Identifying the Global Performance of the Construction Industry

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This paper presents a literature research assessing the performance and issues of delivering construction services worldwide, by exploring reasons for delays and increased construction costs. The study shows a comparison of the performance of the construction industry between different continents and countries. Multiple research databases were looked through and performance information was taken from over 95 publications. The results reveal that although the construction industry is growing throughout the world, there are many of the same problems being experienced in delivering construction projects in developing countries and developed countries. The literature reveals that all countries and continents are experiencing the same issues. On average, 72% of projects are delayed with 38% increase in original contracted duration, also, 63% of projects experienced cost overruns with 24% increase in original contracted cost. Additionally, rework is also a factor that affects performance and accounts for 6% increase in total project costs. Customer satisfaction on projects is low, and 90% of all major issues causing non-performance are due to people. A best value approach was identified as a potential solution to overcome the poor performance on construction projects with the following results: tested over 1900 times, totaling over $6B of procured services, a 94% on time and 97% on budget, and 98% customer satisfaction.

Key Words: Construction, Worldwide, Performance, Best Value PIPS.

Introduction

According to the Pew Research Center, the global population is expected to reach 9.6B in the year 2050, a 26% increase in population (from 7.1B in 2015). Of the 9.6B, 6B will be within the working age of 15-64 years old. Africa is expected to nearly double in population, surpassing the global share of people, while the U.S. is expected to add 89 million people to its population. India is expected to grow by 400 million, surpassing China's population, which is only expected to increase another 25 million. With such a large increase in populations around the world, infrastructure development is also expected to increase. Interestingly, Construction Industry Institute's expert, William Badger, estimates that the world will build more things in the next 30 years than in the last 2000 (CII, 2015).

Problem

A preliminary literature search was performed to identify the state of the construction industry regarding the performance of delivering professional services. The literature identified significant documentation of poor performance in both the U.K. and U.S. The literature identified that the industry has struggled with overcoming poor delivery of services, and has not

seen any significant improvement in the last three decades, despite the increase in professional education and training (Egbu, 2008; Goff, 2014). Projects have become larger and more difficult to manage due to the increasing number of participants, the increasing importance of legal contracts (Kashiwagi, et al., 2009), and all the participants in the supply chain segmented in silos, resulting in an increased level of complexity. The fact remains that the industry as a whole does not understand the source of its own problem and has not done anything effective enough to fix it. The multiple parties proliferating the problem are the following:

- Manufacturers of systems and materials.
- Owners/owner project managers.
- Procurement personnel.
- General contractors/subcontractors.
- General contractors and sub-contractor project managers.

Research conducted in the U.K. has documented construction performance in showing minor improvements from 2000 to 2011 in certain areas, but continues to suffer in others (Kashiwagi, 2013):

- Overall customer satisfaction increased from 63% to 80%.
- Customer satisfaction for projects over 5M Euros was at 73%.
- Projects completing on time increased from 28% to 45%.
- Projects completing on budget increased 50% to 63%.
- Contractor profitability declined to 5% from 7% in 2010.

Studies have also been conducted in the U.S. showing similar results of construction non-performance (Kashiwagi, 2013):

- Productivity has decreased by 0.8% annually.
- Construction companies have the second highest failure and bankruptcy rate of 95%.
- Over 90% of transportation construction jobs are over budget (Lepatner, 2007).
- Almost 50% of time is wasted on job site (Lepatner, 2007).

Because the industry misunderstands the source of its own problems, few academic researchers and practitioners have been able to create a successful hypothesis, run cycles of tests, which have resulted in the changing of industry practices and poor performance. The most impactful research identified, has led to conclusions that pre-planning is critical, hiring expert contractors will result in better performance, risk is mitigated when the supply chain partners work together, and expertise is utilized at the beginning of projects (van de Rijt, and Witteveen, 2011). The fact remains that the delivery of professional services needs a solution that is proven in industry to overcome the seemingly inevitable poor performance.

Hypothesis

With continued industrial growth around the world and poor performance identified in the United States and United Kingdom, the authors propose that every country worldwide with documented performance information has similar issues and performance.

Methodology

The authors propose to conduct literature research on the construction performance around the world. The following was be performed:

1. Literature research on construction performance worldwide.
2. Compare construction performance worldwide.
3. Literature research on major construction issues worldwide.
4. Analysis of worldwide construction data.
5. Identify potential solutions.

