, 2013; Smithwick et al., 2013).
- 2010 Rochester Public Utility: Application of BV on construction projects. (Kashiwagi, 2014)
- 2012 City of Roseville Parks and Recreation: Returns to using Best Value on a large park renovation project. (Smithwick et al., 2014)
- 2012 Hennepin County: Implementation of BV PIPS in the Property Services division. (Kashiwagi, 2014)
- 2012 Elk River ISD 728: Implementation of BV PIPS. (Kashiwagi, 2014)
- 2015 City of Rochester: Procures a $55M convention center modification project using the majority of the proposed changes (PBSRG, 2015).

Table 1

Completed Test Projects Performance Metrics

Performance of the State of Minnesota Testing	City of Rochester	City of Roseville	Hennepin County	District 287	Olmsted County	Rochester Public Schools	Rochester Public Utilities	UMN
Total Number of Projects	8	5	9	4	1	39	2	353
Original projects budget (M)	$39.82	$4.94	$28.97	$29.97	$12.36	$38.13	$1.55	$330.69
Average length of project	361	306	254	285	310	206	325	155
Satisfaction score (out of 10)	9.63	9.71	-	8.88	8.75	9.98	8.13	9.50
% Over awarded budget	1.92%	0.79%	0.57%	2.53%	4.43%	4.71%	2.05%	10.50%
% Due to client	0.92%	0.20%	0.14%	0.36%	1.16%	1.26%	0.06%	9.65%
% Due to vendor	-0.05%	0.00%	0.00%	0.00%	-0.21%	-0.08%	0.00%	0.04%
% Delayed	11.71%	5.37%	13.11%	11.01%	12.73%	1.45%	209.05%	46.16%
% Due to client	7.88%	2.89%	2.52%	7.41%	5.45%	0.50%	81.90%	34.69%
% Due to vendor	3.83%	0.00%	0.00%	3.22%	0.00%	0.06%	0.00%	2.33%

Modified BV PIPS Concepts and Practices

The following changes to the BV approach were identified and implemented during the State of Minnesota test (2005-2015) (Kashiwagi, 2014):

1. Eliminated any descriptions of the required scope of work in the RFP submittal from the competing vendors.
2. Introduced a level of expertise criteria that is totally dependent on the vendor to do a specific and unique project of a client.
3. Introduced a dominance check to ensure the selection process has been done correctly and accurately and verifying that the performance metrics submitted by the Best Value vendor are accurate.
4. Introduced the clarification period (project and risk management), where vendors must have a detailed plan from beginning to end, represented by a milestone schedule that is represented by metrics (cost, time, and deliverables), and produce a weekly risk report (WRR) that is a part of their contract).
5. Phased out of the performance information that was used by the clients/owners to track vendor performance and to modify vendor's the performance rating. This was the emphasis of the previous approach.
6. The implementation of a cost control system that minimized the risk of decision making and overpayment.
7. Utilized metrics to create transparency and communicate a contractor's value.
8. Created transparency by going to a system of performance metrics and cost, making the BV PIPS system totally non-technical.
9. Identified that the designers/engineers were the major source of construction cost and time deviations.
10. Also identified the owner's representatives as the largest source of risk who allowed the professionals to continue to increase design cost and construction project risk.

Without the research testing in the State of Minnesota, PBSRG and their industry partners would not have been able to test and improve the BV approach to resolve the traditional challenges of construction nonperformance. The modified BV approach is to minimize:

1. Owner decision making and MDC.
2. The risk of hiring vendors who do not have the expertise required to perform on a project.
3. Confusion that arises with project cost and time deviation.

These changes were made during the past 10 years and are described in case study bullet points below. The validation of these concepts were exhibited in the last project in the State of Minnesota, which is described in the latter part of this paper.

Lessons Learned and Changes in the BV Approach

The biggest challenge in the research was the change of paradigm to move from the owner price based environment to the Best Value environment (see Figure 2). The change was a paradigm shift and not a legal issue. The change of procurement law allowed the government owners to

use the Best Value Approach, however, the paradigm shift was the more difficult to change. To make this move, the owner had to not act as a technical expert and make decisions and MDC the expert vendors. The owner's technical representatives had a difficult time stepping back, forcing the expert vendors to use performance metrics and cost to identify the Best Value vendor. It showed that the clients were using the BV PIPS as a procurement and not a project/risk management approach.

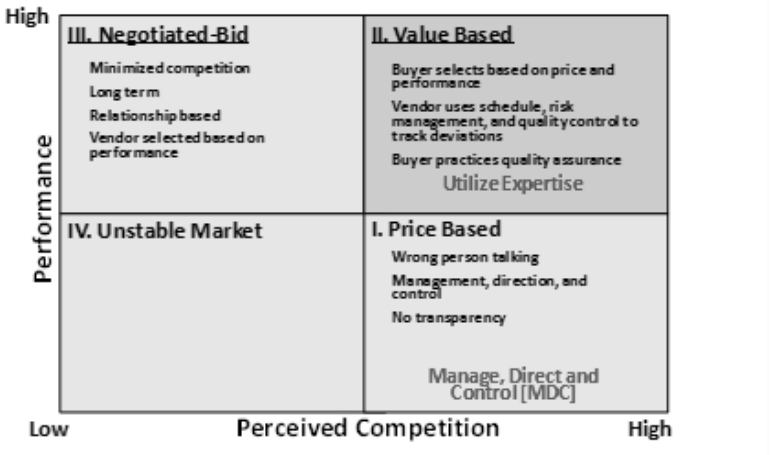

Figure 2: Construction Industry Structure.

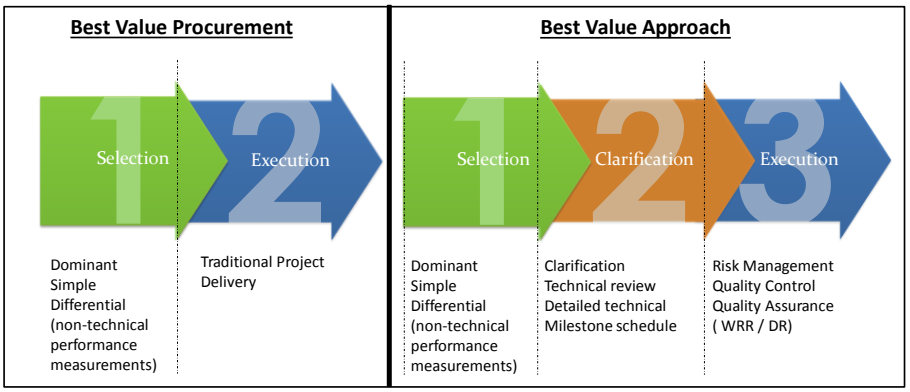

Figure 3: Best Value Procurement to Best Value Approach.

In the last year of testing at the University of Minnesota (UM) (testing lasted for five years), the importance of the clarification period and weekly risk report was realized and implemented. The most difficult task was for the UM visionary Michael Perkins to introduce the change in paradigm after it had been introduced as a BV procurement system. The emphasis changed from the past performance information and database to the importance of using dominant performance metrics which addressed the vendor's level of expertise and capability on a specific project (Figure 3). Only then could a clarification period to create transparency and the implementation of the weekly risk report (WRR) be utilized properly. However, it gave the approach a much better capability on large complex projects. Michael Perkins retired due to a change in administration in 2015 (his job being a political appointed position) (Perkins, 2015). Michael

continues to follow the advancement of the BV approach and attends the annual trainings in Tempe, Arizona.

The UM BV effort was resisted by the professional core of engineers and project managers. When the BV Procurement approach was introduced, the professional engineers went along with the change. It dealt with procurement and was perceived as not affecting their project management. However, when the BV project and risk management approach was implemented, they saw it as a change in their professional job, and resisted.

The City of Rochester was a continuous user of the BV approach. Their use of the process showed the same movement from a procurement system to a project/risk management system that the UM experienced. Their visionary, Richard Freeze, had the main challenges of first, changing his own role from technical to non-technical; second, transforming the effort to get the city to not MDC the vendors through construction managers; and third, minimizing their decision making during the selection, clarification and execution phases.

He also encountered political risks as he had difficulty convincing others in the City of Rochester to understand the advantage of releasing control and utilizing expertise. The city had a practice of hiring a construction manager that did not lead to performing results. Another one of his challenges was the selection of other city personnel who had seemed to have an affinity for the Best Value Approach, but who then reverted to the traditional practices of MDC. He had a very difficult time getting the professional services to understand Best Value. He was one of the main reasons the BV Approach lasted for over ten years in the State of Minnesota.

