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It has been a great year! W117 finished, presented and was identified as the most successful working commission. The metrics on W117 activity include:

23 Years of Research Efforts.	\$17.6M in Research Funding
1,900 Research Tests Conducted	\$6.6B of Services Delivered
270 Refereed Publications	2 Journals published per year for the last three years.
Research testing and implementation in ten countries (education or industry):	
U.S.	Canada
Brazil	Finland
Netherlands	Norway
Poland	Saudi Arabia
Malaysia	India
49 licenses of the technology, making it the most licensed technology at the most innovative university in the U.S. (second year in a row identified by U.S. News and World Report).	
Top-rated engineering university, Jagadguru Sri Shivarathreeswara (JSS) University in Mysore, India, is being groomed to be the third W117 center (along with Arizona State University and Delft University of Technology).	

After watching the engineering and construction industry for the past 20 years, I have recognized the following trends:

- Academic publications continue to be isolated from the industry practices.
- Research work in the delivery of construction services go from one idea to another, in cycles of five to ten years, and then return to ideas proposed in the previous cycle.
- Research work rarely goes past three years, and researchers never have the opportunity to modify their hypothesis and do a second round of testing.
- Through participation in various universities and, in review of work in their project management, risk management and procurement, I continually encounter PhD candidates who have no knowledge of the research work and publications at the Performance Based Studies Research Group (PBSRG) at Arizona State University.
- Many of the research results of project management and procurement lag 10 years behind PBSRG and W117.

Objectives of W117 include the following:

- Publish a minimum of two journals per calendar year.
- Publish quickly, with only two months of peer reviews.
- Ensure that the peer reviewers are knowledgeable of the subject of performance metrics.
- Allow access to the latest publications through www.ResearchGate.net.

W117 is successful because the area of expertise (performance metrics, the language of performance, creating simplicity and transparency) is the movement of the industry. W117 is poised to do to human thinking and decision-making activities in the delivery of services what robotics and automation has done to replace the human functions of thinking and decision-making to create efficiency, value and transparency.

Happy Holidays and a Happy New 2017.

Professor Dean Kashiwagi



Dean T. Kashiwagi



Jacob Kashiwagi



David Gastelum

Identifying the Global Performance of the Construction Industry

Alfredo Rivera (M.S.), Nguyen Le (M.S.), Jacob Kashiwagi (PhD) and Dean Kashiwagi (PhD, P.E.)

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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 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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Introducing the Best Value Quality Checklist in Procurement

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The Best Value Approach (BVA) is a change in paradigm, replacing the non-experts decision making, management, direction, control (MDC) and thinking with the utilization of expertise. The best known BVA model is the Best Value Procurement model (BVP). With the further proliferation of BVP, a growing number of tenders are labelling themselves as “Best Value” without adhering to proper BVA practices. These “hybrid” tenders produce discouraging results, and have a detrimental effect on the wider proliferation of BVA and BVP. An easy-to-use tool is proposed that requires no BVA expertise to assess whether a tender is in fact run as a BV tender, and which may be used to avoid or minimize decision making. A “BV Quality Checklist in Procurement” is established by applying first principles to the Pre-Qualification, Selection and Clarification phase. The three phases have been analyzed with the focus on avoiding all types of decision making resulting in 21 checks. Using the checklist it can be assessed whether a tender procedure is a BV tender. The checklist can also assist in avoiding decision making in the tender process. The approach used here may furthermore be applied in other fields than procurement.

Keywords: Best Value Procurement, TONNNO, public procurement, checklist.

Introduction

The Best Value Approach (BVA) replaces the owner/buyer’s decision making, management, direction, control (MDC) and thinking with the utilization of expertise. BVA includes a procurement model, a risk management model, and a project management model. The procurement model is both referred to as Best Value Procurement (BVP) or Best Value Performance Information Procurement System (BV PIPS). In the past, these acronyms have been used interchangeably. In recognition of the fact that BVA is not a procurement process, but the application of a set of principles stemming from Information Measurement Theory (IMT), only the acronyms BVA and BV (Best Value) will be used here. “BVA” refers to the higher level principles (as in “BVA experts”), and BV is used as an adjective indicating the Best Value Approach has been applied (as in “BV tender”).

Given the potential for confusion we here explicitly define “procurement process” as the process culminating in the “award” of a contract to a vendor. Hence, the procurement process here covers the phases, until completion, of Pre-qualification, Selection and Clarification as described in the BVA manual (Kashiwagi, 2016). The Execution phase, where BVA’s project management

model may be applied (see: Rivera, 2016), has not been included in working towards the Best Value Checklist in Procurement.

In the procurement process of acquiring goods and services the methodology of BVP creates an environment that optimizes the performance of vendors. It can be used by the buyer or by the expert contractor, and it minimizes decision making, the use of MDC, and thinking by the buyer (the “non-expert” with regards to the expertise he is in need of). Historically BVP has evolved from a past-performance information based system and a trust-based system to a utilization of expertise approach. This continuing evolution has resulted in different versions of the step-by-step approach as documented in various textbooks, and may be the cause of confusion regarding BVP.

However, while BVP methods have evolved, the foundational philosophy has remained constant (see: Information Measurement Theory (IMT) and Kashiwagi Solution Model (KSM) (Kashiwagi, 2016a)). Over the years, BVP has been simplified and has thus become a very transparent system. Nonetheless, as BVA represents a shift in paradigm, it is not easy to implement BVA for organizations mired in the traditional model of management, direction and control. The BVP process itself, however, is clear and its steps are well-documented, and with the guidance of a BVA expert, each buyer can successfully run a BV tender (even when BVA is not adopted within the organization).

With the increased public awareness of the results that have been achieved, a larger group of buyers who, in absence of proper BVA training and guidance, have started to use “elements” of BVP in their own specific procurement process, and often present these processes under the flag of running a BV tender. Consequently, a growing number of tenders labeled as “Best Value” are in fact hybrids of BVP and traditional procurement methods. These tenders do not strictly adhere to the underlying IMT/KSM concepts, resulting both in suboptimal results as well as growing confusion and frustration with (expert) vendors who have identified the occurrence of hybrid tenders as one of the most confounding aspects in determining their own approach to BV tendering (Van Abeelen, 2014).

This development will ultimately result in the slowing down of the broader proliferation of BVP. Furthermore, the resulting predictably poor outcomes and confusion caused by this development will dilute BVP’s performance information, and thus the strength of the BVP performance indicators. As BVP and BVA are generally not distinguished between, it is also likely to distort the perception of what BVA stands for or tries to achieve, and may thus also hinder the application of BVA (IMT/KSM principles) in fields other than procurement.

The development of hybrid procurement forms has been reported early on by Van de Rijt and Santema (Van de Rijt, 2012). They state that, based on IMT, this development is unavoidable and that the initial conditions of the environment in which BVP became more popular, “lead to the predication that there will be many different “ways of using BV” (final conditions),” which lead them to claim that “the heavy demand of the BV/PIPS methodology has the risk of non-experts posing as experts of the BV approach”.

Given that a multitude of hybrid BV-labelled tender forms will appear and develop, several approaches have been suggested to help identify, prevent and or to “dampen” the negative impact of hybrid tenders:

1. Whether BVA’s underlying IMT/KSM principles are being understood, can be assessed simply by observing the process and actions of the contracting organization (see: section on Level II Foundational KSM Characteristics (“Observable Actions”) in the IMT manual (Kashiwagi, 2016a)).
2. A certification process for proven experts in the successful delivery of services using BVA has been developed (Van de Rijt, 2012), providing a transparent tool to identify BVA experts.
3. Witteveen & Van de Rijt (Witteveen, 2013) proposed education as a key concept to successfully implement BVA.

Witteveen (2013) stated that “education will lead to a correct understanding of the philosophy” and that “this will lead to a better application of BVA, also by the early majority and other “followers””. Observations of ten common misunderstandings on the concept and theory which may hinder a successful further proliferation of BVA are laid out. With respect to misunderstanding number 9 (“There is Only One Way to Apply Best Value”) Witteveen (2013) stated that it is “natural that there are various ways of applying the Best Value approach” and that “it is important that the main considerations of the Best Value philosophy remain intact”.

By observation:

- Vendors without BVA expertise may not be able to assess whether the actions of the contracting organization follow IMT/KSM principles.
- Certified BVA experts may not always be sufficiently proficient in the understanding of IMT/KSM principles.
- Certified BVA experts may not be sufficiently involved in the process.
- Continuing education may not reach everybody who comes across BVA for the first time.

In line with the statement that the main consideration for a BV tender is that “the Best Value philosophy remain(s) intact”, the authors suggest an additional approach to contribute to the successful further proliferation of BVA: a simple checklist based on basic principles derived from IMT/KSM to verify whether or not “the main considerations of the Best Value philosophy” do in fact remain intact in BV-labelled tenders. The checklist will be derived by applying the five principles known as “TONNNO” and part of the approach called “Decision Free Solutions” to the field of procurement.

Decision Free Solutions (DFS) is a generic, systemic approach to minimize risk by avoiding decision-making based on IMT/KSM (Verweij, 2016). DFS is congruous with BVA, with a larger emphasis on the definition of the aim. DFS identifies four generic steps, “DICE”, and five principles, “TONNNO”, which can be applied in each and every field. The four steps are Definition (of the aim), Identification (of the expert), Clarification (by the expert), and Execution (by the expert). The five principles to be observed to avoid all types of decision-making by the

non-expert, which manifest themselves as “decision making”, “MDC” and “thinking” are: Transparency, Objectivity, No details, No requirements and No relationship.

The link between BVP, IMT/KSM and the five principles known as “TONNNO” will be described. By systematically applying the principles of TONNNO to the phases as they are known within BVP (Pre-Qualification, Selection, and Clarification) the authors will devise a BVP checklist.

Problem

With the further proliferation of BVA as applied in the procurement process (BVP), a growing number of tenders labelled as “Best Value” are run in absence of the required BVA expertise and without adhering to the IMT/KSM concepts which underlie the BVP process. These “hybrid” tenders (mix of BV and traditional procurement processes) have a detrimental effect on the perception of the value of BVP in particular and BVA in general, and result in confusion and frustration with expert vendors. In order to be able to distinguish between a hybrid and a BV tender process an easy-to-use tool (that does not require BVA expertise) is required that will allow both buyers and vendors to assess the tender and to make the necessary adjustments (e.g. in expectations, in the tender structure). Such a tool does not yet exist.

Proposed Solution

By introducing a “Best Value Quality Checklist in Procurement”, both buyers and vendors will be given an easy-to-use tool to assess whether or not a tender process is structured as a BV process.

Methodology

By systematically applying the principles of TONNNO (Derived from IMT/KSM and resulting in the avoidance of all types of decision making) to the phases as they are known within BVP (Pre-Qualification, Selection, and Clarification), a checklist will be compiled.

IMT, KSM, and No Decision-Making

The BVP process, as described step-by-step in “2016 Best Value Approach” (Kashiwagi, 2016), has at its foundation the basic concepts from IMT/KSM. These concepts are “no decision making”, “no management, direction and control (MDC)” and “no thinking”. These are *manifestations* of three different *types* of decision making by non-experts: “decision making” (i.e. choices not substantiated to contribute to achieving an aim), “decision making of the past” (e.g. protocols), and “precursors to decision making” (i.e. thinking), (see: (Verweij, 2016)).

When strictly following the BVP step-by-step the IMT/KSM concepts will automatically be adhered to. However, when project conditions (e.g. legal requirements, company policies) result in deviations from the step-by-step description, it is pivotal that these deviations stick to IMT/KSM concepts. The authors argue that in order to label a tender a “Best Value” or BVP tender, it is *not necessary* to strictly follow the step-by-step description of the BVP process as described in the Best Value manual (Kashiwagi, 2016), but *it is necessary* to abide by the IMT/KSM concepts as described in the IMT manual (Kashiwagi, 2016a). Modification of the BVP process should only be done by a BVA certified professional. Consequently, a good understanding of IMT/KSM is required when designing the structure of a BV tender which deviates from the step-by-step approach.

IMT was first published by Dr. Dean Kashiwagi in 1991 at Arizona State University. It has been continuously developed, tested and refined by the author ever since. IMT was published as a structure for optimizing the effectiveness of information by creating “easy to understand” information environments. The purpose of IMT is:

- Minimize subjective decision-making through the use of dominant (easy to understand) information.
- Minimize the need to transfer information.
- Identify the relationship between information usage, processing speed, and performance.
- Identify a structure (KSM) that minimizes the requirements for decision making, direction, and control of another entity.
- Optimize processes by identifying and removing entities which increase risk and add no value.

IMT can be defined as: “A deductive, logical and dominant observation/explanation of an event. It includes the use of relative and related data to predict the future outcome of an event”.

Three related concepts of IMT are “natural laws”, “conditions” and “events”. Every event (“anything that happens which takes time”) has a unique set of initial conditions and a unique set of final conditions, and is constrained by unchanging natural laws. Knowing all the initial conditions, and all the natural laws, results in knowing the final conditions, or, worded differently, “predicting the future”. IMT defines “an expert” as a person/organization who can predict the future (because an expert perceives all initial conditions and all natural laws).

In reality, no person or organization can accurately perceive all the natural laws and all the initial conditions of their environment. In IMT, the “cycle of learning” is used to explain how a person’s (or organization’s) perception changes, and how the rate of change can be used to predict their future behavior. In short, the “Cycle of Learning” proposes that the application of newly perceived information causes change, and, by observation, change leads to the perception of more information.

Combining the definition of an expert with the “Cycle of Learning”, identifies that “expertise” in a worldly sense is now explained: the expert vendor is the vendor that perceives the most initial conditions (more than other vendors), has a higher rate of change, and thus will perceive more information in the future (than other vendors).

It is pivotal to understand that expertise is linked to the perception of information, and that the more information is perceived the higher the rate of change, resulting in a still higher perception of information. In other words, the expert's amount of expertise increases quicker than the amount of expertise the non-expert possess. From this follows that the expert is better able to "look into the future". Consequently, by definition, the greater the expertise, the greater his possession of information to identify or predict the future, and the fewer decisions need to be made.

The "amount of decision making" is thus a predictive factor for expertise. IMT states that, not just "decision making", but that all characteristics (of a person or organization) are relative and somehow related to the capacity (of a person or organization) to perceive, process, and apply information. In KSM the concepts of IMT are used to show the relationship between different characteristics.

The tenets of KSM are:

- Characteristics are related to the ability to perceive information.
- All characteristics are related in relation to the amount of information perceived and used by an individual.
- A person or organization's behaviors can be predicted by only knowing a few characteristics.

KSM identifies that people or organizations that perceive more information will make fewer decisions and will be more efficient (they expend the minimum amount of resources to meet the accurate expectations). They will have more experience (or information), fewer expectations and they will align people based on their capability (as opposed to trying to manage, direct or control people). For a longer and more comprehensive list of related characteristics see chapter 4 of the IMT manual (Kashiwagi, 2016a).

IMT/KSM gives the foundational understanding to explain the "why" behind the BVP structure. A structure that does not depend on decision making or experience of individuals, and that avoids the need for details, frequent communication, thinking, and the all too common tendency for MDC. The common denominator that is to be avoided is all types of decision making.

The First Principles to Avoid Decision Making (TONNNO)

The aim of the "BV Quality Checklist in Procurement" is to verify that all the conditions are in place to select/award the vendor who achieves the aims of the buyer with minimal risk. This aim translates into ensuring that nothing in the process obstructs identifying the expert, and that the conditions are in place to fully utilize the expert's expertise. BVP sets out to achieve this through "no decision making", "no MDC", and "no thinking" by the non-expert (buyer).