Construction Performance Worldwide

In order to identify the worldwide construction performance, the authors conducted the following three steps:

1. First, the authors identified the four major indicators identifying performance on construction projects:
    a. Rework – work that was not properly done, and required additional hired labor to correct.
    b. Cost overrun – the amount of money exceeding the original cost.
    c. Schedule delay – the amount of time exceeding the end completion date (critical path).
    d. Customer satisfaction – how satisfied the owner/client was with the delivered service.
2. Second, the authors selected 38 major countries from six major regions to further investigate. The major countries were selected, based upon the availability of documentation of performance information on construction projects.
3. Third, the authors created an excel spreadsheet database that would track each country's publications, in terms of the four performance indicators and major issues available.

Searching and Filtering through Literature

The study first looked into currently available construction performance data from CII and KPMG, to quantify the issues within the industry. Next, the study looked for additional performance information in 3,200 publications. Relevant publications were found by viewing abstracts from one of the four research databases (ASCE Library, Science Direct, Taylor and Francis Online, Emerald Insights). In total, out of the 3,200 publications, 260 were found to be

related to the research topic, and were reviewed in more detail. After further review, only 95 had documentation for each selected country, on the four performance indicators and major issues. The regions and countries researched were the following (see Table 1 below):

Table 1

List of Countries Researched (PBSRG, 2016)

Regions	**Countries (# of Documented Papers)**	**Total Countries**	**Total Papers**
Africa	Botswana (1). Ethiopia (1), Ghana (3) Kenya (1), Libya (1), Nigeria (11). Rwanda (1), Uganda (1), United Republic of Tanzania (1)	9	21
America	Canada (1), USA (4)	2	5
Asia	Cambodia (1), China (1), Hong Kong (1), India (6), Indonesia (2), Korea (3), Malaysia (6), Thailand (2), Vietnam (2)	9	24
Europe	Finland (1), Ireland (1), Netherlands (1), Norway (1), Portugal (2), Sweden (1), Turkey (3), United Kingdom (4)	8	14
Middle East	Iraq (2), Jordan (2), Kuwait (2), Oman (2), Pakistan (2), Palestine (3), Qatar (1), Saudi Arabia (5), United Arab Emirates (2)	9	21
Oceania	Australia (5)	1	5
Multiple Regions	Multiple Regions (5)	n/a	5

The study found that worldwide, construction organizations have been struggling with delivering services on time, on budget, with high customer satisfaction (PBSRG, 2016). Interestingly, the authors identified that contrary to popular belief that modern countries have an advantage over third world countries, due to their larger budgets and higher levels of technology, poor performance was the same in every examined country (Liu, 2016).

In support of these conclusions, the authors identified a recent worldwide construction study, conducted in 2015 by the Construction Industry Institute, confirming similar findings (CII, 2015):

- 2.5% of projects defined as successful (scope, cost, schedule, & business).
- 25 to 50% waste in coordinating labor on a project.
- Management inefficiency costs owners between $15.6 and $36 billion per year.
- An estimated $4 billion to $12 billion per year is spent to resolve disputes and claims.

In the next sections, the authors will identify the data that was found from each of the four performance indicators and major issues.

Rework

Ashford (1992) defines rework as ‘‘the process by which an item is made to conform to the original requirement by completion or correction”. In the study, the authors found rework data from three regions (America, Europe, and Oceania), consisting of four countries (USA, Sweden, UK, and Australia), totaling 8 publications. The data identified that rework in general, is responsible for 6% of the total project cost for the last decade. This is consistent with similar

literature the authors identified. According to Jim Zack, Executive Director of Navigant Consulting (construction consulting), "rework happens on every project…" (Moore, 2012). It is estimated that on average, rework by contractors adds 2-20% of expenses to a contractor's bottom line. In total, according to CII, that is an estimated $15B a year. Additionally, CII reported that rework for a standard industrial construction project is 5.6%, whereas a civil and heavy industrial project would increase to around 10%. Additionally, another study was conducted in trying to figure out who was the main cause for rework, identified that it was majorly due to designer error and owner changes (Love, 2000).

Cost Overrun

Cost overrun can be considered as the difference between actual cost of a project and its cost limit. It occurs when the resultant cost target of a project exceed its cost limits where cost limit of a project refers to the maximum expenditure that the client is prepared to incur on a completed building project (Memon, 2012). In the study, the authors found cost overrun data from five regions (Africa, America, Asia, Europe, and Middle East), consisting of 16 countries (Ethiopia, Ghana, Nigeria, Uganda, India, Korea, Malaysia, Netherlands, Norway, Portugal, Turkey, United Kingdom, Kuwait, Pakistan, Palestine, United States), totaling 26 publications. Table 2 shows the percentages of projects by region that are over budget and the average over budget amount compared to the original cost.