The next largest user of the BV PIPS approach was School District 287, who ran the $29 million new school construction. The facility manager, Tom Shultz, with the support of PBSRG, utilized BV PIPS and the triple prime approach (hired general contractor, mechanical contractor and electrical contractor as prime contracts). He also hired the technology vendor as a prime. His performance numbers were very high as contractor generated change orders were under 2% and he saved the school district $2.6 million in construction management fees (Rosemeyer, 2013, Smithwick et al., 2013). Table 2 identifies the major metrics in the ISD 287 BV test. He was awarded the FM of the year for IFMA's Minneapolis chapter in 2014 (IFMA Minneapolis/St. Paul Chapter, 2013).

Table 2

ISD 287 School Construction Metrics

Project Name	Value ($M)	Duration (Months)	Schedule Delay %	Budget Deviation %	Client Satisfaction
NEC – General Construction	$25.9	17	0%	2.8%	10.0
NEC – Technology Systems	$1.6	7	32.7%	0.9%	7.6
NEC – Demountable Walls	$2.0	7	0%	0.4%	9.0
TOTAL:	$29.5	11	11%	1.4%	8.9

James Kelly also used the BV approach in combination with Triple Prime contracting (general contractor, mechanical subcontractor, and electrical contractors as prime contractors). His performance is identified in Table 3. James Kelly perceived that the general contractors were bringing nonqualified contractors into the projects. By using Triple Prime, the high performance mechanical and electrical contractors were identifying and mitigating the risk of poor design work. After James retired, the school, due to a lack of construction expertise, returned to the general contractor approach. The results were not as successful due to general contractors hiring low-performing subcontractors or suppliers. The Rochester Independent School District results shed some light on what the sub-trades were stating about the current construction industry structure and the reason for the Triple Prime approach:

1. The most critical components in many vertical construction projects was the mechanical, electrical and the plumbing (MEP).
2. The general contractors' functions were commodity-based and their markups and MDC of the critical MEP contractors was not optimal.
3. They were proposing either to use the very successful MEP in a triple prime approach or to use BV and identify the MEP components as the most critical.

When the Rochester School District went to utilizing general contractors, they did not get the results that the Triple Prime approach produced. This can be attributed to the following:

1. When using a general contractor, the critical subcontractor's risks and risk mitigation were not considered. It diluted the value of the subcontractor's risk identification and mitigation, as general contractors started using subcontractors risk and risk mitigation for other subcontractors. It resulted in the critical subcontractors' expertise and risk mitigation becoming a commodity item.
2. The general contractors were then shopping for the lowest price.

This case study showed why the Triple Prime contracting (TPC) approach was so effective in both the Rochester Independent School District and District 287 projects. Its strengths are utilizing expertise, maximizing the value of the clarification period, minimizing change orders and minimizing the need for the client to MDC.

Table 3

Important Owner-Related Delay Factors

Performance Criteria	**Rating**
Total number of completed and in-progress projects	33
Total awarded cost	$29.6M
Average number of proposals per project	4
Percentage of awards where Best Value was the lowest price	55%
Average Contractor Change Order Rate	0%
Average Contractor Delay Rate	0%
Average Customer Satisfaction Rating (1-10)	9.9
Performance Criteria	Rating

Rochester Convention Center Extension Case Study

Most of the modifications discussed previously were implemented on the last large project run by the City of Rochester to construct its extension to the existing convention center. PBSRG was utilized to assist in running the delivery of the construction services.

The following concepts were not utilized on the procurement due to discomfort with the concept and the PBSRG project manager's or the City of Rochester project management group's:

1. Level of expertise criteria.
2. Adding criteria of sheet metal, air conditioning and plumbing level of expertise, risk assessment and value added.
3. The criteria of electrical level of expertise, risk assessment and value added criteria.

The process was run and Table 4 shows the resulting award matrix. The Best Value vendor was over 5% more in cost, than the next vendor. Table 5 shows the difference in scoring between the two competitors. The owner selected the lowest costing option due to the lack of sufficient information to differentiate between the value of the two competitors and the large difference in cost.

Table 4

Selection summarized scoring Matrix

				RAW DATA				PRIORITIZED DATA			
No	Criteria	Scale	Weights	Vendor A	Vendor B	Vendor C	Vendor D	Vendor A	Vendor B	Vendor C	Vendor D
1	Cost	-	250	$65.61 M	$67.45 M	$67.45 M	$60.39 M	230	224	224	250
2	Risk Assessment	1 - 10	225	8.1	5.4	5.1	8.4	216	133	131	215
3	Value Added	1 - 10	175	8.8	5.8	4.8	8.8	169	109	91	164
4	Interview	1 - 10	350	8.2	5.6	5.2	7.6	350	239	222	324
5	Critical Subcontractors	1 or 0	15	1.0	1.0	1.0	1.0	15	15	15	15
			1015				**Totals**	**981**	**720**	**683**	**968**

Table 5

Best Value Selection Comparison

Criteria and Weights				RAW DATA		PRIORITIZED DATA	
No	Criteria	Scale	Weights	Vendor A	Vendor D	Vendor A	Vendor D
1	Cost	-	250	$65.61 M	$60.39 M	230	250
2	Risk Assessment	1 - 10	225	8.6	8.4	216	215
3	Value Added	1 - 10	175	8.8	8.8	169	164
4	Interview	1 - 10	350	8.2	7.6	350	324
			1,000				
					Price Points	23%	25%
					Performance Points	74%	70%
					Total Points (1,000)	**97%**	**95%**

The Best Value vendor gave the following justification for their lower price:

1. On previous successful projects that were awarded to their company by the City of Rochester, they had very high performance, no contractor generated time or cost change orders and their pricing had been an average of 5% below the average of the other contractors' pricing (PBSRG, 2015).
2. They had no contingency for risk they did not control, minimizing their cost.
3. They used Best Value practices of minimizing any overhead and markup costs of building systems by hiring multiple sub vendors in the key areas.
4. They used different construction methods.
5. They utilized expertise from outside of the local area to minimize cost in key areas. The outside expertise had been previously utilized by their sister company in a different city.
6. Where possible they utilized local expertise to minimize per diem and travel costs.
7. They realized that the most difficult task on the project was the initial coordination and setup of the Best Value structure. They utilized their top project manager and BV expert to setup the system, and once their project/risk management system (utilizing the weekly risk report) was setup during the clarification phase, the BV project manager would not be on the project full time (minimizing his high salary on the project).

PBSRG, working with the different government entities in the State of Minnesota, had previous information on the BV expert project manager being utilized by the Best Value vendor on this project. Research had shown that:

1. The identified project manager on the project had been selected by the vendor after five unsuccessful attempts to gain a Best Value project based on the project manager's

affinity to the BV philosophy of transparency, accountability, and utilizing the new concepts of risk management. The vendor team adopted the Best Value Approach and won nearly 80% of all Best Value projects that they proposed on that PBSRG was tracking.
2. The project manager had presented on the Best Value Approach with PBSRG in a different state and was expert enough that some of the attendees questioned if he worked for PBSRG.
3. The vendor had become an expert in transparency, clearly laying out the project in the beginning of the project, and identifying the project risks that they could not control and how they proposed to mitigate the risks. Due to the transparency they did not have project contingency funding for risk that they did not control.
4. They had outstanding performance in the local area of the City of Rochester, with no contractor generated change orders.
5. They were highly accountable to service the client's needs.

This vendor had an advantage over the other vendors because the vendor was already practicing Best Value and not just putting together a Best Value tender. The other vendors were putting together teams of highly rated vendors but were not as good at "thinking in the best interest of the client." In the follow-up with the competing contractors, the Best Value contractor's advantage could be clearly identified in the questions and responses of their competitors.

Conclusion

The Best Value Effort in Minnesota is one of the most significant BV testing in the 20 years of the development of the BV approach (1993-2015). The lessons learned include:

1. The BV approach is not a procurement process. It is a paradigm shift of procurement, project management and risk management.
2. The paradigm shift is for the owner to replace management, direction and control with the utilization of expertise.
3. The BV process is not a trust based system, but one of providing transparency using metrics which assists the owner to understand the project in simple, non-technical terms.
4. The BV expert who is grounded in the Information Measurement Theory (IMT) is indispensable to the owner or to the vendor due to their ability to create transparency and win-win situations.
5. If the visionaries representing the client in the delivery of construction are technically oriented, they will have a great propensity to get confused with technical details, decision making and management, direction and control (MDC).
6. The major source of risk in the delivery of construction is the design and engineering element in which the scope is not accurate and does not utilize the expertise of the contractors.
7. The BV approach to project delivery does not necessarily require a visionary in the owner's organization. It can be created by the vendor's visionary in the clarification period or in a post award clarification meeting that vendors can utilize.