In essence the Best Value Approach, and the approach of Decision Free Solutions, is about identifying anything that is either a decision, a result of a decision, or a precursor to a decision - where a "decision" is defined as "a choice not substantiated to contribute to achieving an

unambiguous aim” (Verweij, 2016) - and then consistently applying a set of principles to avoid (the result of, or the lead up to) any kind of decision making itself.

Decision making occurs when information is insufficient and, thus, the outcome of an event cannot be accurately predicted. When the buyer makes a decision he incurs risk. In the BVP process this risk may be defined as “not awarding the contract to the expert vendor”. The buyer should avoid all types of decision making in order to select the expert vendor.

In order to avoid unsubstantiated choices (i.e. decisions) transparency is pivotal. Transparency allows all to perceive the initial conditions. As the buyer is to identify the expert-vendor based on the definition of the aim, an unambiguous aim is pivotal in avoiding decision making. The aim shall be measurable (objectifiable) and not constrict the use of an expert’s available expertise by containing details or enforcing unnecessary requirements. When a client enforces too many requirements, vendors tend to only focus on meeting these requirements instead of providing the best value solution. When all vendors try to reach the same requirements, they become similar, making expertise more difficult to recognize. The buyer should avoid making decisions by relying on existing relationships, thereby discriminating against vendors. Relationships have a high risk of directing the process away from expertise. In short, transparency, objectivity, no details, no requirements and no relationship are all principles to be adhered to in avoiding decision making.

These same principles will thus also decrease the non-expert’s MDC and thinking. MDC constrains expertise. When the non-expert tells the expert what to do or how to do it (e.g. making the expert follow established protocols (decisions made in the past)), the expert cannot fully employ his expertise. Transparency here is “the risk management mechanism for an expert, replacing MDC” (Kashiwagi, 2016, Ch. 3). The non-expert is not to place requirements on how the expert is to use his expertise, and not force the expert to communicate details (e.g. on how the expert does his job), as these will result in forcing the non-expert to think and make decisions. Details (lack of simplicity) make matters more complex and pull one away from a high-level overview. Details are indicative of lack of understanding, make matters less transparent, and place restrictions on solutions. Thinking by the non-expert means the expert has failed in making the non-expert understand (not transparent enough) that what the expert does contributes to achieving the aim (relationship to objective not clear).

In summary, the first principles collectively referred to as “TONNNO” which need to be applied to avoid all manifestations of decision making (“no decision making”, “no MDC” and “no thinking”) are the following:

- Transparency
- Objectivity
- No details
- No requirements
- No relationship

These principles are applied in the phases of “Pre-Qualification”, “Selection” and “Clarification” to compile the Best Value Quality Checklist in Procurement.

European Procurement Law, TONNNO, and BVP

The European public procurement directives, as interpreted in the case-law, expresses three guiding principles: transparency, equal treatment, and proportionality (Weller, 2011). Of these “transparency” is already identified as a first principle to avoid decision making, and “equal treatment” follows from:

- 1) Not excluding vendors from the tender process based on the buyer’s decision making in defining the aim (e.g. by including “details” or “requirements” which steer the solutions that may be proposed away from certain vendors).
- 2) Avoiding decision making during the Selection phase.

For example, if the aim is not measurable (objectifiable), then the buyer tends to make decisions to determine when the aim will actually be achieved (and which vendor comes “closest”). If some vendors have greater access to the buyer’s time or information than others, than this defines a “relationship”, etc.

Whether the principle of proportionality has been complied with in a given instance requires a two-step enquiry: first, determining “whether the measure at issue is appropriate for attaining the objective pursued” and second, determining “whether the measure at issue goes beyond what is necessary to achieve the objective” (Weller, 2011). For example, if the buyer introduces the need for “sustainability” within its aim to achieve the broader objective (e.g. objectives of environmental protection and improvement of social cohesion) then the proportionality principle requires the determination of whether the criterion of “sustainability” is appropriate for achieving the broader objective, and whether the criterion goes beyond what is necessary to achieve these objectives. By ensuring that all elements of the buyer’s aim can be made objective during assessment, then the proportionality principle will always be adhered to. In conclusion, by adhering to the TONNNO-principles one also adheres to the guiding principles of the European procurement law.

BVP replaces the traditional evaluation methodology which entails a long list of requirements which are to be scored. BVP creates an effective system which allows an assessment team to select an expert vendor using only a small number of documents and brief interviews. This system replaces traditional “objective” methodologies (scoring of individual requirements) with an inherently more “subjective” one (assessing quality documents). Running BVP care must be taken to avoid the situation where scoring quality documents is perceived to be at odds with the guiding principle of “equal treatment”.

A particularly useful ruling in this respect is the one provided by the “preliminary relief judge” G.P. van Ham (in Dutch: *voorzieningenrechter*) on September 16, 2015 in the case between a vendor and the buyer using BVP for the procurement of medical equipment (Ham, 2015; Verweij, 2015). In this case, the vendor claimed that the scoring methodology of BVP was subjective and, therefore, not allowed. In his ruling, the judge recognizes the inherent tension between the objective scoring methodology required by European procurement law and the subjectivity inherent to assessing qualitative documents. He goes on to state that this does not mean, however, that this subjectivity is, by definition, “contrary to the principle” of European

procurement law. The ruling then mentions the following requirements when running a BV tender:

- It must be absolutely clear to the tenderer what is expected of him/her.
- The scoring of the BVA-documents are to be assessed using a scoring system that is “as objective as possible”.
- The contracting authority is to motivate its assessment in a manner which allows the rejected tenderer:
 - To assess the way the assessment took place.
 - To verify the assessment validates the (pre-) award decision.

If the BVP is followed correctly the above requirements would be met. These requirements, as well as several other meritorious issues raised in the buyer’s plea in this legal case (see: (Verweij, 2016a)), are also addressed in the BV Quality Checklist in Procurement.

Best Value Checks in the Pre-Qualification Phase

When the “Pre-Qualification” phase is understood in the traditional sense (as it may be interpreted to be in the Best Value manual (Kashiwagi, 2016)) to reduce the number of vendors to take part in the selection phase, this phase does not have to be run. The associated risk of running a traditional pre-qualification phase is that expert-vendors may be excluded.

Here, however, the Pre-Qualification phase will be interpreted in line with DFS’s “Definition” step, in which the aim is defined and verified to be unambiguous. The Pre-Qualification phase now becomes the most important phase, as in this phase the non-expert’s aim gets defined which:

1. Is used to identify the expert.
2. Will be achieved by this expert.

The Pre-Qualification phase creates the optimal conditions for the buyer to identify the expert in the Selection phase. The following activities take place in the Pre-Qualification phase:

- A. Definition of the aim and verification that the aim is unambiguous and understood by both the buyer and prospective tenderers.
- B. Education of both the assessment team and prospective tenderers in BVA and the procedure of BVP.
- C. Definition of “functional requirements” and “minimum requirements” (e.g. legal, financial) for the actual pre-qualification of prospective tenderers.

A - Definition and verification of the aim

It is pivotal to clearly define what is meant with “aims” and how these are different from “deliverable” and “scope”. Following the definition by Van de Rijt (2016), the “deliverable” is a higher level description of the “what”. The “scope” is defined by the awarded expert vendor and

comprises the “how”. The “aims” go beyond the “deliverable” and typically address critical success factors for the project. Aims may carry in them an ambition, or may describe “the vision, goal or intent of the client” (Kashiwagi, 2016). It is with respect to the aims the tenderers can distinguish themselves, not with respect to the deliverable. As noted by (van de Rijt, 2016), the deliverable is to be described separately, and is not to be part of the (description of the) aims. See figure 1 for a schematic representation.

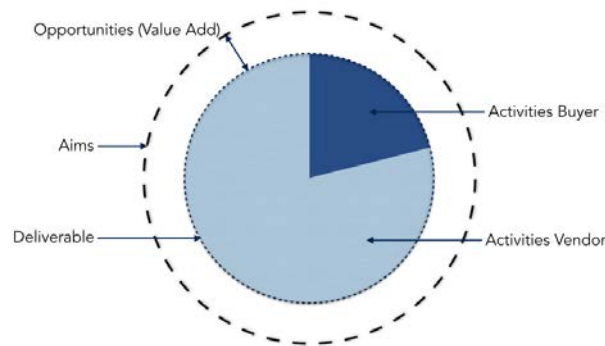


Figure 1: Relation between activities of Buyer and Vendor, Aims and Deliverable (from (van de Rijt, 2016).

As stated, the aims determine what is ultimately achieved by the expert vendor, the aims shall allow tenderers to distinguish themselves, and the aims must allow for an unambiguous assessment of the tender. Verweij (2016) provides the following remarks and suggestions with respect to defining the aim:

- The aim must be defined in relation to the “system” in which it is to be realized.
- When performing a “market consultation” among prospective-experts (to aid in defining the aim), the observations made of the characteristics of the prospective-experts will aid in positively identifying experts (whether or not they are also experts-in-achieving-the-aim is then to be determined in the Selection phase).
- The buyer may provide information on “sought performances” or “what-we-think-we-want” to further increase the understanding of the aim by the vendor.
- The buyer is to prioritize the various elements of the aim.
- The buyer is accountable for defining the aim.

On the one hand aims are the “vision, goal or intent of the client”, while on the other hand the aims must be sufficiently transparent and objective to allow for an as-objective-as-possible assessment of the tender documents. An aim is always defined within a certain context or “system”, and this context provides the prospective-experts with valuable information. Examples are the relation between the aim and an organization’s mission or strategy, recent or expected internal or market developments, financial and political situation, dependence on personnel or priorities which may change, etc.

The selection of the expert-vendor for the aim hinges on the transparent and objective definition of this aim. For this reason the non-expert is advised to provide opportunity for vendors to ensure

the aim is unambiguous and understood the same way. This can be done by way of a market-consultation. A market consultation may then have three purposes:

- 1) Aid the buyer in defining the aim.
- 2) Ensuring the aim is understood the same by buyer and vendors.
- 3) Observe characteristics of vendors to to assess whether they are (likely to be) experts.

When doing a market consultation the principle of “no relationship” is to be adhered to: avoid discrimination and either allow all vendors to participate in the market consultation or have objective guidelines which can be linked to the aim.

BVP sets out to align expertise. The buyer tends to be the expert with respect to “how” and/or “why” to use the product or service being tendered for. This generally makes it of critical importance to provide vendors with a description of the buyer’s own expertise. A tenderer may then incorporate this expertise in how best to achieve the aim (and when selected include it in how the deliverable will be achieved, see also figure 1).

To provide further context with respect to the aim the buyer may define “sought performances” or “what-we-think-we-want”. “Sought performances” provide a map to the buyer’s intended use of the solution, and “what-we-think-we-want” sets an expectation of certain key performances relevant to how the buyer intends to use the solution. It should be noted, however, that even though these “sought performances” and “what-we-think-we-want” are not “minimal requirements”, they may still incite some vendors to perceive them as such. When providing this context the buyer must carefully consider whether or not this may “level the playing field” and thus make it harder to identify experts able to achieve the aim.

The buyer is advised to explicitly prioritize the various elements of an aim. This may be a reflection of the buyer’s expertise, and it may also be used in the assessment of the BVP documents and interviews in relation to the “most relevant” aims. Even though the buyer may not always be in the position to assess the priority of the elements of the aim, as it does not preclude the expert from substantiating a re-prioritizing of the elements, there is no perceived downside to prioritization.

Finally, care must be taken that the aim is understood in an unambiguous way by the buyer’s organization itself. When changes have been incorporated, they should be shared within the buyer’s organization prior to the start of the tender. The aim does not define the scope (as it is defined by the expert-vendor), but it is pivotal in selecting the expert-vendor. The aim is always owned by the buyer, and it is what the expert-vendor sets out to achieve.

The following checks are defined:

- The aim is linked to the context or “system” of the buyer.
- The aim is transparent, objective, and does not contain details or requirements.
- The aim is understood the same by vendors, buyer and the buyer’s organization.
- During pre-qualification, all prospective vendors are provided with the same opportunities.

- The buyer's own expertise in relation to the aim is clearly defined.
- Care is taken to ensure that provided context (e.g. "sought performances", "what-we-think-we-want") is *not* interpreted as minimal requirements compounding the identification of the expert.
- The various elements of the aim are clearly prioritized.

B - Training of the Assessment Team and Prospective Tenderers in BVA

The BVP method uses several filters to avoid situations in which a non-expert is awarded the contract over an expert based on the non-expert having hired the better BVA expertise (see also (Verweij, 2016b)). However, by providing BVA training, including the use of dominant information/performance metrics, the selection of the expert will be facilitated.

The same goes for BVA-training of the assessment team in how to score BVP documents in relation to the (prioritized elements of the) aim. An assessment team trained in BVA will be able to substantiate its scores, achieve consensus more rapidly, and minimize the risk of any decision making taking place.

The training is also to include how the buyer will run the BVP process from beginning to end.

Note that training and explanation of how BVP will be run can also take place after the Pre-Qualification phase.

- The (prospective) tenderers and members of the assessment team are trained in BVA.

C - Definition of Pre-qualification Requirements

While "legal" or "financial" requirements may be defined to pre-qualify vendors, these requirements carry the risk of excluding experts (when these requirements are merely decisions). These requirements shall be relevant in relation to achieving the aim (they may e.g. avoid a perceived risk).

However, using "functional requirements" that reflect the expertise of the buyer, and thus can be substantiated by the buyer to be relevant with respect to the aim, do not carry the risk of excluding experts able to achieve the aim.

An example of a functional requirement used in the procurement of innovative medical equipment (Verweij, 2015a) was the need for the solution to be able to rotate a full 360 degrees around the patient. This reflected the buyer's expertise of the need to "access" the patients from all angles while having to avoid moving the patient as this was scientifically shown to have a negative impact on the quality of the treatment. This requirement excluded several vendors from participating in the tender.

- All requirements used to pre-qualify vendors are substantiated to contribute to achieving the buyer's aim.

Best Value Checks in the Selection Phase

Almost every BVP procedure is unique. Various formal procurement procedures (i.e. in case of public procurement in Europe) can be used, and the number and type of documents to be provided may vary depending on local conditions. The essence is always that the buyer's organization avoids all types of decisions by applying the principles of TONNNO.

The Selection phase is to identify the expert-tenderer in relation to the aim. The buyer provides tender regulations, detailing the BVP process and how the pre-award and the award takes place, and provides a price-ceiling.

The tenderer is to demonstrate its level of expertise through claims and substantiations in a series of BVP documents (usually "Level of Expertise", "Risk Assessment", and "Value Added"), and up to three interviews with personnel the tenderer determines to be key to achieving the aim (see: (Kashiwagi, 2016)).

The following activities take place in the Selection phase:

- D. Buyer's organization publishes tender regulations
- E. Publication of price ceiling by buyer
- F. Agreement (legal contract) is shared
- G. BVP documents and interviews are scored by individual team members
- H. Achieving consensus scores and writing up motivations for rejected tenderers

D - Publishing of Tender Regulations

From the legal ruling of Ham (2015) as referred to earlier, the tender regulations:

- Must make it absolutely clear to the tenderer what is expected of him.
- Must describe the method of scoring of the BVA-documents which is "as objective as possible."
- Explain how the assessment will be motivated by the buyer (whereby the motivation must allow the rejected tenderer to assess the way the assessment has taken place, and to verify the pre-award decision has been validated by the assessment).