Table 2

Cost Overrun by Regions (PBSRG, 2016)

Region	% Project Over budget	% Over budget amount
Africa	69%	29%
N. America	98%	28%
Asia	59%	16%
Europe	50%	29%
Middle East	65%	15%

According to Table 2, 68% of projects from those 5 regions were had cost overruns. Of the 68%, project budgets are overrun on average by 23%.

This data is supported by similar research in this area. Bent Flyvbjerg (2003), a professor in Oxford's Said Business School, identified that it is not uncommon for major infrastructure projects to overrun by 50%. In fact, after looking at many of the large infrastructure projects around the world, he identified fifteen of the world's largest cost overruns that ranged from 255% to as high 36,000% (CIMA, 2013). These statistics similarly match a study CII conducted on cost overruns on construction projects, which identified only 30% of projects completed within 10% of planned cost.

Despite many misconceptions about whether one region has less cost overruns than another, there has been no clear evidence in terms of documented cost performance that would suggest that to be true.

Schedule Delay

Schedule delay can be defined as late completion of works as compared to the planned schedule or contract schedule. It occurs when the progress of a contract falls behind its scheduled program (Memon, 2012). In the study, the authors found schedule delay data from five regions (Africa, America, Asia, Europe, and Middle East) consisting of 17 countries (Ghana, Nigeria, Tanzania, Uganda, Hong Kong, India, Jordan, Korea, Malaysia, Portugal, Turkey, United Kingdom, Kuwait, Oman, Palestine, Saudi Arabia, United States), totaling 31 publications. Table 3 shows the percentages of projects by region that are over schedule and the average delay amount compared to the original schedule.

Table 3

Schedule Delay Performance Metrics by Regions (PBSRG, 2016)

Region	% Projects Delayed	% Delay Amount
Africa	75%	53%
N. America	98%	37%
Asia	68%	37%
Europe	53%	55%
Middle East	79%	30%

Similar to the cost overrun performance information, Table 3 shows similar schedule performance information for most regions. On average, 74% of projects experience delay. Of the 74%, project duration is delayed 42% greater than the original scope. Interestingly, Europe and Africa have the highest percentage of project delay amount, despite Europe being more geographically and economically developed.

Customer Satisfaction

In the construction domain, client satisfaction in particular, plays a fundamental role in determining the perceived success of a project (Cheng, 2006). In the study, the authors found customer satisfaction data from six regions (Africa, America, Asia, Europe, Middle East, and Oceania), consisting of 15 countries (Nigeria, Tanzania, India, Korea, Malaysia, Vietnam, Finland, Portugal, United Kingdom, United Arab Emirates, Jordan, Kuwait, Saudi Arabia, Canada, Australia), totaling 16 publications. Out of the 6 regions, 100% of the publications identified poor customer satisfaction with the construction services delivered over the past 10 years. Out of the major parties, procurement services (private and public owners), public owners identified greater concerns of receiving lower quality of work compared to private owners (Cheng, 2006). Out of the 16 publications, the authors were unable to identify why this is the case.

As support to the data identified in this study, a recent study in 2014 by KPMG International was conducted, and revealed similar information. The study consisted of a survey that interviewed 109 senior leaders from the engineering and construction industry. The respondents were from large organizations that ranged from less than $250M to more than $5B in annual income. The survey was compiled into a report that identified the major setbacks in the global construction industry, to include the level of dissatisfaction on projects. It was identified that project failure

on average was 53%, with its highest failure rates coming from public sector projects, and second highest failure rates coming from the energy and natural resources sector projects. With the continued difficulty of bringing projects in on time, on budget, with little rework, customer satisfaction overall will continue to suffer (KPMG, 2015).

Major Issues of Non-Performance

As the performance of each publication was documented, the authors simultaneously documented the major issues of non-performance reported. Out of the 260 research publications, 57 of them contained documentation of 438 reported issues that can cause non-performance in construction. These publications represented 6 major regions (Africa, America, Asia, Europe, Middle East, and Oceania) and 29 countries. Due to the large number and variability of the major issues identified, the authors documented the top 10 issues from each publication. Next, each of the 57 publications' top 10 list were prioritized based on the number of times a major issue appeared. Once completed, the authors prioritized the top 10 list from most to least documented issues (see Table 4). This formed a new and robust worldwide top 10 list of all major construction issues of non-performance on projects worldwide.