8. The similarity to a boss in an organization micromanaging their personnel, is similar to the owner using MDC in a supply chain delivery of service.
9. Transparency (not MDC) is the way to minimize risk.
10. Transparency is created by the expert in the beginning to minimize confusion and risk caused by stakeholders (who are not expert) during a project.
11. An expert contractor does not have risk. Risk is what an expert does not control. People's misperception of risk is a source of non-transparency and risk.
12. Many owner representatives are uncomfortable with transparency due to the accountability that is inherent in the transparency.
13. The critical trades of mechanical and electrical work are key in minimizing risk in building construction. The Triple Prime contracting approach aligns the expertise to the riskiest areas of construction.

More testing is needed to ensure that the modifications made in the Minnesota testing are effective, efficient and sustainable. Current projects in Canada, Saudi Arabia, the State of Hawaii and in other places across the world are testing these modifications. The researchers propose that more research testing is required and that the new methodology of PBSRG to use deductive logic and actual industry tests is needed to ensure that the industry changes its traditional construction paradigms to increase the performance of the construction industry.

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The Replacement of Warranties with Logic and Common Sense

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Many problems are caused by owners specifying project technical requirements to expert vendors, then picking the low-price vendor, assuming that all the vendors are providing the same quality of product. Research over the last 20 years has identified that when working with highly technical areas, this practice brings high risk to the owner because the vendors do not have the expertise to understand the requirements. The Alpha sprayed polyurethane foam (SPF) roof system has brought the Dallas Independent School District (DISD) high value but also occasional risk caused by the low-price vendor. The authors are proposing that DISD's effort to buy the Alpha SPF roof system through the low-price competition will cause DISD risk. A new approach is proposed to DISD: the Alpha SPF roof system only be used as an alternate value added option. This approach assumes that the only way the Alpha SPF system can be procured is if it is in the best interest of the owner due to dominant value. This approach minimizes the risk that DISD has encountered from low-price contractors who have not been able to minimize risk through the use of expertise and experience because their low-price was directly related to practices which are related to a lack of experience and expertise.

Keywords: roofing, Alpha Program, Sprayed polyurethane, Best Value, performance

Introduction

Sprayed polyurethane foam (SPF) roof systems have been installed since the early 1970s. SPF roof systems have the following characteristics:

1. Have the highest insulating factor out of all roof insulation systems.
2. Have the lowest weight compared to any roofing system (0.50 PSF (3 PCF)).
3. Monolithic.
4. Has a very technical application utilizing an exothermic reaction that transforms two liquid components into a rigid three-pound density SPF.
5. The industry has changed the insulating refrigerant material numerous times to meet EPA standards, causing applicators to change their temperatures and process details.
6. It is a sustainable and green roof system (renewable, minimizes the need to remove the existing roofing system and lightweight).
7. The SPF industry has had difficulty regulating itself, resulting in many SPF roof failures.
8. Properly installed SPF roof systems have performed very well. The industry has always remained less than 3% of the roofing industry due to their inability to regulate the performance of their contractors.
9. SPF roof systems require a coating system to protect it from UV degradation.
10. Confusion on the performance of different coating and SPF roof systems (hail resistance, UV degradation and ability to sustain roof traffic).

11. Warranties are used by sales/marketing personnel to attempt to identify performance.
12. Warranties are used as marketing and are not related to performance.
13. In 2001, when coated SPF systems failed at Dallas Independent School District (DISD), and the manufacturers did not honor the warranty, DISD stopped using coated SPF roof systems.

An example of illogical warranty and marketing information was provided by Factory Mutual (FM), (one of the two largest building insurance groups), who put out a report that all coated SPF systems, offer hail protection against 1-3/4 inch size hail based on their hail testing. Research group known as Performance Based Studies Research Group (PBSRG) testing in 1996 could not verify their results. Their published results identified silicone coating as the most hail resistant, and urethane coatings as offering the worst protection. PBSRG tests found it was the exact opposite (Kashiwagi & Pandey 1996). FM testing was done only on new coatings and coating systems that were weathered using artificial weathering. When actual aged systems in the field were tested, the results verified that the Alpha urethane coating was the only coated SPF roof system that offered protection against 1-3/4 inch size hail (Kashiwagi & Savicky 2003).

Only one SPF coating system has documented high performance in heavy hail areas. The Alpha system, made by Neogard, is the only coated SPF system with documented protection against hail. Other urethane coatings have not documented the same protection after being exposed to the elements.

One of the school districts in Dallas (DISD) used the design-bid-build procurement approach to award contractors to install SPF roof systems. The resulting poor performance of SPF roof systems led to a DISD policy of "no SPF" roof systems on DISD roofs. It has not been proven that the price based approach can be used to utilize the value of the hail resistant Alpha SPF roof system.

Dallas Independent School District

From 1987-2001, DISD had a few high performing Alpha SPF roof systems, but the majority of the SPF systems failed. It was common for the coating and SPF manufacturers to offer warranties but not honor those warranties. Since DISD could not utilize their warranties and due to poor performing SPF roof systems, in 2002, DISD banned the installation of SPF roof systems.

DISD is in a heavy hail area, and is self-insured against hail damage. DISD identified that the Alpha roof system (with sufficient urethane coating) on the Casa View School roof showed 16 year performance with no maintenance. In 2002 DISD allowed the installation of the Alpha SPF roof system in a Best Value Procurement test to identify if the same high performance could be duplicated. The results showed that the Alpha SPF roof systems were installed with high performance (Kashiwagi & Savicky 2003). Due to the dominant performance results, DISD changed their policy and allowed the installation of the Alpha SPF roof systems.

In addition to the test results, the Neogard Corporation supported the Alpha roof system with a joint and several warranty, covering the performance of the SPF and the Alpha coating system. These warranties held the insured parties (Alpha coating manufacturer, SPF manufacturer, and the Alpha contractor) joint and severally, liable for any defects of the system that included blistering and delamination. Defects that were not covered by the SPF industry were covered by the warranty (leaking was the only recognizable defect covered by warranties). The joint and several warranty, along with the proven performance of the Alpha roof system in hail areas, differentiated the Alpha SPF roof system and helped convince the DISD to continue to install the Alpha roof system.

In 2005, DISD had a bond program to renovate their school buildings. The bond program eventually ran short of funding. Due to the shortage of funding, DISD did not utilize the Alpha SPF roof system and its warranty, but utilized a ten year SPF system, with a more traditional 10 year warranty. The 10 year urethane coated SPF system (no joint and several warranty) was still at a much lower cost compared to the traditional built up and modified roof systems. The contractor's bids were shopped and one of the contractors used a SPF system that was not utilized in the Alpha program.

Table 1 shows the SPF roof performance of the Alpha roof systems at DISD based on the physical inspections of 98 roofs. Evaluating roof coverings using physical inspection and reporting the repair or replacement conditions to the owner have been used for other roofing systems (Coffelt et. al. 2010, Sharara et. al. 2009). Table 2 compares the blisters and repairs at DISD for the last 4 years.

Table 1

Overall DISD SPF roof performance

No.	Criteria	Unit	Performance
1	Oldest job surveyed	Years	22
2	Average age of jobs surveyed	Years	7
3	Age sum of all projects inspected	Years	675
4	Average total repairs on each roof	SF	348
5	% of roof repaired	%	0.79%
6	Average total existing blisters on each roof	SF	16
7	% of roof blistered	%	0.035%
8	Average blister size	In.	4"
9	Average job area (of jobs surveyed and inspected)	SF	43,128
10	Total job area (of job surveyed and inspected)	SF	4.3 M
11	Total number of jobs inspected	#	98

Table 2

Blister and repair comparison at DISD

No	Criteria	Unit	2015	2014	2013	2012
1	% of total roof area blistered	%	0.035%	0.038%	0.098%	0.131%
2	Total blisters	SF	1,525	1,599	3,915	4,117
3	% of total roof area repaired	%	0.79%	0.62%	0.38%	0.27%
4	Total repairs	SF	34,137	26,046	14,946	8,721
5	Total job area	SF	4.3 M	4.2 M	4.0 M	3.2 M

Despite the low-bidding and shopping of the Alpha roof contractors bids, DISD has received performance from the roofs that were installed. One of the reasons for using the Alpha roof system was the Alpha program required their contractors to maintain 98% customer satisfaction and no leaking roofs on an annual basis to continue to be allowed to install the Alpha roof system. This included all roofs that were installed by the roofing contractor. If they had issues that resulted in customer dissatisfaction, they were required to fix the roof. This resulted in many of the DISD roofs being maintained by the contractors, not as a warranty requirement, but as a requirement to get further work at DISD.