Transparency and objectivity are key. The tender regulations are to describe the BVP procedure and what is expected of the tenderer, how the BVP documents and interviews will be assessed, and how the assessment of the individual tenderer will be motivated, also against the tenderer who will be selected to move into the Clarification phase.

In order to avoid discrimination during the interview stage, interview questions are standardized and enforced for all potential vendors. These should sufficiently assess the relevance of the interviewees' expertise in relation to the aim. To the standard set of questions the tenderer may be asked to clarify statements made in the BVP documents, but care shall be taken to not trigger exchanges filled with detailed information: it is not the tenderer's "how" or "scope" which is to be assessed.

Special attention is warranted to describe the awarding criteria. The BVP documents, the interviews and the price will be scored. It is to be stressed that any criteria used to determine the score for each awarding criterion is itself also an awarding criteria. All awarding criteria, and how they are assessed, must be transparent, objectifiable and non-discriminatory. If “ambition” or “commitment” is deemed relevant in scoring, it is advised to include this as an awarding criterion and have a clear idea (and description) of how it will be assessed.

A transparent and objective description of the awarding criteria is to be accompanied by transparent and objective description of the scoring terms. What are the distinguishing features between scoring e.g. “good” or “excellent”? Both descriptions are furthermore essential in providing the motivation of the selection to the rejected tenderers. It is important to pay close attention to how the rejection will be motivated in a way that is sufficiently transparent to the rejected tenderers. An important element which may be used in the motivation is the prioritization of the various elements of the aim (which is then to be included in the tender regulations).

It comes recommended to mention in the tender regulations what the rejected tenderers may expect in the motivation they will receive. IMT/KSM suggests that rejected tenderers who are not experts are more likely to litigate than rejected tenderers who are experts, but comparatively, not the best experts in relation to the aim. A rejected tenderer who is not an expert will look for excuses, is more likely not to have understood BVP, thinks in win-lose, and relies more on contracts. From there litigation will only be a small step. If the motivation only refers to “not dominant enough”, “too few metrics” etc., and then hides behind “confidentiality” with respect to the selection claims, this may not prevent the buyer from receiving a court date (Verweij, 2016a).

- The BVP process, the awarding criteria, how the assessment will take place (including scoring criteria), and how the assessment will be motivated for rejected-tenderers are all transparently described and as objective and complete as possible.
- To avoid discrimination interviewees receive the same set of questions and interviews all have the same duration. The number of clarification questions shall be limited and detailed discussions shall be avoided.

E - Publication of Price Ceiling

The price ceiling shall not be the result of decision making. This means that it is, at the very least within the buyer’s organization, to be substantiated, for example by making a business case. When it is not possible to determine a reliable price ceiling, than it shall be left to the tenderers. The price ceiling shall not be used as a MDC-instrument by the buyer’s organization. This will increase the likelihood that a non-expert will be identified through strategic tendering below cost price. Even when the non-expert will be discarded during the Clarification phase the tender procedure will be considerably prolonged and at risk of being invalid.

Note that BVP is often used in the Value Based quadrant II of the Industry Structure (see chapter 8 in the Best Value manual (Kashiwagi, 2016)) where the need for high performance occurs in a market where the perceived competition is above average. In these cases, price is often of much

lesser importance than quality, and often the quality of a product or service (e.g. “productivity”) may have a very large impact on the overall business case that goes over and beyond mere the price difference of the product or service.

- The price ceiling is substantiated and realistic.

F - Agreement (Legal Contract) is Shared

The agreement is (generally) to be shared with the tenderers at the same time as the tender regulations: at the beginning of the tender procedure. Traditionally the agreement is a MDC-tool containing many “decisions made in the past” like guidelines and company policies and instructions. The agreement tends to be long, hard to read, detailed, and include remunerations when certain requirements and or timelines are not met (Chapter 5 of the Best Value manual (Kashiwagi, 2016)).

In the BVP-contracting model the expert vendor is the offeror and the buyer is the acceptor of the offer. The expert vendor thus writes what and how they are delivering, how they will minimize the buyer’s risk and concerns, and what is required from the buyer. In BVP the legal contract no longer is about Quality Control but about Quality Assurance, whereby the expert vendor becomes the main author of the legal contract.

In practice, the structure and the MDC-nature of the legal contract is often unchanged from the traditional procurement. Frequently the expert vendor may indeed provide the “how” and “what” of what will be delivered (the deliverables of the clarification phase tend to become part of the legal contract), but the legal contract generally still contains standards, guidelines, requirements and remunerations. The buyer cannot always avoid this, as there may be national or company standards and or guidelines that must be abided by, and/or standard legal contracts that must be used.

When running a BVP tender, the practical importance of the agreement is starkly reduced as the expert vendor has no internal risk and risks not under his control are identified and mitigated. This however, does not make the agreement a document of lesser importance.

Care should be taken that the agreement is primarily a tool for Quality Assurance, describing not so much how things need to be done, but how matters are to be resolved. Elements of control (e.g. remunerations) that cannot be removed from the agreement shall be, for as far as possible, substantiated against achieving the aim. Ultimately, it is in the buyer’s interest that the agreement does not restrict the awarded tenderer’s use of expertise in achieving the buyer’s aim.

- The agreement is used for Quality Assurance, not Quality Control.
- Any control element the buyer still leaves in (e.g. “minimal up time”) is to be substantiated against the aim.
- Any remuneration included shall pertain to the vendor’s internal risk only.

G - BVP Documents and Interviews are Scored by Individual Team Members

Training of the members of the assessment team in scoring the documents and interviews is of great importance. The substantiations provided by the team members are valuable both for the discussion to come to consensus and can be used in the motivation letters to the rejected tenderers.

To avoid decision making in the individual scoring, it shall be properly described what score to give, and when. When scoring using terms such as “poor”, “insufficient”, “neutral”, “good” and “excellent”, the distinguishing characteristics between e.g. “good” and “excellent” should be unambiguous. Also here the prioritization between the various elements of the aim can be used to provide guidelines. The definitions of the various scoring-terms are to be provided in the tender regulations.

The advantage of using the mentioned scoring-terms over numbers from 2 to 10 is the absence of the connotation that a “10” is supposed to mean “perfect”. It will never be perfect, but it may be excellent.

- The assessment team members are trained in how to score using the scoring criteria, and how to substantiate their scores.

H - Achieving Consensus Scores and Writing up Motivations for Rejected Tenderers

With the assessment team trained in how to score using transparent and objective scoring criteria and in how to substantiate their individual scores, coming to consensus and writing up motivations for rejected tenderers becomes straight forward. The key remains to avoid decision making. As a general rule protracted discussions on how to score a document means transparency is lacking somewhere. Namely: the text in the BVP document is ambiguous, the scoring criteria are not sufficiently clear, or a team member’s substantiation is not understood.

It is important that it is clear both to the assessment team and to the (rejected) tenderers what the procedure is when the assessment team does not achieve consensus on an individual score (especially when this may impact the overall ranking of the tenderers). This situation is always the result of a lack of transparency or decision making earlier in the process.

Of special interest is the selection of the members of the assessment team. IMT/KSM recognizes that not everybody will follow the paradigm shift of the Best Value Approach. Traditionally, “relationships” tend to play an important role in selecting the assessment team. Managers or procurement officers would often attempt to “control” or sway the selection process by appointing biased evaluators. In such a situation, it is more preferable to appoint an outside party with an understanding of IMT/KSM principles (someone who has the characteristics of an expert) to serve as an arbiter who can substantiate accurate scores without bias.

- In assembling the assessment team “relationships” are avoided - or else risk mitigation measures (determining how consensus will ultimately be achieved) put in place.
- The procedure to come to a consensus is mentioned in the tender regulations.

Best Value Checks in the Clarification Phase

If the selected vendor passes the verification “phase” following selection, and if decision making has been avoided in the Pre-Qualification and Selection phase, and all Best Value checks have been ticked off, then everything is lined up for success in the Clarification phase. The vendor has been positively selected as the expert to achieve the buyer’s aims (and is therefore likely to understand BVA), and the assessment team members are both trained and now also fully familiar with BVA and the importance of avoiding decision making.

In practice, this remains a crucial phase where signs of “remission” are all too likely. Both buyer and pre-awarded vendor may experience “relief” and are excited to move forward. The building of a “relationship” is both logical (both are working to achieve a win-win situation) as it is a risk (giving a pass on “substantiations” and relying on “trust” instead). In this phase, decision making still must be avoided, as it is in this phase that the pre-awarded vendor is to clarify how the aim will be achieved.

The only type of “trust” that is permissible in this phase is the trust that is an extrapolation of demonstrated performances. The observed characteristics and performances until now may have demonstrated to the assessment team that the selected vendor is not only an expert (in IMT/KSM’s sense of the word), but also the expert to achieve the buyer’s aim. This only means that the BVP procedure has been successful so far and that the selected vendor is very likely to be awarded a contract too. This does not mean that the BVP procedure has been successfully completed.

The following activities take place in the Clarification phase:

- I. Determination of scope and plans by selected vendor.
- J. Periodic reporting and determination of performance measurements (KPI’s).

I - Determination of Scope and Plans by Selected Vendor

In the BVP procedure it is the vendor who is in the lead in the Clarification phase and who is to determine the schedule for providing and substantiating all the needed documents. These documents typically become part of the agreement.

The buyer’s organization is to accommodate the vendor wherever possible by having the (required) assessment team members available for meetings and to assess the provided substantiations. The assessment team is to make it explicit when provided substantiations with regards to the vendor’s deliverables in this phase have been sufficient. The assessment team is advised to define the procedure by which it “ticks off” deliverables as being accepted from the buyer’s perspective.

To avoid the risk of entering into detailed discussions, the vendor is to ensure the various elements of the aims will be achieved, and to provide language that links its scope and performances to these aims. The situation shall be avoided whereby the assessment team is put in a position of having to trust the vendor in the wrong sense of the word. For example, if the

vendor lists the performances with which he will achieve the aim, and he provides a list of (technical) tests by which the performances have been determined to have been achieved, then he forces the assessment team to “trust” the vendor that passing the tests does indeed guarantee that the aim will be achieved. The vendor shall instead guarantee that the aims will be achieved, and that the tests are merely (internal) checks to demonstrate meeting the required performance-criteria to achieve the aim. A few tests demonstrating a working system, as it will be used by the buyer, are much more useful than a long list of technical tests. Still, if all defined tests are passed, but the aim is not achieved, the vendor has still failed.

- The assessment team has a procedure in place by which the deliverables provided by the vendor are accepted as being sufficiently substantiated.
- The vendor consistently substantiates against, and guarantees the achieving of, the aims (and avoids the assessment team starting to think).

J - Periodic Reporting and Determination of Performance Measurements (KPI's)

The vendor is to ensure that it will be able to fully use its expertise in achieving the aims in the Execution phase. The vendor thus has to ensure that the buyer's organization will not employ MDC-measures. The BVP procedure employs the Weekly Risk Report (WRR) as a means to keep the buyer's organization informed on the status of the plan and the occurrence and impact of eventual deviations to the plan to the achieving of the aims (in terms of time, cost, quality).

This periodic reporting can already commence during the Clarification phase itself. The combination of a detailed plan with milestones and frequent reports on (any) deviations to the plan (including the mitigation measures taken if required) will take away the underlying reason for the buyer's organization to MDC the vendor.

By defining Key Performance Indicators (KPI's), the vendor will be able to both communicate progress to the plan during the Execution phase using metrics, the “language of transparency”, as well as performance of the provided solution once operational. Care is to be taken that the KPI's are related, in one way or another, to the achieving of the aim. They shall not be indicators for the vendor's internal achievement. KPI's shall also not become a control instrument. Examples of KPI's that may be of relevance to the buyer's organization may include the number (or ratio) of open and resolved issues, the average time it takes to resolve issues, number of days ahead or behind schedule, percentage of performance tests successfully concluded, percentage of system availability, etc. etc. (see also (Hutten, 2016) for the use of KPI's in Best Value).

- The vendor sets up periodic reporting on (any) deviations to the plan during the Execution phase using relevant KPI's relating to the achievement of the aim and not to the vendor's internal performance.

Overview of Best Value Quality Checklist in Procurement

Pre-Qualification Phase

1. The aim is linked to the context or “system” of the buyer.
2. The aim is transparent, objective, and does not contain details or requirements.
3. The aim is understood the same by vendors, buyer and the buyer’s organization.
4. During the pre-qualification phase all the prospective vendors are provided with the same opportunities.
5. The buyer’s own expertise in relation to the aim is clearly defined.
6. Care is taken to ensure that provided context (e.g. “sought performances”, “what-we-think-we-want”) is interpreted as minimal requirements compounding the identification of the expert.
7. The various elements of the aim are clearly prioritized.
8. The (prospective) tenderers and members of the assessment team are trained in BVA.
9. All requirements used to pre-qualify vendors are substantiated to contribute to achieving the buyer’s aim.

Selection Phase

10. The BVP process, the awarding criteria, how the assessment will take place (including scoring criteria), and how the assessment will be motivated for rejected-tenderers are all transparently described and as objective and complete as possible.
11. To avoid discrimination interviewees receive the same set of questions and interviews all have the same duration. The number of clarification questions shall be limited and detailed discussions shall be avoided.
12. The used price ceiling is substantiated and realistic.
13. The agreement is used for Quality Assurance, not Quality Control.
14. Any control element the buyer still leaves in (e.g. “minimal up time”) is to be substantiated against the aim.
15. Any remuneration included shall pertain to the vendor’s internal risk only.
16. The assessment team members are trained in how to score using the scoring criteria, and how to substantiate their scores.
17. In assembling the assessment team members “relationships” are avoided or risk mitigation measures (determining how consensus will ultimately be achieved) are put in place.
18. The procedure to come to a consensus is mentioned in the tender regulations.

Clarification Phase

19. The assessment team has a procedure in place by which the deliverables provided by the vendor are accepted as being sufficiently substantiated.
20. The vendor consistently substantiates against, and guarantees the achieving of, the aims (and avoids the assessment team starting to think).

21. The vendor sets up periodic reporting on (any) deviations to the plan during the Execution phase using relevant KPI's relating to the achievement of the aim and not to the vendor's internal performance.

Discussion

A List of 21 checks has been defined which are designed to avoid all types of decision making. Given the complexity of the process, there are many more instances of decision making to be found which may not all be covered by these checks. In this sense, the number of checks provided is arbitrary. Nonetheless, the authors are of the opinion that the list of checks provided is a useful addition to existing methods put in place to assure a BVP process is set up in line with IMT/KSM principles.

Since BVA presents a paradigm shift, both vendors and buyers are likely to have strong tendencies to use practices which are not in line with IMT/KSM principles. The checklist will aid in identifying instances of decision making, and thus will allow them to be avoided. The availability of (access to) BVA expertise (even more so than merely experience with the BVP process) remains pivotal, as is the timely training and education of both (prospective) tenderers, the buyer's organization and the assessment team members.

As a mere suggestion, running a "BVP-test" by requesting (prospective) tenderers to provide i.e. a single page BVP document in relation to a particular aim, having the assessment team members score and substantiate the pages, and have a BVA expert provide feedback to all, will go a long way in making the BVP procedure more transparent to all.