From this analysis, the authors found that financial problems are the most commonly observed issue worldwide. The full list of causes, their ranking, and percentage appearance are listed in the table below:

Table 4

Top 10 Causes of Non-Performance (PBSRG, 2016)

Top Ranked Issues	No. of Incidents	Rank	% Appearance
Monthly payment difficulties/ financial problems	47	1	15.3%
Poor project/contract management	28	2	9.2%
Shortage of materials/equipment	25	3	8.2%
Additional work/variation in client's	24	4	7.8%
Design change	23	5	7.5%
Poor planning and scheduling	22	6	7.2%
Poor qualification/shortage of labors	19	7	6.2%
Delay in construction/other delays	18	8	5.9%
Unforeseen site condition	17	9	5.6%
Poor/inaccurate estimate	16	10	5.2%

The top 10 major issues make up of 78% of all causes of non-performance reported. Interestingly, 9 out of 10 major causes are due to people and not external circumstances such as weather or natural phenomena.

Overall Analysis

After analyzing 95 construction publications, in terms of construction performance (rework, cost overrun, schedule delay, and customer satisfaction), Table 5 shows the overall results.

Table 5

Overall Analysis (PBSRG, 2016)

	% Projects Delay	% Delay Amount	% Projects Over budget	% Over budget amount	Customer Sat.	Rework
Africa	75%	53%	69%	29%	Dissatisfied	No data
Asia	68%	37%	59%	16%	Dissatisfied	No data
Europe	53%	55%	50%	29%	Dissatisfied	5%
Middle East	79%	30%	65%	15%	Dissatisfied	No data
N. America	98%	37%	98%	28%	Dissatisfied	9%
Oceania	No Data	No Data	No Data	No Data	Dissatisfied	5%

Overall, all major regions worldwide have similar documented construction performance. Despite geographical and economic statuses, the data does not support any dominant advantages one major region may have over another in this regard.

Potential Construction Solutions

In a literature search for potential solutions, to resolve the low performance in the delivery of services, the authors identified three landmark studies.

The first was commissioned by the CIB, Task Group (TG61), which performed a worldwide study in 2008 which identified innovative construction methods with documented high performance results. The study filtered through more than 15 million articles and reviewed more than 4,500 articles. In the end, the study found only 16 articles with documented performance results. The Best Value (BV) Performance Information Procurement System (PIPS) was one of three construction methods found in those articles, and it was found in 75% (12 of 16) of the articles (Egbu, et al., 2008).

The other two methods were the Performance Assessment Scoring System (PASS) and the City of Fort Worth Equipment Services Department (ESD - FT). After further investigation, it was found that although the PASS had measured performance information, the system could not show any improvement in performance of their projects. The ESD - FT had measurements to show improvement in their projects, however, this system did not have documented information for how the process worked. It also was a process that was internal to the organization and did not involve projects with suppliers or other organizations (Rivera, 2014).

The Performance Based Studies Research Group out of Arizona State University commissioned the second study, to conduct a follow on worldwide study to the CIB worldwide study in 2008 by Task Group (TG61). The study's objective was to identify all research efforts and systems around the world that are similar to the BV PIPS, as well as construction performance. The study sifted through hundreds of papers, websites, and personal industry contacts, and found similar results as the first study. In this case, BV PIPS was the only method with documented performance results (Rivera, 2014; PBSRG, 2016).

The third study was performed in 2013, by a graduate researcher, who was interested in identifying the difference between delivery systems. The study reviewed 780 publications in five major databases (EI Compendex, Emerald Journals, ABI/Inform, Google Scholar, and ASCE Library). From the 780 publications reviewed, 103 delivery systems were analyzed and compared. Additionally, 10 company management models were assessed. Lastly, the top 22 major buyer/supplier theories were identified including: Lean Construction, Supply Chain Management, Total Quality Management (TQM), Just in Time (JIT), Project Management Body of Knowledge (PMBOK), and Conflict Management. After comparing the 133 different delivery approaches, the study found that the Best Value (BV) Performance Information Procurement System (PIPS), was the only model that did not use management, direction, and control to improve performance of the delivery of services, and had documentation showing increased project performance (Kashiwagi, 2013).

BV PIPS was the only process that had sufficient documentation showing that it could improve customer satisfaction and value on projects in the construction industry.