However, the following factors led to a degradation of the some of the contractor's roof system performance:

1. The Alpha roofing contractors are shopped for price through general contractors and traditional roofing contractors.
2. A relatively new contractor, who needed work, took the majority of the work due to their very low-prices.
3. The low-price contractor used substandard SPF due to a shortage of SPF material.
4. The low-price contractor had an excessive amount of work and ended up cutting corners, such as installing SPF in marginal conditions.

In studying the defects of the Alpha system, it is clear that the majority of the problems were contractor generated. Requiring the manufacturers to pay for the repair of the defects under a 10 year warranty, cannot be enforced. Once the contractor is paid, there has not been a way to force the contractor to fix the defects. If the defects are large, the contractor will go out of business. If the roofing system did not have a joint and several warranty, the roof owner has no recourse but to install another roof.

The low-price contractor installed 62 out of the 98 roofs and there were 16 roofs which had defects that required maintenance. The contractor did not charge enough to maintain their roofs through the ten year warranty period (DISD expectation). The roofing manufacturers (Alpha coating and SPF manufacturer) continued to sell their materials to the contractor. DISD continued to hire and utilize the contractor. The contractor began to have issues with their roofs, and was not doing their maintenance work to keep the roofs performing. The contractor ended up going bankrupt in 2015. DISD requested Neogard to cover the warranties, but with the ten year warranty, Neogard and their SPF manufacturing partner BASF, did not cover the SPF roof defects. Table 3 shows the number of roofs installed at DISD every year.

Table 3

Roofs installed per year

Year	# of roofs installed
1987	1
1992	1
2002	3
2003	1
2004	15
2005	28
2006	11
2007	4
2008	1
2010	5
2011	12
2012	9
2013	6
2015	1
TOTAL	**98**

Another analysis of the roofs show that the majority of the problem roofs were installed in 2014 and 2015 during the beginning of the 2004/2005 bond program (Table 3). Ten years later the roofs show the problems which could have been avoided with more careful installation, and better materials. Despite a number of poor performing roofs, the number of performing roofs outnumbers the poor performing roofs (Figure 1). To identify the performance of a few nonperforming roofs due to extenuating circumstances in the bond program, with the performance capability shown on other roofs that are installed correctly would minimize the value that the DISD could receive from the Alpha SPF roof system.

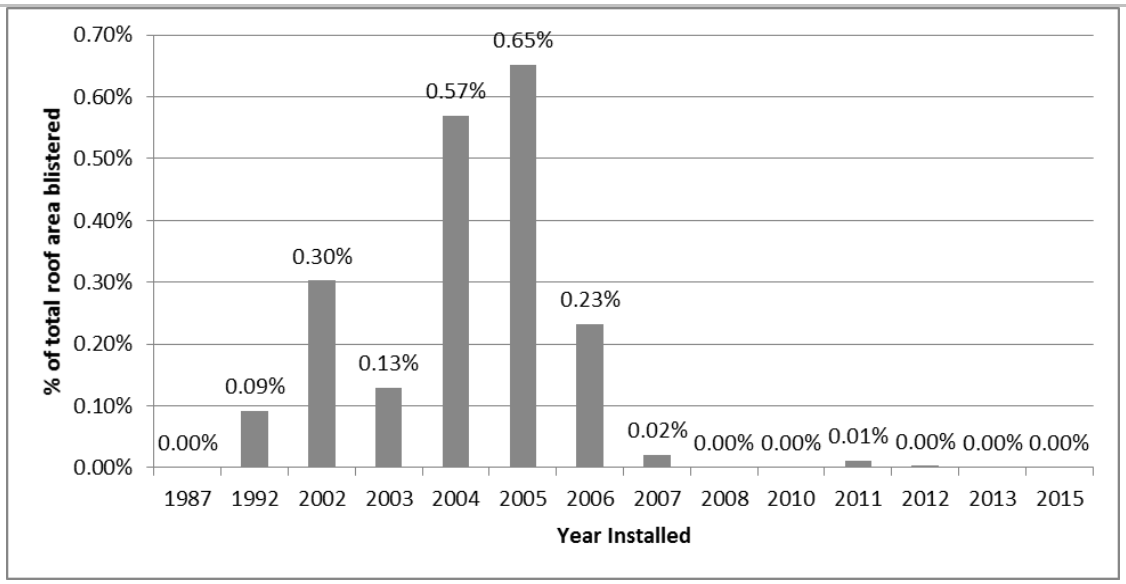

Figure 1

Yearly roof analysis

Problem

The warranties accompanying the coated SPF roof systems could not be enforced. The warranty is provided by the manufacturer to the buyer as a protection (Agrawal et. al. 1996). Since the manufacturer provides the warranty, it is written by their legal representatives (Murthy & Djamaludin, 2002), and contains exclusion that will void the warranty if encountered (Christozov et. al. 2009). Hence warranties have no proven correlation to the actual performance of the product; however, contractors still use them for marketing purposes (Kashiwagi, 2012). Similar to the history of the SPF roof industry, where warranties were used as marketing tools to convince building owners that a longer warranty meant that they had a longer performing roof system with protection against defects, DISD found themselves with a few SPF roofs with problems which were not protected by the warranty.

DISD is aware of the value of the SPF roof systems when they are installed correctly. They are also aware of the impact of the "low-bid" delivery system on the value and performance of the roof system.

There were additional problems that DISD and the Alpha coating manufacturer (Neogard) encountered:

1. Neogard did not get the needed support from the SPF manufacturer that they had partnered with. The SPF manufacturer charged a higher price for the Alpha SPF, but offered no added support for the needed maintenance repairs.
2. Neogard no longer wanted to cover the liability for the correct installation of the SPF.
3. The contractors did not have the sufficient business acumen to take needed steps to minimize the risk of SPF roof defects.
4. The bonding companies were charging unaffordable rates to cover joint and several warranties. Due to this the contractors were not willing to sign the joint and several warranty.
5. DISD had 4M SF of the Alpha system installed and had seen it was a good value proposition.

However, DISD wanted a joint and several warranty, and none of the vendor parties were interested in taking on the liability.

The challenge to the Alpha coating manufacturer and DISD is:

1. To create a system that self-motivates the contractors to install a quality roof system.
2. Motivate the SPF manufacturer to take accountability of the SPF performance.
3. Minimize the risk of non-performance at key points in the installation process, therefore minimizing and not transferring risk of non-performance to non-responsible parties.

Table 4 lists the roofs that have high damage.

Table 4

Roofs with high damage (over 1% blistered)

School	Roof Area in SF	Date Installed	Contractor	Total SF of Blisters	% of Total Roof Area Blistered	# of Blisters over 1 SF	# of Open Blisters
Russell ES	27,295	May-04	Alpha Contracting	1,050	3.85%	10	5
Samuel HS	147,500	Aug-05	Alpha Contracting	4,000	2.71%	27	0
Spruce HS	85,000	Aug-05	Alpha Contracting	2,150	2.53%	25	7
Lincoln HS – Flat	12,000	Oct-06	Alpha Contracting	230	1.92%	4	1
Hawthorne ES	45,200	Jul-05	Alpha Contracting	660	1.46%	6	3
Russell ES - Old Admin Bldg.	10,500	Aug-04	Alpha Contracting	150	1.43%	0	0
Terry ES	28,400	Dec-04	Alpha Contracting	320	1.13%	4	3
Peabody ES	32,600	Aug-05	Alpha Contracting	350	1.07%	7	4

Note. All high damaged roofs were installed in 2004, 2005 and 2006 and account for 66% of all blisters at DISD

Approach and Solution to the Problem

The steps to the solution of this opportunity must include the following:

1. Identify the DISD delivery system of construction and construction systems.
2. Identify the value of the Alpha roof system.
3. Identify the source of risk caused by non-performance and create a new system that minimizes risk due to the structure of the approach and does not depend on a warranty to minimize non-performance (has not worked at DISD in the past 10 years).
4. Create a Best Value structure that minimizes the risk of non-performance.
5. Create a transparent environment that clearly identifies expertise and the source of risk.