The time in which check-related activities should take place may vary between procurement procedures and also depend on the possibilities the procedure allows (e.g. in case of public procurement in Europe). Pre-qualification of vendors may be required simply to keep the work load to a level that can still be handled by the buyer's organization. In other instances, the phase may be only be used to come to an unambiguous definition of the aims. Time and financial constraints usually apply, and there is no one way to run a BVP procedure that will meet all needs. Pivotal is only that IMT/KSM principles are adhered to.

As the title of the article implies, Best Value checklists can be devised for fields other than procurement. Another field under consideration to apply the principles of TONNNO to is the field of project management.

Conclusion

With the further proliferation of BVA as applied in the procurement process (BVP), a growing number of tenders labelled as "Best Value" will be run in absence of the required BVA expertise and without adhering to the IMT/KSM concepts which underlies the BV process. In order to be able to distinguish between a hybrid and a BV tender process an easy-to-use tool (that does not

require BVA expertise) will allow both buyers and vendors to assess the tender and to make the necessary adjustments (e.g. in expectations, in the tender structure).

By introducing a “Best Value Quality Checklist in Procurement,” both buyers and vendors are provided an easy-to-use tool to assess whether or not a tender process is correctly labelled as a BV tender.

By systematically applying the principles of TONNNO (following from IMT/KSM and resulting in the avoidance of all types of decision making) to the phases as they are known within BVP (Pre-Qualification, Selection, and Clarification) a Best Value Checklist in Procurement has been arrived at which is believed to be of benefit to both buyers and vendors, and in the hope it will contribute to the further proliferation of the Best Value Approach, both within and outside of the field of procurement.

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The Cost Effectiveness of Alpha SPF Roofs: Casa View Elementary School Roofing Case Study

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The performance of the Alpha Sprayed Polyurethane Foam (SPF) roofing system is perceived as not an economical option when compared to a 20-year modified roofing system. The Dallas Independent School District (DISD) is replacing the existing Alpha SPF roof systems with new roof systems rather than recoating the existing systems at a cost that is 100% more than the recoating costs. The DISD is in a heavy hail area, and the proven hail resistance of the Alpha SPF roof system is an additional benefit for DISD who is self-insured. The Casa View Elementary School roof system was installed with a Neogard Permthane roof system in 1987. This roof was hail tested with ten drops from 17 feet 9 inches of 1-3/4-inch steel ball (9 out of 10 passed) and three drops from 17 feet 9 inches with a 3-inch diameter steel ball (1 out of 3 passed). The analysis of the passing and failing core samples show that the thickness of the top and base Alpha SPF coating is one of the major differences in a roof passing or failing the FM-SH hail test. The current potential cost savings of purchasing a 61,000 square feet Alpha SPF roof versus modified bitumen roof is approximately \$610,000 for DISD. The past hail tests on Alpha SPF roof systems show high customer satisfaction (9.8 out of 10) and an over 40-year service life after a \$6.00/SF recoat.

Keywords: Alpha roof system, sprayed polyurethane foam, roofing, sustainability, FM-SH hail testing.

Introduction

Recently, a number of sprayed polyurethane foam (SPF) roof systems were being replaced at Dallas Independent School District (DISD). The replaced SPF roof systems were installed by contractors not following the Alpha SPF roof system requirements (50 mils coating thickness, manufacturer approved Alpha SPF, third party inspection of SPF before and after installation, and contractor tracking of deviations of roof installation). The Alpha manufacturers of coating and SPF did not repair the roofs, and the DISD facilities and engineering personnel removed the few roofs (4 roofs/100 roofs). Since the substandard roofs were installed, DISD has installed only Alpha SPF roof systems. The performance of the Alpha Sprayed Polyurethane Foam (SPF) roofing system is perceived by DISD engineers as not an economical option when compared to a 20-year traditional modified bitumen roofing system.

Roof installation websites regarding the use of SPF roofing claim that SPF roofs require more maintenance than modified bitumen and recoating every 10 years (Improvenet, 2014). Additionally, other sites claim that based off of cost and maintenance, built up roofs and modified bitumen are the best value, lasting up to 30 years (Maintenance Solutions, 2015) However, a study of Carnegie Melon's roofing system over 20 years found that the average cost of roof replacement, including the repairs for modified bitumen roofs was \$269 per square meter,

which is equivalent to \$24.75 per square foot with an average leak rate of 5.2 leaks per building per year (Coffelt, 2010). After speaking with a roofing expert for Dallas Independent School District (DISD), the average price to apply a traditional modified bitumen roof with tear off on a commercial building is approximately \$16 to \$19 per square foot. Today, the majority of roofs are being replaced and the prices of replacing a modified bitumen system are far greater than the cost of recoating a performing Alpha SPF roofing system.

SPF roofing requires significant contractor expertise in order to provide a high performance roofing system. Installation workmanship is one of the major reasons for SPF roofing defects. These SPF roofing defects can severely minimize the service period (Alumbaugh et. al, 1984; Kashiwagi & Tisthammer, 2002). In the past, it was common for the coating and SPF manufacturers to offer warranties but not honor those warranties, blaming the contractor. The poor performance of the SPF roof system has relegated the SPF roof system to 3% of the roofing market share in the United States (Kashiwagi, 2016).

In order to combat the stereotype of the SPF roofing system providing poor performance and low quality, the coating manufacturer, Neogard, implemented the Alpha roofing program to identify the best contractors in the industry and to measure the performance of their roofs. As a result of Neogard’s motivation to change the industry, the performance on Alpha roofing system has been heavily documented. Table 1 includes the Performance Metrics of Neogard’s Alpha Contractors, Alpha Contractor Requirements, and an Overview of Neogard’s Coating Warranty Coverage (PBSRG, 2016):

Table 1a

Alpha Roofing System Performance Metrics (PBSRG, 2016)

No	Neogard's Alpha Program	Unit	Overall
1	Overall customer satisfaction of Alpha Contractors	(1-10)	9.5
2	Oldest job surveyed	Years	36
3	Age sum of all projects that never leaked	Years	29,714
4	Age sum of all projects that do not leak	Years	37,057
5	Percent of customers that would purchase again	%	99%
6	Percent of jobs that do not leak	%	100%
7	Percent of jobs completed on time	%	98%
8	Percent of satisfied customers	%	100%
9	Percent of inspected roofs with less than 5% ponded water	%	90%
10	Percent of inspected roofs with less than 1% deterioration	%	95%
11	Percent of inspected roofs with less than 1/4" slope	%	62%
12	Average job area (of jobs surveyed and inspected)	SF	30,698
13	Total job area (of jobs surveyed and inspected)	SF	230M
14	Total number of jobs inspected	#	2,286
15	Total number of different customers surveyed or inspected	#	2,834
16	Average number of returned surveys per contractor	#	23
17	Total number of returned surveys and inspections	#	5,223

Table 1b

Alpha Roofing System Performance Metrics (PBSRG, 2016)

No	Neogard's Alpha Contractor Requirements	
1	Minimum years of experience	5
2	Random survey of roofs	Every other year
3	24 hour response to leaks	Yes
4	Warranty covering labor	Yes
5	Maintenance inspection programs	Annual

Table 1c

Alpha Roofing System Performance Metrics (PBSRG, 2016)

No	Neogard's Alpha Coating 15 Year Warranty Coverage	
1	Bird Pecking	Yes
2	FM-SH Hail Test 4470 (1.75 inches)	Yes
3	90 MPH Wind	Yes
4	Full maintenance	Yes
5	Independent third party testing	Yes
6	Proprietary details	Yes

These performance metrics document significant results in the SPF roofing industry. The Alpha roof system has shown consistent high performance (9.5 out of 10 customer satisfaction rating and 99% of customers saying they would purchase an Alpha roof system again) on over 229 million square feet of surveyed roof. Neogard's Alpha roofing system's past performance outmatches any other roofing system's performance history.

The Alpha SPF roof system has the following attributes (Kashiwagi, 2016; Kashiwagi, 2015):

1. It is lightweight.
2. It is renewable.
3. It is hail resistant to hail sizes up to 1-3/4 inch hail as tested by the Factory Mutual Severe Hail (FM-SH) test 4470 within the 15 year warranty period.
4. It is green as it provides the highest insulating value and minimizes the need to rip off the existing roof system.

SPF roofing has an R-value of R6 per inch and is used by the owners of the building as a recovery system over existing roofs including built-up roof (BUR), modified bitumen, concrete, wood, asphalt shingles, clay tile, and metal (Knowles, 2005). The advantage of the Alpha SPF roof system is that it does not require the removal of the existing modified or BUR system saving owners as much as \$6/SF (50% less than the traditional BUR system) in removal costs and costs of a new modified or BUR system. A properly installed Alpha roof system has been documented to resist up to 4 inch diameter simulated hail stones (four inch diameter steel ball dropped from more than 17-3/4 feet height). (Kashiwagi, 2015, Kashiwagi and Savicky, 2003)

The Dallas Independent School District (DISD) has been using the Alpha roofing system since 2002, when they ran a Best Value test to compete the modified BUR system with the Alpha

system. The results showed that the Alpha SPF roof systems were installed with high performance with proven longevity and durability. Once recoated, the Alpha SPF system can take almost twice the level of damage (Kashiwagi and Savicky, 2003).

The Dallas Independent School District is self-insured against hail damage and is interested in using roofing systems that have the capability to withstand hail damage to minimize their cost. The DISD bond program engineers are not procuring the more traditional modified roofing system for \$16 / square foot, when the Alpha SPF system may be half of the cost of the traditional system. After seeing the performance of the Alpha SPF system, DISD has continually procured the high quality Alpha SPF roof system over the last 15 years. (Kashiwagi, 2016).

Problem

The DISD engineering, facility management and procurement staff is questioning if the Alpha roof system is renewable. They have bought some SPF roof systems that were not installed according to the Alpha requirements. These SPF roofs suffered damage and were not repaired by the manufacturers and contractors. The Casa View roof is being used as a case study to identify if a properly installed Alpha SPF roof system can perform and also be renewed. The case study will also analyze the hail resistance of the system and its potential cost savings to DISD.

Proposal

The authors propose to analyze the performance and economic feasibility of an existing Alpha SPF roof system at the Casa View School in the DISD. The analysis will include the hail resistance of the roof system (hail damage being a major problem for the DISD) and potential for recoating the existing SPF roof system. The economic analysis will compare the cost of recoating the existing Alpha SPF roof system when compared to the cost of a new modified bitumen roof system.

Research Methodology

The research was conducted as follows:

1. Identify the existing roof characteristics of the Casa View Elementary School Roof.
2. Hail test the Casa View Roof with 1-3/4 inch steel ball as specified by FM-SH test 4470 (Koontz and Crenshaw, 2001).
3. Identify if requirements are met to determine the roof's long-term performance as per DISD's roofing standards.
4. Identify if any of the drops do not pass the requirement, how many failures and are there extenuating circumstances such as insufficient coating.
5. Identify the indentations of the hail drops.

6. Use a larger 3 inch diameter steel ball to identify if the roof is potentially more robust than the perceived capability to pass the 1-3/4 inch test to further determine the roof's long-term performance to exceed DISD's roofing standards with OSH 2.75 hail test (Kashiwagi and Pandey, 1996).
7. Test an SPF core sample of the hail tested areas that passed and failed.
8. Analyze and compare the results compared to previous Alpha hail testing.

Findings

Casa View Roof Characteristics

Casa View roof system (61K SF roof area) was installed with a Neogard Permthane roof system in 1987. This means that the roof was 29 years old at the time of the visit. The authors performed a roof inspection on the Casa View Elementary school roof on June 27, 2016 (Table 2). On the 61,000 square foot roof, there was a total of 774 square feet of blisters, 65 penetrations, 102 square feet of delamination, and 6,000 square feet of repairs on the roof.

Table 2

Inspected Roof Details and Defects

Insp. Date	6/27/2016
Roof Area	61,000
Penetrations	65
Aggregate % of Granules	0%

	Square Feet	% of roof area
Blisters	774	1.3%
Delamination	102	0.2%
Ponding	400	0.7%
Repair	6,000	9.8%

There was some ponding, which is standing water on the roof. The areas with extended ponding increased blisters as shown in Figure 1. The repairs were applied mostly to the edges of the roof, most likely due to higher exposure to the heavy rainfall and runoff. The Alpha system installed with proper slope and drainage improves performance, and will result in less repairs.



Figure 1: Ponding found during roof inspection.

The Casa View roof has the following performance characteristics as seen in Table 3.

Table 3

Casa View Roof Characteristics

No	Criteria	2016
1	Overall Customer Satisfaction of Casa View	9.4 out of 10
2	Current Age of Casa View	29 Years
3	Average Age of Casa View When Surveyed	21 Years
4	% of Customers Satisfied and Would Purchase Again	100%
5	Owner	DISD
6	Contractor	Phoenix1
7	Foam Manufacturer	BASF
8	Coating Manufacturer	Neogard
9	Coating System	Urethane
10	Warranty Type	Alpha 15 Year Warranty
11	Service Life of The Roof with An SPF Recoat	45 Years
12	Total Job Area	61,100 SF
13	Total Number of Roof Inspections	7
14	Year of Installation	1987

Cost of Alpha SPF versus modified bitumen

The cost of recoating and continuing the Alpha roof system of the Casa View roof will be approximately \$6.00 per square foot for a SPF recoat. The cost of tearing off the existing system and installing a new traditional modified bitumen roof will be approximately \$16 per square foot. The Casa View Elementary School roof is 61,100 SF. Since there was a sunk cost already incurred to DISD with the installation of the roof, the only values to document is the current decision to recoat or to tear off the existing roof and install a traditional modified bitumen system. The Alpha recoat of Casa View’s roof at \$6/SF would cost \$366,000 with a 15 year warranty (lasting 45 years), and the installation of a traditional modified bitumen roof at \$16/SF with a 20-year warranty would cost \$976,000 (lasting 50 years). Based on total costs, opting to

install an Alpha recoat would result in a cost savings of \$610,000 and cuts the cost down by 62.5% on the project, assuming that each roof lasts the same amount of time. The yearly cost of \$24,400 for the Alpha recoat with a 15-year warranty (\$366,000/15) would be 50% less than the yearly cost of \$48,800 for a 20-year warranty for a traditional modified bitumen roof installation (\$976,000/20). Based off of yearly costs, the Alpha recoat is 100% more cost effective than a new traditional modified bitumen roof installation (table 4).

Table 4

Cost Comparison of Modified Bitumen vs. Alpha SPF Roof

	Total Cost
Traditional Mod Bit	\$976,000
Alpha SPF Roof	\$366,000
Cost Savings	-\$610,000
	Yearly Cost
Traditional Mod Bit	\$48,800
Alpha SPF Roof	\$24,400
Yearly Cost Savings	-\$24,400

Hail Test Results

1 3/4 inch steel ball FM-SH test 4470

The Casa View Elementary School roof was hail tested with ten drops of 1-3/4 inch steel ball from 17 feet 9 inches, which is equivalent to the industry standards of FM Class 1-SH 4470 hail tests on June 27, 2016 (see Figure 2). These hail tests were performed to determine the long-term performance of Neogard’s Alpha roof system and the performance of Alpha contractors.



Figure 2: FM-SH Hail Test from 17’9”.

The Casa View Elementary roof passed in 9 of 10 drops. One drop broke through the coating to reveal the foam due to insufficient base coating. The other two drops broke only to the top coat. The drop that failed had a top coat of 8.17 mils and a base coat of 21.67 mils. The average, after removing the high and low values from the tests was 12.06 mils of top coat and 39.45 mils of base coat. The average versus the failed test shows an insufficient use of base coating, which caused the hail to damage the roof in that particular area (see Table 5).