BV PIPS Introduction

BV PIPS is a revolutionary approach to improving the delivery of services. The system was first conceived in 1991 as part of Dean Kashiwagi's dissertation, where he used the Information Measurement Theory (IMT) as the theoretical foundation to identify the construction industry structure and the cause of poor performance (1991). IMT proposes the use of natural laws and logic to explain reality and identify expertise and value. The Industry Structure (IS) model proposes that the buyer or end user (people factor) may be the major source of project cost and time deviation. Initially used strictly as a procurement model to select roofing systems and contractors for private organizations including Intel, IBM, and McDonald Douglas, BV PIPS has since been heavily documented and has spread to be tested in the entire supply chain (construction and non-construction services). Its methodology has been researched and developed, in support of professional groups like the International Council for Research and Innovations in Building and Construction CIB and the International Facility Management Association for the last 23 years, and has been identified as a more efficient approach to the delivery of professional services. Some of the impacts of the BV PIPS are as follows:

1. Most licensed university technology developed at Arizona State University with 49 licenses issued by the innovation group, AZTech, at Arizona State University. BV PIPS tests have been conducted in 32 states in the U.S. and five different countries besides the U.S. (Finland, Botswana, Netherlands, Canada, and Malaysia).
2. Documented performance of over 1900 projects or $6 billion (1635 projects, $4B construction and 315 projects, $2B non construction), customer satisfaction of 9.8 (out of 10), 94% of projects on time and 97% on budget.
3. Arizona State University business services and procurement department tested the PIPS system and generated $100M of revenue based on the method in the first three tests, and currently observe $110M a year from using the method.
4. Research tests show that in procuring of services outside of construction, the observed value is 33% or an increase of revenue or decrease in cost of 33% (Kashiwagi, 2013).

5. Minimization of up to 90% of the client's professional representative's risk management efforts and transactions due to reduced risk levels and the transfer of risk management and accountability to the vendors.
6. The results of PIPS testing has won numerous awards: 2012 Dutch Sourcing Award, 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.
7. Largest projects: $100M City of Peoria Wastewater Treatment DB project; $53M Olympic Village/University of Utah Housing Project; $1B Infrastructure project in Netherlands.

The former Associated Vice-President of Arizona State University Business Services, Ray Jensen, who led ASU to deliver $1.7B of services at ASU, commented on PIPS, saying, "I have been successful in the business of procurement and services delivery for the past 30 years. I saw in PIPS, improved solutions of performance/contract administration issues that are so dominant, that I am willing to change my approach to the business after 30 years" (Kashiwagi, 2013). Outside groups have analyzed the BV PIPS system multiple times in the last 17 years. However, two investigations performed a thorough study on the impact and effectiveness the BV PIPS system has had on 100+ unique clients:

- The State of Hawaii Audit (State of Hawaii PIPS Advisory Committee, 2002).
- Two Dutch Studies on the Impact of PIPS (Duren JV & Doree A, 2008).

These studies all confirmed that the performance claims of the PIPS system were accurate. Duren and Doree (2008)'s study found the following for BV PIPS projects performed in the United States:

- 93.5% of clients who worked with BV PIPS identified that their projects were delivered on time.
- 96.7% of clients who worked with BV PIPS identified that their projects were delivered within budget.
- 91% of the clients stated that there were no charges for extra work.
- 93.9% of the clients awarded the supplier's performance with greater than an 8 rating (on a scale from 1-10, 10 being the highest performance rating).
- 94% of clients would hire the same supplier again.

Currently, the BV PIPS is used mainly as a procurement/risk management system (Kashiwagi, 2001)(Kashiwagi, 2003), but also has project management applications (Kashiwagi, 2010). The BV PIPS minimizes the complexity of increasing project sizes and supply chain participants by creating transparency using performance information (Kashiwagi, 2002)(Kashiwagi, 2003b).

The authors propose the BV PIPS as a potential solution to improve industry performance due to the following reasons:

- BV PIPS is the only system with sufficient documentation showing that it can deliver projects on time, on budget, and with high customer satisfaction (Kashiwagi, 2014).

- BV PIPS has been tested in multiple countries and regions around the world, all showing similar results (Kashiwagi, 2006).

Limitations of Study

Though extensive, the authors recognize that this study's findings can be strengthened through documenting and analyzing more publications per major region. Additionally, there may be undocumented and missing data for each region. The intention of this paper is not to confirm that worldwide construction performance is poor, only show that the performance is similar.

Conclusion

The demand for construction around the world is rapidly increasing, as populations grow. Construction development will be greater in the next 30 years, than in the last 2000. As projects become increasingly more complex due to increased size, number, and supply chain participants, project managers are having difficulty delivering services on time, on budget, with high customer satisfaction. Despite the assumed ideas that wealthy countries have a significant advantage of higher performance and quality, due to increased access to advanced technologies and qualified laborers, research has shown neither advantage playing a huge role in increased performance of delivering services. Construction performance suffers in every country around the world that has documented performance information. All countries are experiencing similar issues in construction. The BV PIPS model is proposed as a potential solution for overcoming the current industry non-performance.

Recommendation

In an attempt to understand the root cause of the issues the construction industry is has been facing, the authors propose to conduct a follow on study. The study will investigate the major parties responsible for causing the issues, and examine why it occurs.

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