Description of the DISD Procurement/Delivery System

The DISD delivery system of construction is a design-bid-build (DBB) delivery system. The designers in the system do not have accurate information of the performance of different roofing systems and therefore do not have the expertise to select or design highly technical roof systems. They also do not have the legal liability or accountability of the roof system performance over the duration of the roofing system's lifespan. Due to the lack of information, the designer's decision making increases risk. The only party that does have the responsibility of roof system performance is the DISD roofing maintenance expert. He has the responsibility to resolve all roofing issues. Any change in roof system policy requires the DISD roofing expert's support.

The SPF roofing contractors and manufacturers in the DISD environment have shown the following characteristics:

1. Vendors who cannot accurately price roof systems accept the accountability of the performance of the roof for the duration of 10 or more years. The Alpha SPF roof system should never be competed based on price.
2. Manufacturers of both the Alpha coating system and the SPF have not consistently exhibited leadership or control over the vendors pricing, installation and maintenance activities. Neither have consistently understood or supported the vendors at key times in the beginning of a project and at the end of the project to ensure the minimization of risk.
3. The Alpha SPF roof system has not consistently and successfully been competed among the SPF contractors. Rather than assume the cause of this lack of success, the Alpha SPF roof system should only be an alternate to the traditional modified or built up roof system, and should only be installed when there is tremendous value for DISD (cost savings of 30% or higher).
4. Warranties have shown minimal value in protecting the client against SPF defects and should not be used to protect the building owner. The more DISD depends on the warranties, the greater will be DISD's risk.

Value of the Alpha SPF Roof System to the DISD

The DISD is in a heavy hail geographical area and is a self-ensured organization/entity. The Alpha SPF roof system has the following characteristics:

1. When installed correctly, the roof has a proven 20 year history of performance in hail areas with the ability to withstand 1-3/4 inch size hail. It has been documented to resist larger hail, but due to the uniqueness of the hail shape and hail storm characteristics, expectations of hail resistance for larger hailstones must be tempered.
2. DISD documentation showing that the Alpha SPF roof system at DISD has exceeded 25 years (Foster Elementary and Casa View) and has the capability to be recoated for an additional 15 years (total of 40 years). The aged Alpha SPF system's ability to withstand hail damage shows no degradation over time.
3. The Alpha SPF system does not require the removal of the existing Built-up Roof (BUR). Together with the BUR it forms a better waterproofing system. It does not require the throwing away of the existing roofing system, which is also an environmentally friendly solution (Knowles 2005).
4. The Alpha SPF system is renewable through recoating.
5. The SPF is the highest quality known insulating material, and is monolithic, which increases the insulation value.
6. The documented and observable value of the Alpha SPF system is 40 – 50% less that the price of the traditional BUR of modified roof system. This is established from the DISD base price of $16/SF for BUR vs the SPF pricing of Wattle & Daub (Tisthammer, identified as the best SPF performing vendor in the United States, 2015).

Risk of Defects in the Alpha SPF Roof System

Due to inconsistency in performance of the same roofing system, it has been observed that the craftspeople installing the SPF roof system commit easily avoidable errors that lead to SPF defects. The industry expert (has been doing research for the longest duration, has help create the Alpha program for SPF roof systems, and has the most dominant performance in the SPF industry in the U.S.) stated, "the SPF system may exceed the planning and technical capabilities of the average SPF roofing manpower force" (Tisthammer, 2015). The defects observed over the past 20 years in the SPF industry are attributed mainly to applicator error (Bailey & Bradford 2005). The number of occurrences that are due to material problems have been rare. The sensitivity of the chemistry of the SPF system when installed (temperature, ratio of the two components, not stepping on the cured system before it is cured, sensitivity to moisture, and not installing on a substrate with moisture), increases the need for expertise to follow specific installation instructions.

The defects require a system to assist installers to identify and mitigate risk that the installers may not instinctively do. This issue is not unique to the SPF industry, but is observable in the construction industry in general. Oftentimes, if the SPF installers have a discussion with the manufacturers' representatives, DISD roofing expert and other DISD involved stakeholders, many of the issues that cause risk can be eliminated. By observing the DISD Alpha SPF roof performance history, and having an on-site clarification meeting where the vendor's experts clearly articulate their concerns and challenges and then get input from the DISD and other stakeholders, would have minimized most of the risks and defects encountered over the last 13 years at DISD.

The second observation of the DISD Alpha SPF roof history performance is that lab testing of the installed Alpha roof system must be performed, and the results should be analyzed not only for the newly installed roof, but compared with the physical characteristics of all other installed SPF roofs at DISD. The results of the tests and analyses should be accessible to all stakeholders and to the industry. The current DISD environment has a lack of transparency with their technical metrics.

The third observation of the history of DISD Alpha SPF roof system performance is that any warranty documentation must be simple and the responsibility of the SPF and coating defects must be clearly stated. Once the Alpha coating and SPF physical metrics are checked and approved, the Alpha coating manufacturer is responsible for the coating defects, and the SPF manufacturer is responsible for the SPF defects. Another option is for the contractor to be responsible for all SPF defects. However, if the contractor is responsible, the risk is greater and the owner may require a performance bond due to the financial instability of roofing contractors.

Creation of a Best Value Structure for the Alpha Program

A Best Value structure is required for the DISD use of the Alpha SPF roof system. As previously identified, the Alpha program must have transparency, show responsibility and accountability

and show expertise of the vendor to successfully install and maintain their Alpha SPF roof systems. This structure includes:

1. The inspection of a minimum of 50 performing SPF roof systems.
2. Have 98% of roofs not leaking and customer satisfaction of all SPF roof systems installed.
3. Annual surveys of all SPF roofs installed.
4. An inspection every other year of 25 or more roofs being installed.
5. Response to a leak or customer dissatisfaction within a week, and fix the defect within two weeks unless given more time by the owner's representative.

Any vendor who fails to meet any of these requirements at any time shall be suspended from the Alpha program. Re-entry into the program will require the above five steps to be redone.

Transparent Environment Built by the Manufacturers, Contractors and DISD

The Best Value environment is transparent. When an environment is transparent, the following characteristics are observable:

1. Consensus: All stakeholders will know the performance of any building system, vendor or system.
2. Metrics: All performance will be delivered in terms of relative number of years the roofs have been performing, initial and repair costs, number of leaks, was the leak fixed, the duration of time it took to be fixed and customer satisfaction.

The Alpha SPF roof system cannot be consistently and successfully specified and installed. The Alpha SPF system can only be selected and installed if the following is observed:

1. The budget for the traditional roof system is exceeded, and the Alpha SPF system can be installed within the constraints.
2. The Alpha SPF roof system is a dominant value (30% or more in cost savings of the specified system).
3. The alternative option which warrants all coating and SPF defects (with verifiable information that the manufacturer's system has been operational in covering defects). The options that identify that the manufacturer will cover defects caused by their material has no value. It must state that the SPF manufacturer covers all SPF defects. This forces SPF manufacturers to cover the risk of applicators who do not respond to installation problems.

Conclusion

The Alpha SPF roof system has shown tremendous value for the Dallas Independent School District (DISD). However, the following are observations of the last 13 years of DISD attempting to deliver the Alpha SPF roof system using the low-bid environment:

1. A few of the Alpha SPF roofing contractors have not been able to escape the low-bid pressures that have led to occasional non-performance issues.
2. A high performance Alpha SPF roof system cannot be consistently delivered in the DISD low-bid environment as lower performing contractors win jobs with low-prices.
3. The Alpha coating and SPF manufacturers and DISD have not been able to regulate the contractor performance by proper quality control and the use of performance information.
4. There are Alpha SPF contractors who do not have the management and planning expertise and discipline to identify and minimize sources of SPF performance risk at the beginning of the project.
5. The Alpha SPF manufacturers have not provided the transparency that would have minimized DISD risk by testing for performance metrics at the end of the project, and continually comparing the project metrics to existing DISD Alpha SPF roof metrics.

Instead of using the traditional warranties which are difficult to enforce, the Alpha SPF manufacturers (Alpha coating and SPF) must create a new risk mitigation environment. The risk shall be minimized by identifying the sources of risk, and eliminating the sources of risk before the project begins instead of passing the risk to another party (traditional warranty system). The DISD will also participate in the program by following simple rules of Best Value. The new environment will minimize risk sources regardless of who causes the risk.