Table 5

1 ¾ inch diameter steel ball hail tests – FM 4470

Number	Result	Pass or Fail	Top Coat (mils)	Base Coat (mils)
Test 1	No Damage	Pass	14.17	38.33
Test 2	No Damage	Pass	20.00	57.50
Test 3	No Damage	Pass	15.50	30.83
Test 4	Break to Foam	Fail	8.17	21.67
Test 5	Crack to top coat	Pass	6.33	30.67
Test 6	Crack to top coat	Pass	6.50	33.33
Test 7	No Damage	Pass	10.33	40.83
Test 8	No Damage	Pass	13.00	47.50
Test 9	No Damage	Pass	16.67	45.83
Test 10	No Damage	Pass	14.00	48.33
Average	<i>Removed Tests 2 and 4 as outliers</i>		12.06	39.45

During the 1 ¾ inch steel ball hail tests, the researchers found that only 1 out of 10 tests failed. On a 29 year old roof that has outlasted its warranty by 14 years, the roof continues to show proven performance. Out of the 9 tests that passed, only 2 of those tests cracked to expose the top coat, due to insufficient base coat levels as well (see Figure 3). All others had no damage or exposure to top coat or to the foam.

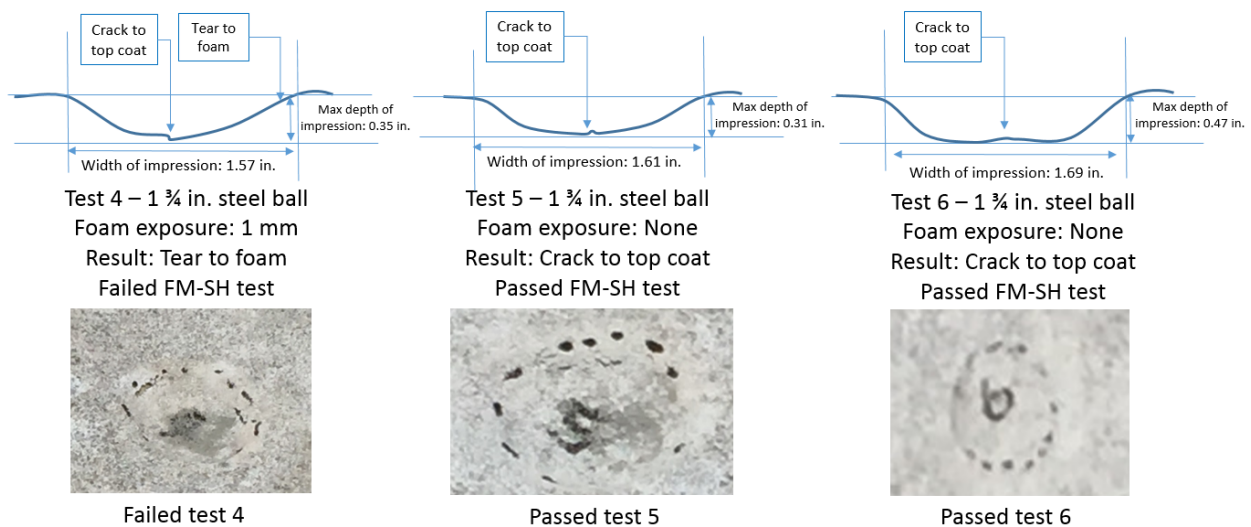


Figure 3: 1 ¾ in. diameter hail tests that broke to the foam or cracked to expose the top coat.

These foam test drawings show that the indents of hail into the roof will not necessarily damage the integrity of the roof. When the dents do not tear to the foam, the roof can continue to last for many years. The average width of the dent was very consistent on all of the tests, averaging to about 41 mm. The average indent size was about 9 mm. The max depth of the indent during the FM 4470 tests was 12 mm, which still did not cause the roof's integrity to fail.

3 inch diameter steel ball hail test – OSH 2.75

The researchers additionally dropped the 3 inch diameter steel ball three times from the same height of 17 feet 9 inches. One of the steel ball drop damaged the coating to the SPF (see Table 6). The other two drops resulted in tears to the top coat. This clearly exceeds the FM SH test requirements.

Table 6

3 inch diameter steel ball hail tests

Number	Result	Pass or Fail	Top Coat (mils)	Base Coat (mils)
Test 11	Crack to top coat	Pass	15.83	35.00
Test 12	Crack to top coat	Pass	9.00	45.00
Test 13	Break to Foam	Fail	8.00	30.00

During the 3 inch diameter steel ball hail tests, the researchers found that 1 out of 3 tests failed. On a 29 year old roof that is far past its warranty, the roof continues to show proven performance. Due to the heavy impact, the ball caused the roof to crack to top coat on the two tests that passed the test (see Figure 4). The average width of the dent was very similar on all of the tests, averaging to about 88 mm. The average indent size was about 12 mm, due to the size of the ball being dropped (see Figure 5).

There is a significant and noticeable difference in the coating thickness of the SPF core sample that passed the 3 inch diameter steel ball hail test and the SPF core sample that did not pass the 3 inch diameter steel ball hail test. The researchers conclude that when there is less coating thickness, the integrity of the roof is more likely to be compromised with the hail tests tearing to the foam.

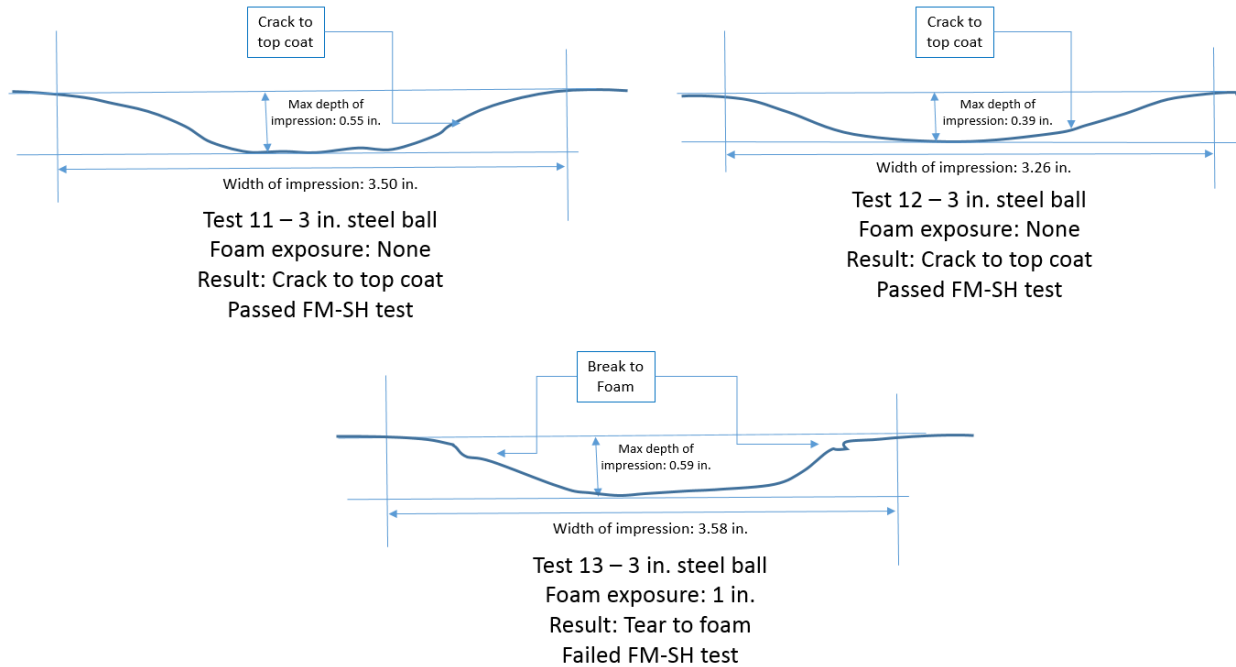


Figure 4: OSH 2.75 hail tests using a 3 inch diameter steel ball that broke to the foam or cracked the roof to expose the top coat



Figure 5: Passed dent from 3 in. diameter steel ball test compared to dents from a 1 ¾ in. diameter steel ball hail tests

These 3 inch diameter steel ball hail tests show the durability of Neogard’s Alpha roof system and the performance of the contractors within the Alpha program. The roof has lasted a substantial amount of time without a recoat. With another Alpha SPF recoat, the roof can easily last another 15 years.

SPF Core Sample Results

In order to determine the difference between the sections of the roof that passed the 3 inch hail test and the section of the roof that failed a 3 inch diameter steel ball hail test, the researchers extracted 2 SPF core samples to be examined. From this information, the researchers seek to determine why one section failed the hail test and why the other section passed (see Figure 6).



Figure 6: Passing, failing and new core samples

Figure 6 above has 3 core samples. The left SPF core passed the hail test with a 3" steel ball (also see Figure 7). The middle SPF core failed the 3" hail test (also see Figure 8). The right is a new and never used SPF core. The existing 29 year SPF, in areas where the 3 inch diameter steel ball hail test passed could not be differentiated from new SPF in terms of coating thickness.



Figure 7: Passing Core Sample



Figure 8: Core Sample #1 (Failing Core Sample)

Table 7

Core Sample Compressive Strength and Density

	Sample #1	Sample #2a	Sample #2b
Comp. Strength (psi)	55.7	49.8	34.9
Density (pcf)	2.89	3.07	2.72
Height (in)	2	1.25	.95

As shown in Table 7, Sample #2a and Sample #2b originally constituted one core sample that passed the 3 inch steel ball with the FM-SH test 4470, but due to a testing error, the company tested them as separate core samples. The two core samples' compressive strengths and densities show some significant differences. In determining the differences between the compressive strength and density of the samples, it should be noted that Core Sample #1 was .75 inches and 1.05 inches taller than Sample #2a and Sample #2b respectively. With regards to the density of the different core samples, it was noted that the compressive strength of the failing core sample (Sample #1) was greater than the passing core samples. Sample #2a, which was the top portion of the core sample, had a higher density than Sample #1. However, these tests cannot prove that more compressive strength or density will extend the roof's longevity.

The base coating thickness and the top coating thickness were both significantly greater in the core sample that passed the 3 inch steel ball OSH 2.75 hail test. These results show the necessity of the installation of SPF roofs to be performed by Alpha quality contractors and coating with proven long term performance such as Neogard's Alpha SPF coating. With a consistent coating application, observing Alpha specifications, the entire roof would have passed the OSH 2.75 hail test with a 3 inch diameter steel ball.

Analysis of hail drop information

The results of the hail drop on the 29 year old Alpha roof not only prove that the Alpha roof system has FM-SH hail test performance, but it has outlived its warranty by 14 years. This level of performance outlives a traditional modified bitumen roof due to the average repair and tear off of 20 years. The longevity of the roof outlasts the traditional modified bitumen with greater hail resistance as well.

Past Alpha SPF roof hail tests

The Performance Based Studies Research Group (PBSRG) at Arizona State University did a comprehensive hail study in 1996 with a 1 ¾ inch steel ball, and a hail test using a 4-inch diameter steel ball in 1998 (severe hail [SH] test). PBSRG concluded the following in those two studies:

1. Aged Neogard urethane coated SPF roofs passed the hail test with 20 mil coating after 20 years of service.
2. Aged Neogard coating systems passed the FM SH (4-inch diameter steel ball dropped from 17-3/4 feet height) at 15 years of service with 50 mils of urethane coating.

The PBSRG has published the following publications that relate to the performance of Sprayed Polyurethane Foam Roofing Systems:

1. Hail Resistance of SPF Roof Systems – 1996.
2. Oversize Hail Resistance Test of SPF Roof Systems – 1997.
3. Hail Resistance of the Alpha SPF Roof System – 2003.
4. Hail Resistance of SPF Roof Systems – 2008.

The previous hail tests revealed that the customers were extremely satisfied (9.8 out of 10) with the SPF roofing system. SPF roofing systems are high performing roofs when installed by an expert and capable contractor and can resist severe hail damage (drop of 4-inch diameter steel ball from 17-3/4 feet in height).

Comparison of a 2015 Alpha SPF Hail Test

The performance of the roof at Casa View Elementary School is not the only hail test that has been performed on an Alpha SPF roof over 25 years old in the last year. Table 8 shows the previous hail tests performed at an Alpha SPF roof at Foster’s Elementary School in 2015 (Kashiwagi, et al, 2016):

Table 8

Foster’s Elementary School Hail Test Results

2” steel ball				4” steel ball			
Drop No	Pass / Fail	Average Impact Width (in.)	Average Impact Depth (in.)	Drop No	Pass / Fail	Average Impact Width (in.)	Average Impact Depth (in.)
1	Pass	1.5	0.125	1	Pass	3.5	0.5
2	Pass	1.5	0.25	2	Pass	3.5	0.25
3	Pass	1.5	0.125	3	Pass	3.5	0.875
4	Pass	1.5	0.125	4	Pass	3.5	0.25
5	Pass	1.5	0.375	5	Pass	3.5	0.375
6	Pass	1.5	0.1875	6	Pass	3.5	0.25
7	Pass	1.5	0.125	7	Pass	3.5	0.375
8	Pass	1.5	0.375	8	Fail	3.5	0.375
9	Pass	1.5	0.125	9	Pass	3.5	0.25
10	Pass	1.5	0.125	10	Pass	3.5	0.375
		1.5	0.193			3.5	0.388

A summary of the Foster Elementary School’s hail test results are as follows (Kashiwagi, et. al., 2016):

- The roof was 28 years old at the time of testing, with one recoat
- The hail test on the Alpha coating showed no signs of damage.
- Only 1 out of 10 drops of the 4” steel ball (severe hail simulation) resulted in a ½” slit.
- The SPF sample had a total thickness of 4”, average compressive strength of 50.7 psi and

- average density of 2.96 PCF (matching new Alpha roof SPF requirements).
- The roof only has 3 SF of blisters (0.006% of roof area) and is free of leaks and deterioration.
- The roof could have lasted another 15 more years with a simple recoat (resulting in 38 years of performance at a fraction of the cost of a traditional modified roof).

Cost of an Alpha SPF roof at Foster’s Elementary School

The cost of continuing Alpha service of the Foster’s Elementary School roof would be approximately \$6.00 per square foot for a SPF recoat. The cost of tearing off the existing system and installing a new traditional modified bitumen roof is approximately \$16 per square foot. On a 50,754 square foot roof at Foster’s Elementary School, costing \$16 per square foot, which includes existing roof tear off, each traditional modified bitumen roof installation costs \$812,064 (50,754SF x \$16/SF). For the \$6.00/SF recoat installations of an SPF roof at Foster’s Elementary School, the cost would be \$304,524. This is a cost difference of \$507,540. In performing an analysis of the cost savings and useful life of both roofs, the following results are found in Table 9 (Kashiwagi, et. al., 2016):

Table 9

Casa View ES and Foster’s ES Cost Savings

	Foster’s ES	Casa View ES
Traditional Mod Bit (TMB)	\$812,064	\$976,000
Traditional Mod Bit Yearly Cost (20 yr)	\$48,800	\$48,800
Alpha SPF Roof	\$304,524	\$366,000
Alpha SPF Roof Yearly Cost (15 yr)	\$24,400	\$24,400
Cost Savings	-\$507,540	-\$610,000
Total Cost Savings	-\$1,117,540	

In looking at both tests, Casa View Elementary School and Foster’s Elementary School’s hail test results and financial comparison are summarized as follows:

1. Alpha SPF roofs that were 28 years old and 29 years old consistently passed the FM Class 1-SH hail test with a 1.75” ball and a 2” steel ball 19 out of 20 tests (95% of the time).
2. Alpha SPF roofs passed at least 66% of the time at Casa View Elementary School while dropping a 3” steel ball (4 lbs) and 90% of the time at Foster’s Elementary School while dropping a 4” steel ball (9.4 lbs).
3. Alpha SPF roof systems last over 28 years, and can be recoated for a service life of over 40 years.
4. The Alpha SPF roof systems for Casa View ES and Foster’s ES had the potential to save DISD \$1,117,540 over their useful lives compared to the traditional modified bitumen system with an Alpha SPF recoat.

