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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.

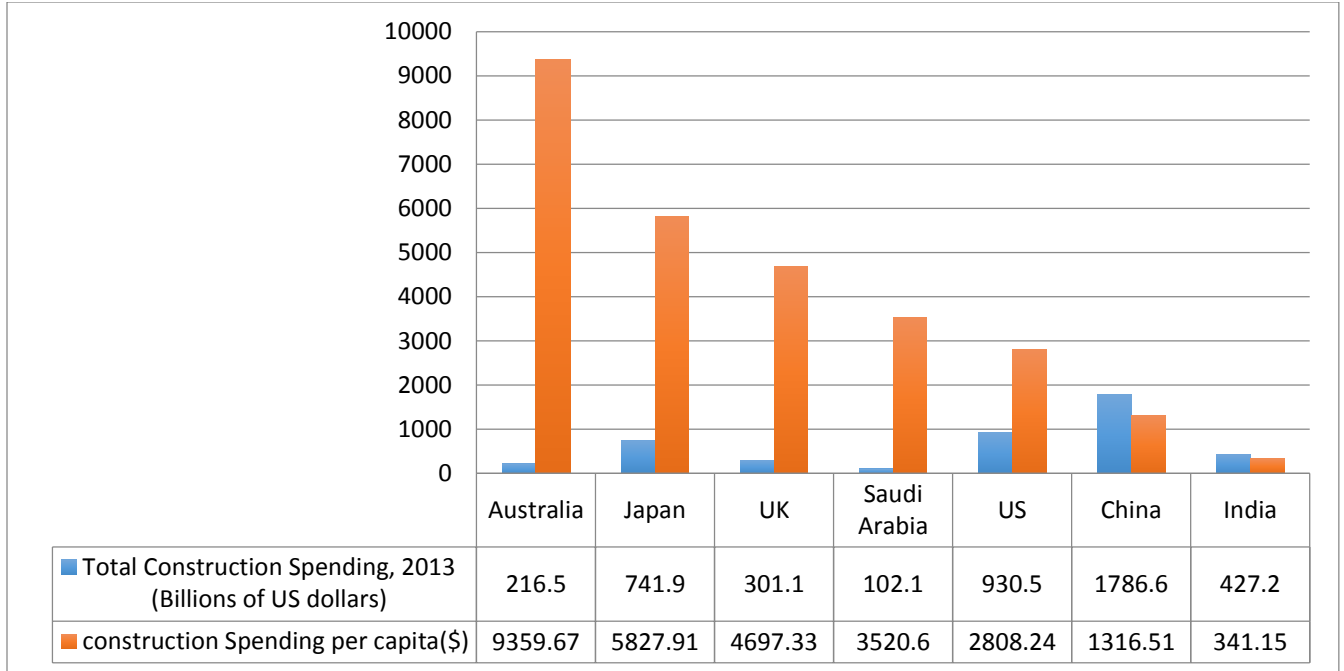


Figure 1: Total Construction Spending per capita (\$) by country.

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).

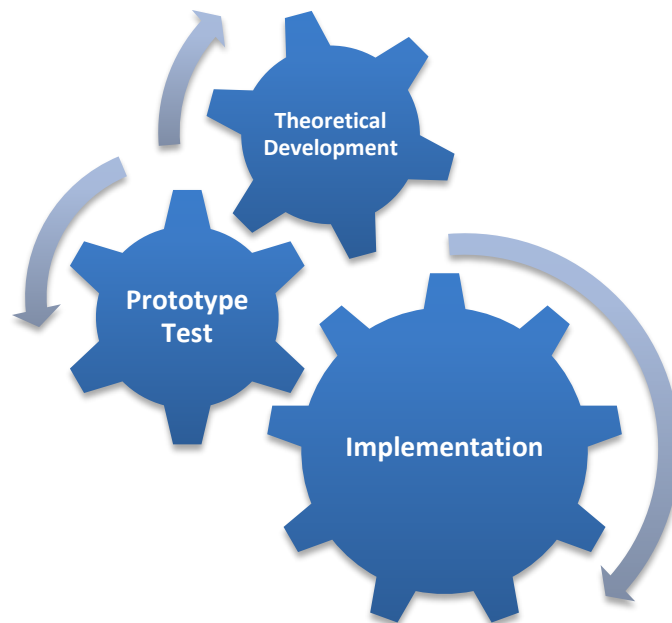


Figure 2: PBSRG Research Model

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).