The following are the risk mitigation mechanisms:

1. The SPF Alpha system should only act as an alternative to the traditional modified BUR system and can only be selected if it shows tremendous value for DISD (a minimum of 30% cost savings). The Alpha roof system is already identified as an alternate roof system in the DISD approved specifications.
2. The SPF alternative proposal will be selected if the SPF manufacturer covers all SPF defects regardless of cause (and shows an operational process that has been in place) and still shows dominant value over the traditional specified system (minimum of 30% cost savings).
3. A clarification period will be held on every Alpha SPF project that is approved that requires the manufacturers' representatives and DISD stakeholders to attend. The Alpha contractor should clarify how they will install the Alpha system, present a list of risks and risk mitigation and have a schedule that will be tracked throughout the project.
4. The contractor will have third party inspection of the roof of coating thicknesses and SPF density, compressive strength and material stability. The testing metrics will be in a system that is accessible to all and easy to understand, creating transparency in the event that there are performance issues during the service period of the Alpha SPF roof system.
5. The contractors will show their level of expertise by belonging to an Alpha performance program that monitors the performance of all their SPF roof applications.
6. This Alpha program suspends the contractor if they do not follow any of the requirements of a high performance contractor (maintains their roof systems, maintains customer satisfaction and roofs not leaking to a 98% level of performance, and fixes any deficiencies within two weeks of notification).

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Upgrade the Saudi Arabian Procurement System Delivery Method

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Saudi Arabia has had many issues in delivering mega construction projects, such as delays, high costs, and low customer satisfaction. Some studies show that around 70% of public projects in Saudi Arabia are delayed. One factor that might be causing these performance issues is the traditional low bid contracting system in Saudi Arabia, or the Saudi procurement system. In Saudi Arabia, owners select contractors based only upon the lowest price. This paper researched ways to modify the current Saudi procurement system and show quick and simple modifications that can be done to improve the low performance. This research proposes that by adding the clarification phase from the Performance Information Procurement System (PIPS) to the Saudi traditional procurement process could greatly improve construction performance. The clarification phase requires the selected contractor to submit a project scope, detailed and milestone schedule, potential risks that they do not control, and performance measurement before a contract is awarded. The PIPS system is one of the most successful systems around the world, which shows success rate of 98% in six different countries with risk and cost reduction up to 30%. The clarification phase has been identified as the most important step in the PIPS to ensuring a successful project. This paper conducted a survey among construction professionals in Saudi Arabia, including 157 engineers, 33 consultants 9 owners, 5 vendors, 13 academics, and 28 architects, in order to develop the public procurement system in Saudi Arabia. The participants work in government sectors with an interest in the Saudi Arabian procurement system. The survey confirmed that professionals in the Saudi construction industry believe that the procurement system should be changed and that the inclusion of the clarification phase to the procurement system is a way to improve the procurement system.

Keywords: Design-bid-build, delays, Saudi Arabia, Best Value, contractors' solation.

Introduction

Saudi Arabia has the largest construction industry in the Middle East. Moreover, it is predicted to lead much of the growth in the Middle East through 2015 (World Construction, 2012). The construction industry in Saudi Arabia has encountered many problems resulting in multiple projects in the country failing to meet their objectives. The Saudi government has spent millions of dollars to try to fix the problem.

There have been several studies that were aimed to measure the size of the problem. Zain Al-Abedien (1983) discovered that delays were the norm in Saudi Arabia with 70% of the projects taken up by the Ministry of Housing and Public Works being delayed. Al-Sultan (1989) did another study that shows a similar percentage and concluded that 70% of Saudi Arabia's public projects had time-overrun issues.

On the other hand, Al-Ghafly (1995) surveyed contractors, consultants, and owners to determine the frequency and degree of construction delays. The contractors said that 37% of the projects suffered from delays while the consultants agreed that 84% of the projects under their supervision suffered from delays. In addition, he stated that the estimated time overrun versus the total original time specified for a project amounted to 39%. Assaf and Al-Hejji (2006) conducted a survey to measure the performance of several different projects in Saudi Arabia, they have found that the average percentage of delays in projects is between 10% and 30% of the original schedule.

Al Turkey (2011) conducted a survey by distributing a questionnaire to more than 300 project managers from different sectors and disciplines. The questionnaire addressed implementation issues associated with projects in Saudi Arabia, such as project structure and organization; this study concluded that 80% of the projects were subject to overrun costs, while 97% faced time issues. Another study was conducted to identify the main causes of the delay in Saudi construction industry. These studies identified 63 factors that adversely affected projects, and these factors were classified into four main criteria. The most impactful factors were those related to the client's selection process (Albogamy et al, 2012).

Problem

One of the major causes, which affects the Saudi public construction performance, is the Saudi procurement system delivery method. Studies have shown that there is a correlation between low performance and using the low bid method **(**Assaf and Al-Hejji, 2006; Kashiwagi, 2013). According to Albogamy (2012) the major risk that affects project performance is the use of the low bid delivery system in the Saudi government procurement.

Previous research has found that the Performance Information Procurement System (PIPS) is one of the most successful procurement systems around the world in terms of its ability to deliver high performing construction projects (Kashiwagi, 2013). Since 1994, Dr. Dean Kashiwagi has been testing the PIPS model, through the Performance Based Studies Research Group (PBSRG) at Arizona State University, more than 1,800 times in 32 United States and six countries, delivering $6.4 billion in construction and non-construction services with a success rate of 98% (Kashiwagi, 2014; PBSRG, 2014).

Proposal

This research proposes that by analyzing the difference between the low performing Saudi traditional procurement model (low bid or design bid build method) with the high performing PIPS model, a potential solution can be developed that will improve construction performance in Saudi Arabia.

The main objectives of this research include the following:

1. To identify the main differences between the Saudi procurement system and PIPS.
2. To identify a potential solution that could improve the current public procurement system in Saudi Arabia.
3. To identify if professionals in the Saudi construction industry agree that the procurement system should be improved and if the proposed solution is viable in the Saudi construction industry.

Methodology

The following steps were performed to verify the proposal and achieve the objectives of the research:

1. Review the current Saudi Arabian procurement system.
2. Review the Performance Information Procurement System (PIPS).
3. Compare the two delivery methods and identify the fundamental differences.
4. Conduct a survey with the aim of measuring the view of construction industry participants on the current system and the proposed improvements.
5. Propose a solution based on the PIPS concepts and survey.

The Government Procurement System in Saudi Arabia

The Ministry of Finance in Saudi Arabia published the Government Procurement System in March of 1997, issued by Royal Decree No. M/14, which can be found on the official website. The system received minor changes in September of 2006, issued by Royal Decree No.58M. A government entity can make three different types of purchases: competitive, direct, and specific/special/unique purchases. Most construction services are purchased under the competitive category. However, some of the purchases are unique. The Saudi procurement system aims to uphold several principles such as justice and equality, separation between personal interests and the interests of the government, enhanced transparency, and maximized benefits through competition.

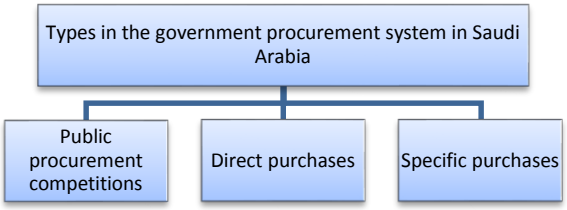

Figure 1: Different Types in the Government Procurement System in Saudi Arabia (Ministry of Finance 2006)

Government Procurement under Public Procurement Competitions

Projects under the public procurement competitions start with the proposal submission phase. This phase includes sending an announcement to all the competitors identifying the date of the pre-bid meeting, the deadline for submitting bids, and the location that the bids will be opened. At the appointed date, all of the bids will be opened at a specific location and the selection phase will begin. In this type of procurement, the main factor that determines the winning contractor is the lowest price. The three main phases of the procurement process are shown in Figure 2.

Figure 2: Vendors' selection phases (Ministry of Finance, 2006).

The selection phase is the most important phase in this process. In this phase members of the evaluation committee review the vendors' offers. If all of the provided offers' prices are more expensive than market price (project budget), there are two different ways to handle this situation as follows:

1. The members of the evaluation committee will negotiate with the vendor who has the lowest proposal to reduce his price to be close to market prices. If the vendor refuses to lower his price, they will negotiate with the vendor who has the second lowest offer.
2. If the government is not able to find a vendor who has a cost similar or close to the market price, then the Commission will remove one or more of the project specifications provided, so that it does not affect the project in the future.