Conclusion

The Casa View roof system case study confirms that the Alpha sprayed polyurethane (SPF) roof system is a high performance roof system for the Dallas Independent School District (DISD). The case study results show that the Alpha SPF roof system has a proven service period of 29 years, and a conservative predicted service period of 45 years with a recoating. The Alpha roof system also has a cost that is 50% less than a traditional modified bitumen roof system. The sprayed polyurethane foam of the Casa View roof installation showed no deterioration over the 29 year service period. The Alpha roof system showed resistance to the FM-SH roof test of a drop of a 1-3/4 inch steel ball from 17 -3/4 foot height. A further test using a 3 inch diameter steel ball dropped from 17-3/4 feet showed that the roof system passed the test when the coating was of sufficient thickness. Failure of system occurred when a drop occurred when coating thicknesses were abnormally low, but if the coating is installed with sufficient thicknesses, the Alpha roof system will perform for 45 years. The Casa View Alpha roof system material analysis shows that the roof sprayed polyurethane foam (SPF) system was installed according to the manufacturer's specifications.

Additional roof studies on Alpha SPF roofs show that they can last over 28 years, and can be recoated for a service life of over 40 years. The average customer satisfaction rating of these roofs is 9.8 out of 10, and has shown consistent performance even under severe hail tests with 9.4-pound steel balls (4-inch diameter) after 25 years.

Lessons Learned

After conducting a roof inspection of the Casa View roof, the authors found that the areas with extended ponding increased blisters. The authors advise that the Alpha system installed with proper slope and drainage improves performance, and will result in less repairs.

If the DISD engineering and procurement staff decide to remove the existing performing Casa View roof, and replace it with a modified bitumen roof system instead of recoating the Alpha SPF system, the DISD will be wasting over \$1M in building maintenance funding.

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Rank-Order Analysis of Factors Causing Claims on Road Construction Projects in Botswana

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Claims are considered to be one of the most serious disruptive forces to successful project delivery in the construction industry. In a small developing economy like Botswana, it is germane to identify the sources and the frequency of occurrence of claims so that the burden of project cost overrun, a hallmark of the country's construction industry is substantially reduced. Detailed literature review and preliminary field investigations were used to identify causes of claims related to road construction projects. The study identified six major types of claim and twenty seven causes of claims. Using questionnaire as research instrument, respondents (construction industry major stakeholders i.e. clients, consultants and contractors) were asked to rank the frequency of occurrence of the types and causes of claims in road construction projects on a Likert-type scale. Relative importance index (RII) method was used to analyze the data collected from the questionnaire survey. The analysis was carried out for each group of respondents and on the overall results (all the parties combined). A total of 27 useful responses made up of nine clients, ten consultants and eight contractors) were analyzed. Findings indicated that the clients and consultants specified delay claims followed by extra work claims were the most frequent type of claims in the construction of roads in Botswana. Contractors perceived differing site conditions followed by delay claims as the most frequent type of claims. From the overall response, delay claims were ranked first followed by extra work claims. Acceleration claims were ranked least. The top five most frequent causes of claims based on overall ranking were: variation in quantities, design errors, poor site management and supervision by contractor, ineffective planning and scheduling of project by contractor, and low price of contract due to high competition. Construction industry research in Botswana has never looked into the issue of claims and yet it is one of the hidden sources of construction project failure in the country. It is perceived that hedging against the most adverse causes of claims will stem the tide of incessant cost overrun, litigation and project abandonment on road projects in Botswana.

Keywords: Claims, road, construction projects, Botswana.

Introduction

The construction industry is a pivotal sector of any country's economy. In Botswana, the industry contributes on average about 5.3% to the country's economy and is responsible for a proportionate employment of labour. Despite its role as an engine of growth in the economy, the industry is characterized by poor project performance occasioned principally by time and cost overruns, claims, dispute, litigation and sometimes project abandonment. As noted by Zaneldin, (2006), claims permeates nearly all construction projects and is a direct result of growth phenomenon in an economy. Claims appear to be the hindrance to successful delivery of road projects in Botswana as it fuels project cost escalation and is linked to disputes in the industry. Botswana's government is investing millions of pula to improve road infrastructure in the country every financial year. The majority of these road projects are being constructed in cities and towns with arteries to the rural areas. Considering the land mass of Botswana (582,000

square kilometres) and the size of the road network required it is not surprising that the number of claims continues to increase.

Construction claims are considered by many project professionals to be one of the most disruptive and unpleasant events of a project (Ho and Liu, 2004). Bakhary et al. (2015), stated that claims in construction projects have increased to such a degree that they have become almost routine and can be caused by a number of factors. Therefore, understanding the causes of construction claims is a step towards avoiding them. Sambasivan and Soon (2007) stated that when a project is delayed, it is either accelerated or has its duration extended beyond the scheduled completion date and therefore it incurs additional cost. The conventional approach to managing the extra cost is to include a percentage of the project cost as contingency in the pre-contract budget (Aibinu and Jagboro, 2002). According to Bryan (2004), the ability to reduce the frequency and severity of claims stems from the identification of construction project risk factors and dealing with them and/or providing for them in the construction or design contracts.

Background

The major financier of road construction projects in Botswana is the Botswana government through the Ministry of Works and Transport represented by the Department of Roads. A number of foreign funding agencies have also contributed to road projects, studies and technical assistance. For example, contributions have been received from organizations such as ADB, BADEA, CIDA, DANIDA, EEC, IBRD, Kuwait Fund, NORAD, OPEC, UNCDF and USAID. Some of the projects that are externally funded are still ongoing. The Botswana Roads Department employs both competitive and selective tendering for projects. The criteria for selection of contractors as specified in the tender documents for construction include the following:

1. Competence and integrity.
2. Past performance of the contractor and its reputation in terms of similar jobs (track record).
3. The personnel strength of the contractor, its financial status and ability to co-finance projects.
4. The contractor's scheduled time of completion and final tender price.

The contractual arrangement is as shown on Figure 1. The client first appoints the consulting engineers to design and advice on a variety of specialist works, e.g. structural, civil works and pavement design. Consultants are also engaged to provide a site team during construction to ensure that the project is kept within cost and complies with the design. The principal contractor is employed by the client on the advice of the engineer by nomination or competitive tendering. They are required to administer the construction program within the engineer's direction. A domestic subcontractor is employed by the principal contractor to assist with the general construction or installation, e.g. bricklaying, fencing, and etc.

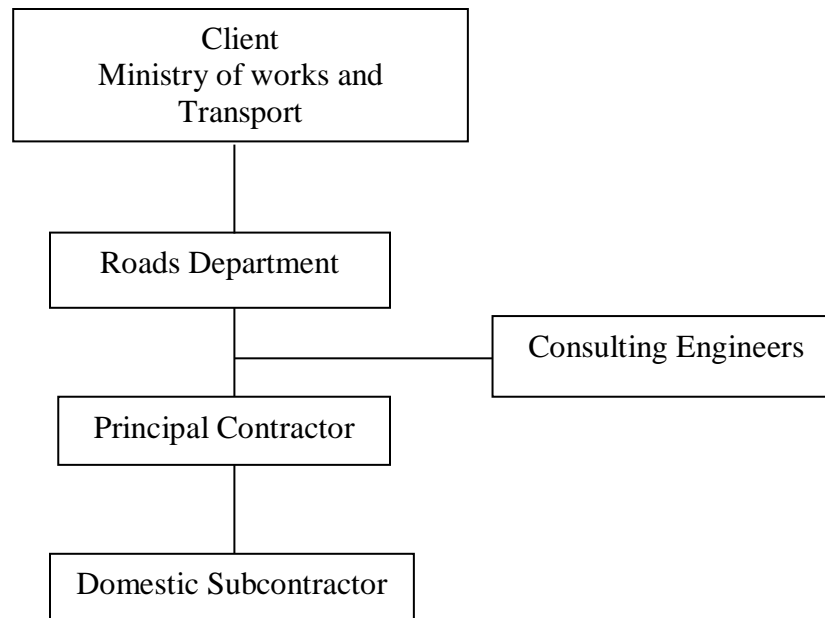


Figure 1: Contractual Arrangement for the Construction of Roads in Botswana (Segwabe, 2008)

The relative high resource commitment by Botswana Government to road construction projects has been highlighted in the Department of Roads website, (www.roads.gov.bw); during the years 1966 to 1986 more than P260 million (Botswana Pula) was invested in new road infrastructure. During the National Development Plan (NDP) 7, for the period from 1991 to 1997, P870,746,559.00 was spent for the development of the network. During the National Development Plan 8, for the period from 1997 to 2003, P2,661,274,384.00 was spent. For the period from 2003 to 2009 the estimated amount was P2,467,660,000.00.

The nature of work in highway construction projects in Botswana and other countries and the environment within which they are constructed make them susceptible to delays and claims. The influential factors (Segwabe, 2008) can be summarized as:

1. High uncertainty associated with such projects because they require operations such as excavating and crushing in varying soil conditions. A good example of such an uncertainty happened in the construction of the Dibete Mahalapye rehabilitation project. The parent rock that was to be crushed for production of road stones had a much higher strength than anticipated. This resulted in the crusher plant producing at lower rates than those estimated during the planning stage.
2. Work in these projects depends heavily on equipment and may be delayed because of the need for equipment repair, maintenance and at times transportation from overseas.
3. Numerous government authorities are involved in the project and each may require the contractor to obtain a permit with restrictions on time and work area such as mining licenses required before opening borrow pit areas. The logistics involved in going from one authority to another may take considerable time hence resulting in project delays.
4. Land expropriation process which can delay construction activities. This would happen when property owners within the road reserve are dissatisfied with compensations that are due to them. Such a case was experienced at the ongoing construction, Mahalapye – Kalamare road, where a farm owner refused to pave way to the contractor only because

he was not satisfied with the value of the compensation. The contractor then abandoned the section of the road to proceed with the works on the other sections. The normal practice is that the contractor will submit a claim for disruption of progress and for remobilizing his plant to the abandoned section when it has been sorted out.

These factors increase the likelihood of delay and claim in road contraction projects in Botswana as compared with other construction projects. Furthermore, associated delay problems can also result in dispute, arbitration, total abandonment and protracted litigation by the parties. Small citizen contractors in Botswana are experiencing cash flow problems and thus cannot afford to absorb costs of arbitration. This results in some of the contractors getting liquidated and abandoning projects. To some extent the contract parties through claims usually agree upon the extra cost and time extension associated with delay. This has in many cases given rise to heated arguments between the contractor and the owner. The question of whether a particular delay to progress of work warrants an extra cost and or extension of project duration is usually the cause of disagreement between the parties (Sambasivan and Soon, 2007).

Against the foregoing, the Botswana government is concerned with the quality of roads funded, and the time and cost overruns in delivering the projects. Out of the 31 road construction projects that were completed, between 1996 to 2005 by the Department of Roads, only 6.5% of the projects were completed within the scheduled completion dates and 32% were completed within budget. These indicate that there are serious problems within the construction industry in Botswana most especially on road project delivery. The motivation for this research therefore is a lack of required information relating to the factors causing claims on road construction projects in Botswana for the purposes of reducing its impact on project delivery. Such questions, usually involve questioning the facts, causal factors and contract interpretation. Synthesis of delay analysis techniques such as provided by AlKass et al. (1996) can address these questions.

Literature Review

Significant cost overrun on construction projects has given research impetus to the nature of claims in the construction industry in the last three decades. Zanelidin (2006), studied the types, causes and frequency of construction claims in the United Arab Emirates (UAE) by collecting information for 124 claims related to different construction projects in Dubai and Abu Dhabi Emirates. The data was collected from 71 different entities (29 contractors, 33 consultants and 9 owners) in the two emirates. The data for the 124 claims was mainly extracted from owners, consultants and contractors claims database. Owners and firms were also asked to provide information related to types of claims, causes of claims and frequency of each type and cause by completing a questionnaire. Data received indicated that the types of claims in construction projects in UAE can be classified into six main types and there were 26 possible causes of claims viz: Contract ambiguity claims, Delay claims, Acceleration claims, Changes claims, Extra-work claims and Different site conditions claims. The study found that the most frequent type of claim is “changes” type of claim and “extra-work” type of claim was ranked second. Of the 26 identified possible causes of claims, “change orders” are the most frequent causes of claims with an importance index of 52.5%. The types of projects considered included buildings, roads and highways, water and sewer lines, power plants and airports. Roads and building projects had the

highest percentage among all other types (34.7% and 30.6% respectively). In comparison to the current research the research by Zaneldin (2006) covered a wide range of projects including roads (34.68%), Buildings (30.65%) sewer line (12.10%), water line (11.29%), airport ((4.03%), power plant (3.23%) and others (4.03%). This research was deemed relevant to the current study because of the higher percentage of road construction projects covered.

Odeh and Battaineh (2002) conducted a survey aimed at identifying the most important causes of delay in construction projects executed under the traditional procurement system from the point of view of construction contractors and consultants. The survey included public and private buildings, roads, water and sewer projects in Jordan. The study was based on 28 causes of delay to which the participants were asked to indicate their perceived level of importance of each cause. The researchers categorized the delay causes into eight major groups as follows:

1. Client related factors – finance and payments of related work, owner interference, slow decision making and unrealistic contract duration imposed by owners.
2. Contractor related factors – site management, improper planning, inadequate contractor experience, mistakes during construction, improper construction methods and delays caused by subcontractors.
3. Consultant related factor - contract management, preparation and approval of drawings, quality assurance/ contractors, and long waiting time for approval of tests and inspection.
4. Material factors - quality and shortage.
5. Labor and equipment factors - labor supply, labor productivity and equipment availability and failure.
6. Contract factors - changed and mistakes and discrepancies in contract documents.
7. Contractual relationships factors - major disputes and negotiations during construction, inappropriate organizational structure linking all parties involved in the project, and lack of communication between these parties.
8. External factors - weather conditions, changes in regulations, problems with neighbors and site conditions.

The researchers found that according to the contractors, labour productivity was the most important delay factor. However, inadequate contractor experience was the most important delay factor to the consultants. The results also indicated that the two parties generally agreed on the ranking of individual delay factors. They agreed that inadequate contractor experience, owner interference and financing of work were among the top five most important factors. Moreover the researchers found that delays caused by subcontractors, slow decision making by owners, improper planning and labour productivity were among the top ten most important factors for both parties. Operation factors such as labour productivity, construction methods, site management and equipment availability and failure were more important to the contractors than to the consultants. Contractors were also more concerned with factors related to contract clauses that may alter their contractual obligations and rights. These factors included change orders, mistakes and discrepancies in contracts documents and major disputes and negotiations. However factors dealing with subcontracting, planning, organizing and communicating were more important to the consultants than to the contractors. This study focused on only two parties; the contractor and the consultant. These two parties will normally blame each other on certain issues concerning the execution of the work and therefore this can give rise to distorted/bias

information from either party. The client should therefore be brought in as a third party to add a sense of neutrality to the information. It was also possible for the two parties to be biased since the claims were categorized straight away as those emanating from contractors and those from consultants.