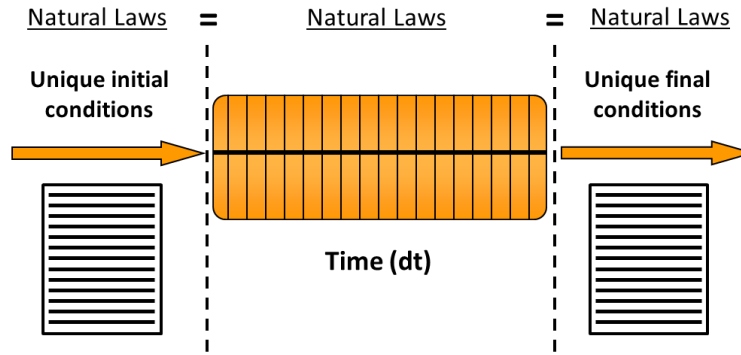


Figure 3: Event Chart (Kashiwagi, 2015)

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.

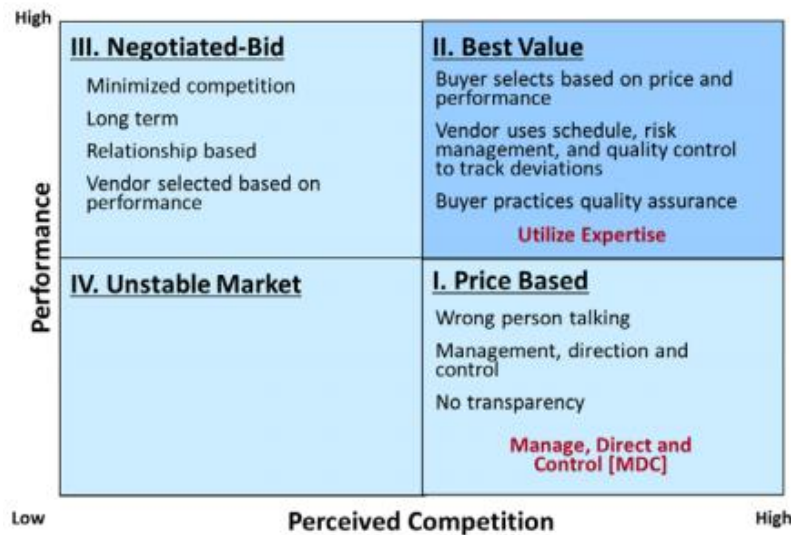


Figure 4: Construction Industry Structure (Kashiwagi, 2014).

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.

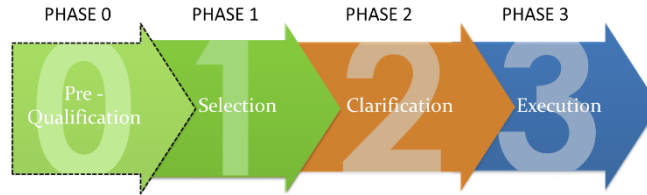


Figure 5: Performance Information Procurement System (Kashiwagi, 2015)

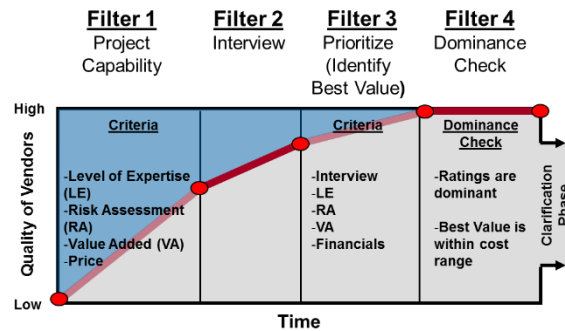


Figure 6: PIPS Filters (Kashiwagi, 2015)

### 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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