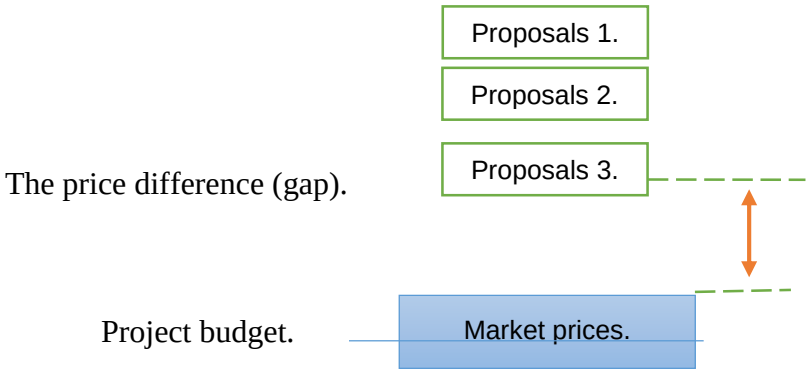

Figure 3: Handling with proposals (Ministry of Finance 2006)

The final phase in the process is the proposal formulation phase. In this phase the proposals are formulated and submitted. The Ministry of Finance (2006) specifies that the only language that is acceptable to use is Arabic, but they do not mind providing another language alongside Arabic. All the documents such as contracts, time of the tasks, project specifications, drawings, and

correspondence need to be in Arabic. The operation and maintenance contracts must be in the period of five years (there may be an increase in the period as deemed appropriate) (Ministry of Finance, 2006).

Change Difficulties in the Saudi Procurement System

Since the Saudi procurement system was initiated in 1977, few changes have been made to the process. Alyaum newspaper (2013) interviewed Nasser Al-Hajri, who works as a member of Chamber of Commerce in the eastern region in Saudi Arabia. He identified that the current system is outdated and has not been developed over the years, focusing only on cheap prices and does not include quality. Sabq online newspaper (2015) also identified the procurement system has many gaps causing significant damage to development plans in the country. The newspaper hinted that it is due to the difficulty the country has in changing policy. One of the biggest issues in improving the Saudi procurement system is the slow changing policy in the country. Thus, any solution must fit into the current legal structure of the country.

Performance Information Procurement System (PIPS)

The PIPS model has four phases as shown in Figure 4. The phases focus on requiring the contractors to prove that they are experts who have a proven record of completing similar projects and know how to ensure the completion of the project being bid on (Kashiwagi, 2014). It seeks to do this with reducing transactions between the owner and the contractor. Its objective is to reduce the effort of all parties involved and utilizing the expertise of contractors to reduce project risk and improve performance. The process consists of the following four major phases:

1. Pre-qualification
2. Selection
3. Clarification
4. Execution

During the prequalification phase, the client and vendors receive education and training on the Best Value Approach and how to use performance information to increase the competition. Additionally, the client may have stipulations they set before the RFP is released to include ensuring vendors meet the legal and financial requirements to run the project. During the selection phase, vendors compete based on their level of expertise. This is determined by their past performance metrics, ability to identify risk, and capability of their key personnel. The vendor that is highest ranked moves into the clarification phase. In the clarification phase, the vendor is required to explain how they will accomplish work efficiently and with high customer satisfaction. They are required to identify performance metrics that they will track throughout the contract. Vendors do this by creating a plan that includes their scope, detailed and milestone schedules, budget, risk management plan (RMP), and performance metrics. Vendors then set up a meeting to clarify the project to the owner for approval. Upon approval of the project, the last phase vendors move through is the execution phase. In this phase, vendors will receive projects as work is required. Each vendor's project progress is tracked using a Weekly Risk Report

(WRR), which is an excel spreadsheet that measures cost and schedule deviations. The WRR is filled out by the vendor and is and turned in each week to the client. The WRR is submitted to the client throughout the execution of the project, and becomes performance documentation of the project after completion.

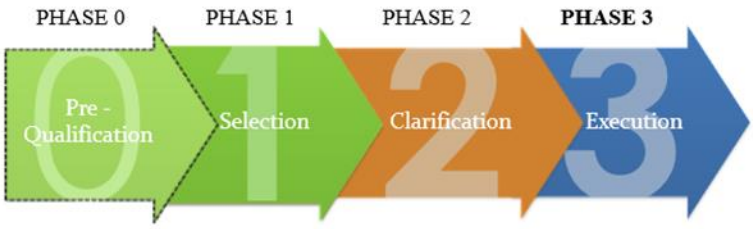

Figure 4: Four Phases of PIPS

Previous studies have found that the most important phase for ensuring a successful project is the clarification phase (Kashiwagi, et al., 2004a; Rivera, 2013; Kashiwagi, 2014) for the following reasons:

1. It requires a contractor to pre-plan the entire project and minimize all concerns of the client before a contract is signed. Contractors cannot fulfill this requirement unless they are experts at what they do. One of the most important factors to ensuring a successful project is the expertise of the contractor performing the work.
2. This ensures that the contractor selected in Phase 1 is an expert and knows how to complete the project.

A Comparison of the Performance Information Procurement System (PIPS) and the Procurement System in Saudi Arabia

Table 1 explains the comparison between the Saudi procurement system and PIPS delivery method. The main difference between PIPS and the current Saudi procurement system is as follows:

1. PIPS selects based on expertise and proven performance.
2. PIPS requires the contractor to clarify and determine the contract and requirements of the project.
3. PIPS utilizes the expertise of the contractor.
4. PIPS does not award a contract until the contractor has proven that they are an expert through showing verifiable performance metrics, creating a project plan, identifying project risks, and minimizing the owner concerns.
5. The Saudi procurement system requires the owner to manage, direct, and control the project.

Table 1

A comparison of PIPS and procurement system in Saudi Arabia

Phases	PIPS procurement system	Saudi Arabian procurement system
Pre-Qualification and Proposals submission	• Education and training. • Using matrices. • May include finical info and insurance.	• There is an education for contractors among the finance ministry. • Bidding must be by the same time and place with all the required documents, such as total price, 1-2% of primary financial guarantee. • The owner may exclude contractors, if the project size is larger than their financial and technical capabilities.
Selection	• Vendors selected for their expertise, how they can control risks with value added, cost of the project and interview (five criteria). • Zone prices are only more or less than the project budget, around 10%. • Do not select based only on the lowest price.	• The minimum number of vendors is two. • Selection based on the lowest price, and the price should be in the market prices. • In some cases, removing some elements from the project. • The contractor's proposals should be in the market prices or less up to 35%. • Prices are negotiable.
Clarification	• Scope. • Project schedule. • Identify risks that are with and without control. • Performance measurement. • Milestone schedule. • WRR that includes RMP.	• Negotiations with the selected contractor on price and scope. • Determination of rewards and penalties in the contract.
Execution and Implementation	• WRR (weekly risk report). • DR (directors report).	• There is an inspection of the contractor's performance by the consultant.
Risk handling	• WRR (weekly risk report). • Using experts to identify risks.	• Punishments system.

Based upon the differences in PIPS and the current Saudi procurement system, the most viable and impactful changes that could occur would be to add the clarification phase in the PIPS process to the Saudi procurement system. This is because no changes would be required legally to implement the clarification, due to the clarification phase activities being able to pass for contract negotiations. There are other portions of PIPS that could be used to improve the Saudi procurement system, however, they are more difficult to implement.

Construction Professional Survey Research

A survey was created asking two types of questions:

1. Current satisfaction and performance of the current Saudi procurement system.
2. Agreement and feasibility of the proposed improvements to the current procurement system.

The following six questions were asked:

1. Do you think that the traditional Saudi procurement system selects poor performing contractors?
2. Do you think that the selection of contractors based only on the lowest price criterion, affects project negatively?
3. Requiring the contractor to identify risks before signing a contract, would improve project performance.
4. A contractor having a plan before signing a contract will improve the performance of the project, thus minimizing losses in time and money.
5. Requiring a contractor that review the scope of a project and verify that it is correct, will improve project performance.
6. Requiring a contractor to resolve all owner concerns before signing a contract, will improve project performance.

The participants were asked to rate each questions on the following two scales:

1. Strongly Agree; Agree; Don't know; Disagree; Strongly Disagree.
2. Yes; No; I am not sure.

The surveys were then sent out through the head of the government engineering professional group to all of the participants in government sectors with an interest in the Saudi procurement system. The response was 245 surveys returned out of 664 participants, this included: 157 engineers, 33 consultants 9 owners, 5 vendors, 13 academics, and 28 architects.