A similar study was conducted by Sambasivan and Soon (2007), to include the client as one of the parties surveyed. The researchers found that the main and top ten most important causes of delay were contractors improper planning, contractors poor management, contractors inadequate experience, inadequate client's finance and payment for the completed work, problems with subcontractors, shortage of material, labour supply, lack of communication between the parties and mistakes during construction stage. The study also identified the main effects of delay as time overrun, cost overrun, claim, disputes, arbitration, litigation and total project abandonment. Assaf and Al-Kahlil (1995) outlined the main causes of delay in large building projects and their relative importance. The researchers found that 56 causes of delay exist in Saudi Construction projects. According to the contractors surveyed the most important delay factors were preparation of shop drawings, delay in contractor's progress, payment by owners and design changes. The architects and engineers' views were cash problems during construction, the relationship between subcontractors and the slow decision making process of owner. The owners agree that the design errors, labour shortages and inadequate labour skills are important delay factors. This research was specific to building projects but most of the outlined delay factors are applicable to road construction projects.

Al-Khalil and Al-Ghafly (1999), conducted a survey to investigate three components of delay in the construction of water and sewerage works in Saudi Arabia. The components investigated were; (1) the frequency of delay projects, (2) the extent of delay and (3) the responsibility for the delay. Delay causes were compiled based on review of literature, interviews and discussion with some government authority representatives, contractor engineers, consultant engineers working on water and sewerage projects and personal pertaining to delay in public projects. The research was conducted by administering a questionnaire survey to the three groups of construction industry stakeholders. The respondents were requested to give their opinion on the frequency and severity of each cause on a four point Likert-type scale. Sixty causes of delay were identified by literature review and interviews. These delay causes were summarized into six major categories; contractor performance, owner's administration, early planning and design, government regulation, site and environmental conditions and supervision. The result showed that a large number of projects experienced delay, especially in medium and large size projects. They also found that the owners and the consultants assigned the major responsibility for delay to the contractor but the contractors placed it mostly to on the owner. On average the contractor was assigned most responsibility. The researchers outlined the important causes of the delay as cash flow problems and financial difficulties, followed by difficulties in obtaining work permits issued by various government authorities. The researchers opined that government practice of assigning contracts to the lowest bidder without regard to qualification is another important delay factor. Other factors are tendency to underestimate project duration, subsurface conditions and scheduling by the contractor and shortage of manpower. Although this research was based on water and sewerage projects, the findings may also be applicable to other projects.

Al-Momani (2002), investigated the causes of delays on 130 public contractors in Jordan. Projects investigated in this study included residential, office and administration buildings, school buildings, medical centers and communication facilities. The result indicated that poor design and negligence of the owner, change orders, weather conditions, late delivery, economic conditions and increase in quantities are the main causes of delay. The study suggested that special attention to factors will help industry practitioners in minimizing contract disputes. The research by Al-Momani, (2002) was more oriented to building projects and did not cover civil works. The outlined causes for the delay are also not specific, they were generalized. If we take an example of, “economic conditions”, the economic parameters were not defined by the study. In the case of Botswana, we could consider the devaluation of the Pula that happened in 2005. This can significantly delay the progress of works especially if we look at it from the perspective of material suppliers. Some contractors would find it difficult to mobilize their resources if the rates they used during tender stage have changed. A good example in this case will be the Dibete – Mahalapye road that is still ongoing. The Pula was devalued when the contractor was about to mobilize resources to the site. The devaluation significantly affected the mobilization of resources to the project site.

Assaf and Al-Hejji (2006), studied the causes for delay in construction projects in Saudi Arabia. The field survey studied frequency, severity and importance of the causes of delay. Seventy – three causes of delay were identified through research. The identified causes were combined into nine groups. The field survey included 23 contractors, 19 consultants and 15 owners. A questionnaire was developed in order to evaluate the frequency of occurrence, severity and importance of the identified causes. The researchers found that; owners specified that the causes of delay are related to the contractor and labour. The study also found that owners and consultants realize that awarding to the lowest bidder is the highest frequent factor of delay, while contractors considered severe causes of delay are related to owners. They also found that one cause of delay was common between all parties, which is “change orders by owner during construction’. Other common causes are: delay in progress payment, ineffective planning and scheduling by contractor, poor site management and supervision by contractor, shortage of labours and difficulties in financing by contractor. Though this work was not specific to the types of projects which were studied, the causes of delay identified are useful to the current research on claims in road construction.

Arditi and Pattanakitchamroon (2006) reviewed 20 research studies that discuss various aspects of delay analysis methods in resolving construction claims and summarized the advantages and disadvantages of widely used delay analysis methods, including the as-planned versus as-built, impact as-planned, collapsed as built and time impact analysis methods. The researchers found that time impact was the most accepted by the literature as the most reliable delay analysis method. The work by Arditi and Pattanakitchamroon was not directed towards finding the causes of claims or delay. The current research aimed at explicitly investigating the types and causes of claims in road construction.

Semple et al. (1994) identified that more than half of all claims constituted an additional cost of at least 30% of the original contract value based on their survey on construction projects in Canada. In addition about a third of the claims amounted to at least 60% of the original contract value. In some cases the claims were as high as the original contract value. Chan and

Kumaraswamy (1997), conducted a survey to evaluate the relative importance of 83 potential delay factors in Hong Kong construction projects. They found that the five principal and common factors to be: poor risk management and supervision, unforeseen site conditions, slow decision making involving all project teams, client oriented variation of works. They also compared their findings from Saudi Arabia and Nigeria and found that different perceptions of the causes for time overrun exist between respondents in Hong Kong and those in Saudi Arabia and Nigeria.

Aibinu and Jagboro (2002), conducted a study that was aimed at investigating by a questionnaire survey of construction practitioners, the effects of construction delay on project execution and by empirical method the effects of delay on completion cost and time in the Nigerian construction industry. The major conclusion of the study was that cost overrun and time overrun were the two most frequent effects of delay in the Nigerian construction industry. Delay had significant effects on actual project duration. Loss and expense claims arising from delay and fluctuation claim during the delay period had significant effect on cost overrun. The researchers stated further that acceleration of subsequent site activities in cases of delay to make up for the lost time has frequently failed in Nigeria building projects due to deficiencies in clients project management procedures and the contingency sums included in the pre-contract estimate of projects were not always adequate to offset cost overrun. The study was able to establish an allowance of 17.34% of total cost estimate as contingency. Even though the research focused on the effects of delays on construction projects, it can be deduced from the results that the effects of the delays are generally claims for extension of time and for loss and expense claims that would ultimately lead to cost overruns and thus the results are useful for research on road construction claims. While proffering several guidelines for managing extension of time (EOT) claims, Alnaas et al. (2014), warned against the concept of “wait and see” which results in contractors submitting their claims for extension of time at the end of the project or after the contract completion date. They advised contractors to submit EoT claim whenever they foresee delay event that will elongate the project completion date inasmuch the delay event is excusable and compensable.

Hassanein and Waleed El Nemr (2008), conducted a research with the objectives of knowing the status of claims management, change order claims and how to generate means of improving the status of change order claims management with respect to the contractors handling industrial construction projects in Egypt using 21 projects. Findings in this research showed that change order claims ranked first and represented about 54% of the total number of claims. This was followed by delays caused by the owner in the form of:

- Delay in supply of material and equipment.
- Delay in payments.
- Delay in providing construction drawings

In Palestine, Enshassi et al. (2009), investigated the problems associated with claim management from the perspective of local contractors by analyzing six groups of claim procedures namely: claim identification, claim notifications, claim examination, claim documentation, claim presentation and claim negotiation. Findings from this study emphasize the need for site personnel who can detect claims during project execution in addition to good project documentation.

Hardjomuljadi (2010) posit that the best way to avoid disputes, particularly to reduce its impact, is firstly to understand the main causal factors of claims and then the employer should try to find the pre-contract strategy and to improve the monitoring system of the project. He investigated the factors responsible for claims in the Indonesian construction industry through questionnaire distributed to the users of FIDIC Conditions of Contract made up of clients, consultants and contractors. Findings showed that possession of site and design changes were the main source of claims in Indonesia and that different interpretation of claims sometimes create disputes.

In Oman, Al Mohsin (2012) found that the main causes of claims are: delayed approval of schedules, change orders and slow processing of change order and lack of expertise. The clients were implicated as contributing about 41.36% to the occurrence of claims due mostly to the lack of experience while contractors and consultants contributed 21.47% and 20.94% respectively to claims. The rest 16.23% were attributed to inadequacies and errors in the contract documents.

According to Yoke-Lian et al. (2012), change orders by consultants resulting in project delay in the Malaysian construction industry is the most common reason for EoT claims. Further, Yusuwan and Adnan (2013a), in a questionnaire survey, asked respondents to rate the frequency of occurrence of eleven most contentious issues associated with EoT claims and their preferred method of dispute resolution as drawn from literature. Concurrent delay was found to be the most contentious issue associated with EoT claims. They (Yusuwan and Adnan, 2013b) submitted in another investigation that poor submission of claims by contractor (such as lack of details and particulars), late submission of claims by the contractor, and collection of relevant facts from site records to establish the principle of the claim ranked highest by the respondent as reasons for late assessment of EoT claim in the Malaysian construction industry. Further studies of claims in the Malaysian construction industry (Bakhary et al. 2015), revealed that the highest three reasons for claim in ranking orders were:

1. Design changes introduced at the post-tender award stage.
2. Hurried implementation of project without recourse to adequate site investigation, design work and contract documents.
3. Changes in the client/users requirement during the post tender stage.

In India, Kamble and Kambekar (2013), investigated the extent of delay claims on three types of project and found that claim was 14.5% of the contract sum for a mall project in Mumbai; 1.08% for the construction of hotel and casino in Goa and 400% total for power transmission tower at four locations in Raigad district of Maharashtra. The factor of delay damages for the mall project was shortage of shuttering materials; for the hotel and casino and the power station it was delay in allotting the site to the contractors. Also Chaphalkar and Iyer (2014), found that out of 52 arbitration awards available for study, 38 awards pertained to delay related claims. The delays were observed due to numerous reasons like late handing over of site, late issue of drawings, late supply of materials, delayed payments and delay on the part of sub-contractors.

Braimah (2013), reports on approaches to delay claims in the UK based on the views of practitioners in the construction and consulting companies using a nation-wide questionnaire survey. Findings from the survey revealed that:

- Delay claims are often resolved late and not close in time of occurrence of the delay events, creating more difficulties;
- Simplistic delay analysis approaches are widely used in practice and form the basis of successful claim resolutions, although they have major weaknesses;
- The sophisticated approaches, although are more robust, are generally not popular in practice.

He recommended improved programming and record keeping practices as means of promoting reliable approaches to claim settlement in order to minimize dispute.

Klee (2013), reported that claim management started to gain prominence in the Central European (CEE) countries due to recent recession forcing countries to compete for international jobs. The objective of this research was to suggest appropriate way for contractors management claim by identifying what the existing problems were through questionnaire survey. Respondents stressed that construction companies do claim but not systematically. The main problem associated with unsystematic claims was insufficient coordination of information flow between the respective project management and the superior company management.

In South Africa, Preez (2014), conducted ten interviews on project procuring professionals on the use of conciliation as a means of settling disputes arising from claims. Findings suggested that placing emphasis on conciliation will add value to claims management in project procurement and prevent the differences between parties from developing into disputes. It was recommended to Project Management Institute (PMI) to include conciliation as a fundamental method of dispute resolution in claims as this was missing where claims management was addressed in the Project Management Body of Knowledge (PMBOK).

In the United States, Shrestha et al. (2014) administered a questionnaire containing 14 questions on 40 construction professionals. The goal of the study was to determine the current procedures being adopted for delay claim analysis in the construction industry. It was found that the basis of delay claims were schedule changes (changes in the original schedule due to change in the scope of work and/or delay in the construction), drawing errors, change orders, geotechnical reports, and schedules. And the top three types of subcontractors that submitted the most delay claims were concrete, excavation, and steel subcontractors

Hadikusumo and Tobgay (2015), studied construction claim types and causes on large scale hydropower projects in Bhutan using archival records. It was reported that the dominant cause of claims was from differing site conditions (55% of claim amount), which resulted in both changes and delays that led to several claims. Negotiation was the primary mode of claim settlement used in this project and was determined to be the most effective in terms of cost and time. More than 95% of the claim cases were settled through negotiation and approximately 5% were dealt with by arbitration. The duration of the claim settlement varied from a minimum of six (6) months to as long as four (4) years. The claims that were settled through negotiation took considerably less time than the arbitration cases, which took up to four (4) years. Most of the cases that took longer to settle were due to omissions or ambiguous/conflicting contract provisions/clauses (1.64 years) and claims due to force majeure (1.63 years). All claims originated from the contractors. Overall, 39% of the amount claimed was successfully resolved for payment while 61% was unsuccessful. The various reasons for the high rejection of claims were as follows: (1) Quantity difference

between the contractor's claim amount and the actual site executed, (2) Ghost work, where some tasks were not executed but were claimed by the contractor, (3) Incompatibility with required contract provisions and (4) Disputed/unwarranted claims that needed to be referred to a higher level for settlement but were later dropped by the contractor.

It is evident from the literature that the problem of delays and claims in the construction industry is a global phenomenon. There is need for awareness in Botswana's construction industry on the impact of claims on project delivery. Information related to the causes of construction claims in Botswana and the ways to prevent or minimize them are to a large extent still missing. This study, therefore, presents the results of a questionnaire survey involving road construction professionals on the types and causes of claims (alongside their frequencies of occurrence) in road projects in Botswana.

Research Methods

Based on literature and the preliminary investigation conducted on road project stakeholders (Segwabe, 2008), it was possible to identify certain major types and causes of delay and claim on road project delivery. Six categories of claims identified are contract ambiguity claims, delay claims, changes claims, different site conditions claims, extra work claims and acceleration claims. The associated twenty seven causes of claims are:

1. Shortage of construction materials.
2. Change or variation orders.
3. Delays in handling site to contractor.
4. Different subsurface of jobsite conditions.
5. Abnormal weather.
6. Inadequate contract documentation.
7. Incomplete tender information.
8. Low price of contract due to high competition.
9. Variation in quantities.
10. Poor site management and supervision by contractor.
11. Contractor financial problems.
12. Change in government regulations.
13. Ineffective planning and scheduling of project by contractor.
14. Design errors or omissions.
15. Improper construction methods implemented by the contractor.
16. Poor communication by between parties.
17. Suspension of work by owner/client.
18. Unanticipated low productivity of labours and equipment.
19. Specification and drawing inconsistencies.
20. Subcontracting problems.
21. Changes in material and labour costs.
22. Delay in payment by owner.
23. Delay in decision making by owner/client.
24. Accidents on site.
25. Late supply of drawings by consultant.
26. Poor contract management.
27. Imported materials and plant items.

These 27 factors were the subject of a questionnaire sent to respondents for ranking. A total of 52 questionnaires were distributed to the road project stakeholders. Out of the 52 questionnaires, 27 usable responses were received, which represents 52% response rate. Responses included 8 contractors, 10 consultants and 9 owner's (client) representatives. The contractors surveyed were

those that registered within Public Procurement and Asset Disposal Board (PPADB) categories D and E and had an average experience of about 13 years while the respondent consultants were those that have an average of about 21 years of experience. All the respondents were practitioners related to road projects in Botswana and are either currently working on ongoing road projects or have completed some road projects in Botswana.