The experience of the respondents ranged between less than 3 years of experience and more than 16 years (124 participants had less than three years, 128 participants had between 4 to 15 years, and 34 participants had more than 16 years). All participants have practical experience in the most common types of construction such as residential buildings, commercial building, healthcare construction, industrial construction and heavy civil construction.

The results of the survey identified the following:

1. 81% of participants in the survey believe that the traditional Saudi procurement system selects poor performing contractors.
2. 95.97% of participants think that the selection of contractors based only on the lowest price criterion affects projects negatively.
3. 89% of participants either strongly agreed or agreed that if a contractor were required to identify risks before a contract was signed would improve project performance.
4. In addition, 96% of participants strongly agreed or agreed that requiring a contractor to submit a plan before a contract is signed, will improve the performance of the project, thus minimizing losses in time and money. Only 1% disagreed with this and the rest were unsure (3%).

5. 95% of participants strongly agreed or agreed that if a contractor was required to review the scope of a project and verify that it is correct, this would improve the performance of their projects.
6. 82% of participants strongly agreed or agreed that requiring a contractor to resolve all owner concerns before a contract is signed, would help improve the performance of their projects.

Upgrade the Saudi Arabian Procurement System Delivery Method

Based on the results of the survey, which supports making some improvements into the Saudi procurement system, a new phase will be proposed to be added to the existing Saudi procurement model: the clarification phase. This phase will ensure an expert has been selected, which is one of the biggest factors in ensuring project success and high performance.

This addition would create four different phases in the Saudi procurement process: Proposal Submission, Selection, Clarification, and Contract Formulation. All vendors have to pass the four phases before the selected vendor will be able to sign the project contract.

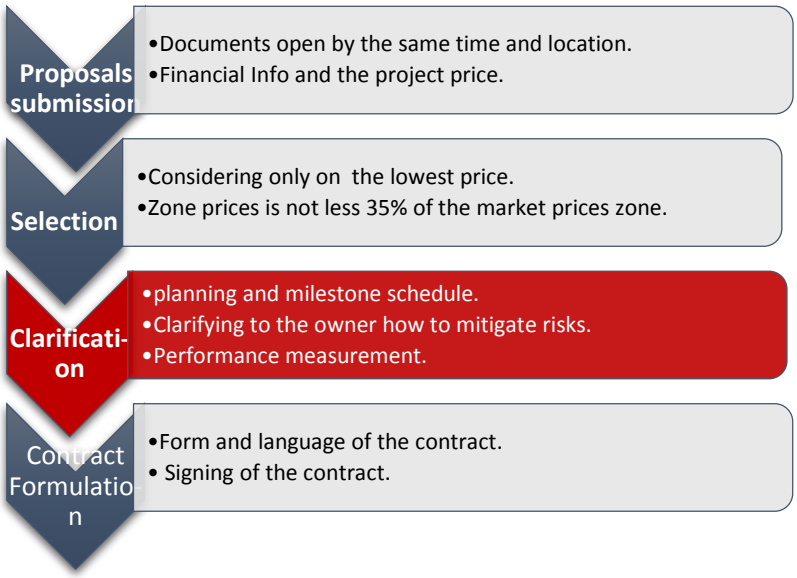

Figure 5: Proposed Upgrade to the Saudi Arabian Procurement System

Table 2 explains each phase in the proposed Saudi procurement model. The following is a more detailed explanation of each of the four phases:

Table 2

Upgrade the Saudi Arabian Procurement System

Phase	Upgrade the Saudi Arabian procumbent system Delivery Method
Proposal Submission	• Proposals must be submitted at the same time and location. • The owner may exclude contractors, if the project size is larger than their financial and technical capabilities. • May include financial info and the project price in one page.
Selection	• The minimum number of vendors is two. • Vendors selected based on only lowest prices. • Zone prices is no less 35% of the project budget in market prices zone.
Clarification	• Scope. • Project schedule. • Identify risks that are with and without control. • Performance measurement. • Milestone schedule.
Contract Formulation	• Form and language of contracts. • Signing of the contract.

Upgrade the Saudi Arabian Procurement System Delivery Method

The proposal submission phase is all about attached documents, which consist of:

- Financial security: primarily 1% of the total price of the project.
- Price, which is offered by the vendor.

Moreover, all documents must be submitted in the same place and time that are specified in the announcement of the project.

1. Selection phase: Contractors are selected based on the lowest price, as is the current situation in the Saudi government procurement system to win the project requirement. The selection phase proposed is based on the following conditions:
    a. Two contractors is a less then acceptable number for a competitive system.
    b. The vendor selected must be the owner of the winning contractor and have the lowest price compared to other offers.
    c. The proposed price of the contractor must be within market prices (project budget) and must not be more expensive than market prices.
    d. The proposed price must not be less than the market price (project budget) by 35%.
2. Clarification phase: The winning contractor who has the lowest price, has to pass the clarification phase, and he/she must complete the following:
    a. Planning and milestone schedule.
    b. Clarifying to the owner how the contractor will mitigate risks.
    c. Create performance measurements.

3. Contract Formulation: After the contractor/vendor has completed all phases successfully, he has to formulate contracts to be able to sign them with the owner. In this step, the contract is documented in the Arabic language and the winner can attach the contract in a secondary language, as well. The second step is for all parties (the contractor and the owner) to sign the contract.

Conclusion & Recommendations

Saudi Arabia has struggled to deliver high performing construction services over the last 20 years. The current Saudi construction procurement system has been identified as one of the causes of this low performance. To find a solution to improve the procurement system the Performance Information Procurement System (PIPS) was analyzed, due to its documented high construction performance.

The analysis identified that the following are the main difference between the current Saudi procurement system and PIPS:

1. PIPS selects based on expertise and proven performance.
2. PIPS requires the contractor to clarify and determine the contract and requirements of the project.
3. PIPS does not award a contract until the contractor has proven that they are an expert by showing verifiable performance metrics, creating a project plan, identifying project risks, and minimizing the owner concerns.
4. PIPS utilizes the expertise of the contractor.

Out of the four main differences, it was identified that the most viable and impactful difference, would be the implementation of the clarification phase, or in other words, requiring the contractor to clarify the project and create a plan before an award is made. This would take no legal changes and could be implemented during the usual negotiations phase.

To verify if this would be viable a survey was conducted to identify if construction professionals in Saudi Arabia agreed that these changes would be an improvement and if they felt the current procurement process needed to be improved and was causing low performance on projects. The survey was distributed from the head of the government engineering group, which 245 professionals participated in the survey with the following responses:

1. 96% of participants think that the selection of contractors based only on the lowest price criterion, affects project performance negatively.
2. 89% percent of participants believe that if a contractor were required to identify risks before a contract was signed would improve project performance.
3. 96% of participants believe that requiring a contractor to submit a plan before a contract is signed will improve the performance of the project.
4. 95% of participants believe that if a contractor were required to review the scope of a project and verify it was correct would also improve the performance of a project.

5. 82% of participants believe that to require a contractor to resolve all owner concerns before a contract is signed would help improve the performance of a project.

Based upon the analysis of PIPS and the survey that was conducted with Saudi construction professionals, this research identifies that implementing the PIPS clarification phase in the current Saudi procurement system, could improve construction performance on projects.

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Appendix A: Survey Questions

1. Do you think that the traditional Saudi procurement system selects poor performing contractors?
    a. Yes.
    b. No.
    c. I am not sure
2. Do you think that the selection of contractors based only on the lowest price criterion, affects project negatively?
    a. Yes.
    b. No.
    c. I am not sure
3. Requiring the contractor to identify risks before signing a contract, would improve project performance.
    a. I strongly agree • I agree • I am not sure • I disagree
    b. I strongly disagree
4. A contractor having a plan before signing a contract will improve the performance of the project, thus minimizing losses in time and money.
    a. I strongly agree • I agree • I am not sure • I disagree
    b. I strongly disagree
5. Requiring a contractor that review the scope of a project and verify that it is correct, will improve project performance.
    a. I strongly agree • I agree • I am not sure
    b. I disagree • I strongly disagree
6. Requiring a contractor to resolve all owner concerns before signing a contract, will improve project performance.
    a. I strongly agree • I agree • I am not sure • I disagree
    b. I strongly disagree

CIB Volume 7, Issue 1
Table of Contents

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TABLE OF CONTENTS

VOLUME 7, ISSUE 1