The respondents were in the first instance asked to rank the individual effects of construction delays on claims and next, to rank the individual effects of construction delays based on the frequency of occurrence on a Likert-type scale. A weight in the scale of 0 to 4 was given for each of the frequencies with weight of zero for never, 1 for rare, 2 for average, 3 for frequent and 4 for very frequent. No weight was given when a response was not provided. The five point scale was later transformed to relative importance index for each of the categories and causes of claims for ranking purposes.

Results

The relative importance index, RII was calculated for each factor as follows:

$$RII = \frac{4n_1 + 3n_2 + 2n_3 + n_4 + 0n_5}{4N} \dots\dots\dots (1)$$

where:

n1 = number of respondents for ‘always’; n2= number of respondents for ‘mostly’;
n3 = number of respondents for ‘sometimes’; n4 = number of respondents for ‘seldom’;
n5 = number of respondent for ‘never’; N = total number of respondents.

Categories of Claims

The primary data collected from the second part of the questionnaire was analyzed from the perspective of clients, consultants, and contractors. The study identified, through literature review that claims in construction projects can be classified into six main types; contract ambiguity claims, delay claims, changes claims, different site conditions claims, extra work claims and acceleration claims. Relative importance index (RII) was computed for each type of claim to identify the most frequent categories of claims. The categories of claims were ranked based on the RII values. The ranking of the categories of claims are presented in Table 1. The table shows that clients and consultants rank delay claims highest followed by extra work claim as the most frequent types of claims on road construction projects in Botswana. According to the table, contractors perceive different site condition followed by delay claim as the most frequent sources of claim. Table 1 also gives the overall ranking of the types of claim. On the overall, delay claim ranked first followed by extra work claim. Accelerated claim ranked least.

Table 1

Ranking of the Frequency of Occurrence of Categories of Claims

Types of Claims	Clients		Consultant		Contractor		Overall	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Delay claims	0.833	1	0.700	1	0.844	2	0.787	1
Extra work claims	0.750	2	0.675	2	0.688	4	0.704	2
Different site conditions claims	0.611	3	0.475	3	0.875	1	0.639	3
Contract ambiguity claims	0.528	4	0.525	4	0.750	3	0.593	4
Changes claim	0.528	5	0.500	5	0.563	5	0.528	5
Acceleration claim	0.333	6	0.275	6	0.281	6	0.296	6

Delay claims

Delay claims ranked first among all the individual parties and on the overall basis. It is not surprising that this type of claim is the most frequent in Botswana. Most of the causes of claim identified in the study resulted in elongation of the project duration, e.g. different site conditions, variation in quantities, design errors or omissions and variation orders. The delay occurring in a project can be classified into a number of types depending upon the stages at which it occurs as well as the nature of the outcome, i.e. claims. This defines the criticality of the delay in the overall project completion and its impact thereafter. Different types of claims arising out of time delay and extension clauses are as follows: claim for price escalation of resources by the contractor when the work is not completed in time and extensions are to be allowed because of client's default, claim for idling resources by the contractor due to delay by the client, delay due to handing over of site, delay due to rework etc. It is evident from the literature that delay claims are of great concern to the construction industry practitioners.

Extra work claims

In a similar study conducted by Zaneldin, (2006) in the United Arab Emirates, this type of claim was also ranked as the second most frequent type of claim after "changes claim", out of the six types of claims which were also adopted for this study. The nature of construction industry is such that full scope of work cannot be decided at the time of tendering and change orders are inevitable for successful completion of the project. Subsurface conditions and clients changing requirements are often unpredictable leading to extra work. To avoid the claims and disputes related to extra work, experience plays a vital role in forecasting the probable areas of extra work and incorporating the relevant clauses in conditions of contract.

Different site condition claims

This type of claim was ranked third by clients and fifth by both consultants and contractors. Based on overall ranking, it was ranked third as depicted in Table 6. From the literature, different site conditions relate to the hard rock, black cotton soil encounter, subsurface water flow, archaeological things found on site, etc. however, the causes of change of site condition could be attributed to negligence of project designers and client. The client and project designer should give full and detailed underground information to the contractor. Usually designers sometimes assume the design factors in difficult conditions of site, which may differ during construction

works later. If it is not possible due to time constraint or whatever other reasons, then provision of proper compensation in case of changed conditions should be categorically mentioned in the contract document to avoid claims later. Change of site condition is a prominent problem in construction projects globally as revealed by previous studies; Arditi et al. (1985), Chan and Kumaraswamy, (1997) and Acharya and Lee, (2006). So it is not surprising to find this result true in the context of Botswana.

Change order claims

Change order claims was ranked fourth by clients and third by consultants. On an overall basis it was ranked fourth. It seems from the literature that variation orders are inevitable in any construction project. Needs of the client may change in the course of design or construction. Factors like community needs may influence design and the choice of the engineer. The engineer's review of the design may bring about changes to improve or optimize the design, hence the operations of the project. Furthermore, errors and omissions in drawings or construction may force a change. All these factors and many others necessitate changes that are most of the time costly and generally unwelcome by all parties to a contract. Management of changes and claims is the management of risks. It begins with the allocation of risk in the project owner's selection of a particular construction method. A study by Zaneldin, (2006) found this type of claim as the most frequent type of claim.

Causes of claims

Table 2

Ranking of the Causes of Claims

Causes of Claims	Clients		Consultant		Contractor		Overall	
	Index	Rank	Index	Rank	Index	Rank	Index	Rank
Variation in quantities	0.583	6	0.525	5	0.750	4	0.611	1
Design errors or omissions	0.500	12	0.475	9	0.875	1	0.602	2
Poor site management and supervision by contractor	0.778	1	0.650	2	0.281	24	0.583	3
Ineffective planning and scheduling of project by contractor	0.667	2	0.75	1	0.313	23	0.583	3
Change or variation orders	0.556	8	0.525	5	0.656	5	0.574	5
Different subsurface of jobsite conditions	0.528	10	0.450	12	0.781	2	0.574	5
Low price of contract due to high competition	0.667	2	0.600	3	0.438	16	0.574	5
Contractor financial problems	0.667	2	0.600	3	0.375	19	0.556	8
Specification and drawing inconsistencies	0.500	12	0.425	13	0.781	2	0.556	8
Shortage of construction materials	0.556	8	0.400	14	0.625	7	0.519	10
Unanticipated low productivity of labour and equipment	0.500	12	0.400	14	0.656	5	0.509	11
Poor communication between parties	0.528	10	0.500	8	0.469	13	0.500	12
Imported materials and plant items	0.389	19	0.525	5	0.594	8	0.500	12
Abnormal weather	0.639	5	0.350	22	0.500	11	0.491	14
Changes in material and labour costs	0.583	6	0.400	14	0.469	13	0.481	15

Poor contract management	0.500	12	0.400	14	0.563	9	0.481	15
Inadequate contract documentation	0.417	17	0.475	9	0.531	10	0.472	17
Improper construction methods implemented by the contractor	0.472	16	0.475	9	0.344	22	0.435	18
Late supply of drawings by consultant	0.417	17	0.375	19	0.500	11	0.426	19
Incomplete tender information	0.389	19	0.400	14	0.438	16	0.407	20
Subcontracting problems	0.389	19	0.375	19	0.469	13	0.444	20
Delay in decision making by owner/client	0.306	23	0.375	19	0.375	19	0.352	22
Changes in government regulations	0.333	22	0.325	23	0.375	19	0.343	23
Delay to hand site to contractor	0.306	23	0.275	24	0.406	18	0.324	24
Delay in payment by owner	0.306	23	0.275	24	0.219	25	0.269	25
Suspension of work by owner/client	0.222	26	0.275	24	0.219	25	0.241	26
Accidents on site	0.194	27	0.225	27	0.156	27	0.194	27

Table 2 is a summary of the RII ranking by the three parties and on the overall. Based on the ranking, the five most frequent causes of claims as perceived by clients were: Poor site management and supervision by contractor, contractor financial problems, low price of contract due to high competition, ineffective scheduling and planning of project by contractor and abnormal weather. The five most frequent causes of road construction claims as perceived by consultants were: ineffective planning and scheduling of project by contractor, poor site management and supervision by contractor, low price of contract due to high competition, contractor financial problems and variation orders. The five frequent causes of claims as perceived by contractors were: Design errors or omissions, different subsurface or jobsite conditions, specification and drawing inconsistencies, variation in quantities and unanticipated low productivity of labours and equipment.

From the above list, it is interesting to compare the causes of claims as perceived by three parties; consultants and clients generally agree on the top four most frequent causes of claims in Botswana. The two parties blame the contractor for financial problems, ineffective scheduling and planning of project and poor site management and supervision as the most frequent causes of claims. The two parties also agree that low price of contract due to high competition is one of the most frequent cause of claims. This is due to the fact that tenders are awarded to the lowest bidder to execute the road projects. Generally, the lowest bidders are unqualified contractors with shortage in resources and low capabilities. This results to low performance and cause delay in completion of the work. Contractors at times end up putting up claims in order to cover for the losses and for the tender price. All the three parties agree that accidents on site, suspension of work by client and delay in payment by owner are the least frequent causes of claims. From the overall ranking, the five most frequent causes of claims are variation in quantities, design errors, poor site management and supervision by contractor, ineffective planning and scheduling of project by contractor and low price of contract due to high competition.

Conclusion

The important issue focused on in this study is claims in the construction of roads in Botswana. Since claims are considered to be a serious problem in the construction industry for both client

(Roads Department, Botswana) and contractors, this study investigated the types and causes of claims in construction of roads in Botswana. From an extensive literature review and preliminary investigations conducted at the outset of this study, it was possible to identify major types of causes and claims on project delivery. The study identified six major types and twenty seven causes of claims.

A questionnaire was then designed and distributed among the three major groups of stakeholders (clients, consultants, and contractors) on the frequency of occurrence of each type and cause of claims. Relative importance index (RII) method was used to analyze the data collected from the questionnaire survey. The analysis was carried out for each group of respondents and on the overall results (all the parties combined). The indices were then used to determine the rank of each item. The responses were collected from 27 respondents (nine clients, ten consultants and eight contractors).

The results indicated that clients and consultants specified delay claims followed by extra work claims as the most frequent types of claims in construction of roads in Botswana. Contractors perceived different site conditions followed by delay claim as the most frequent types of claim. From the overall response, delay claims were ranked first followed by extra work claims. Acceleration claims were ranked last.

The five most frequent causes of claims as perceived by client were: poor site management and supervision by contractor, contractor financial problems, low price of contract due to high competition, ineffective scheduling and planning of project by contractor and abnormal weather. The five most frequent causes of road construction claim as perceived by consultants were ineffective planning and scheduling of project by contractor, poor site management and supervision by contractor, low price of contract due to high competition, contractor financial problems and variation orders. The five frequent causes of claims as perceived by contractors were design errors or omissions, different subsurface or jobsite conditions, specification and drawing inconsistencies, variation in quantities and unanticipated low productivity of labors and equipment.

Comparing the causes of claim as perceived by the three parties, the consultants and the clients generally agreed on the four top-most frequent causes of claims in Botswana. The two parties blame the contractor for his financial problems, ineffective scheduling and planning of project and poor site management and supervision as the most frequent causes of claims. The two parties also agree that low price of contract due to high competition is one of the most frequent cause of claims. All the three parties agree that accidents on site, suspension of work by client and delay in payment by owner are the least frequent causes of claims. The top five most frequent causes of claim based on overall ranking were: variation in quantities, design errors, poor site management and supervision by contractor, ineffective planning and scheduling of project by contractor, and low price of contract due to high competition.

The results of the study revealed differences in perceptions as to the causes of claim between the groups of contractors and clients and also between contractors and consultants. Clients and consultants generally agreed on the causes of claim. It is suggested that this apparent collective biases of different industry groups may often direct blame for claim to the other group and this

discourages a search for the root causes of claim and solutions to same. The origin of such biases may be traced to group conditioning as well as to the present adversarial nature of the contractual systems, including the clashes and the blame allocation. Perhaps the wording of the factors in the questionnaire itself might also be re-examined to minimize any defensive posturing by different groups but a residual is apparent even if allowances are made for this possible distortion.

Recommendation

From the literature review, the traditional practice of awarding contract to the lowest bidder has been implicated as a source of time and cost overruns and consequently claims. It is customary to award road contracts through traditional procurement in Botswana. It will be recalled that traditional procurement gives preference to the lowest bidder who in most cases are the least competent to manage the risk associated with the work. The continued adoption of traditional procurement system (TPS) for public infrastructure is a misnomer most especially when considering road projects. Love (2008) reported a general move away from the TPS in Australia due to multifarious problems associated with it which include delay claims. This paradigm shift is common to all developed countries whereby procurement system such as design-build, management oriented procurement system (MOPS) and recently performance information procurement system (PIPS) is preferred to TPS. Adeyemi and Kashiwagi (2014) treatise low-bid infrastructure procurement system as unsustainable and dissuaded African governments from its continued adoption. In the same vein, Adeyemi et al. (2015) analyzed 40 public infrastructure projects and found that all the projects incurred cost overrun to the tune of 622.00 million Botswana pula for projects implemented through TPS between 2009 and 2014. It is therefore recommended that road infrastructure procurement in Botswana shift to best value procurement typified by PIPS where emphasis is placed on the construction process rather than price.

In this procurement system the best value contractor, that is, the contractor that can identify and manage the risks associated with the project is selected through stage by stage sieving and past records (Adeyemi et al. (2011). The issues of delay claims, extra work claims, change orders and different site conditions as encountered in this research are endogenous risk factors which a best value contractor can foresee.

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Appendix

List of Abbreviations

ADB	African Development Bank.
BADEA	Arab Bank for Economic Development in Africa
CIDA	Canadian International Development Agency
DANIDA	Danish International Development Agency
EEC	European Economic Community
IBRD	International Bank for reconstruction and Development
NORAD	North American Aerospace Defense Command
OPEC	Organisation of Petroleum Exporting Countries
UNCDF	United Nations Capital Development Fund
USAID	United States Agency for International Development

Prefabricated Foundation System for Single Storey Houses

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Prefabrication technologies have been used in the building industry since the 19th century. The technologies vary from the innovative materials to novel techniques of construction and the prefabricated systems range from individual components to the entire structure. The major prefabrication technologies prevalent today include sandwich panel walling elements, hollow core slabs, light gauge steel frames as well as modular housing. Even though prefabrication technologies have been widely used in slabs, beams and columns, prefab foundation system is still a relatively new concept. The construction of foundation is the most important part of building process and hence a sound prefabricated foundation system is the need of the hour. In this paper, an attempt has been made for construction of a portable prefabricated reinforced concrete foundation which can be used in buildings up to three storeys.

Keywords: Prefabrication, Foundation, Reinforced concrete.

Introduction

Prefabrication technologies have gone through a number of changes since its inception. A lot of advancements have been made in the prefabricated technologies corresponding to the superstructure. However, studies regarding prefabricated foundations are scarce. As it is widely known, prefabrication technologies have a number of advantages including efficient resource utilization and faster construction; therefore, a prefabricated foundation system will be instrumental in improving the performance of the building industry. The current research addresses this gap and proposes a prefabricated portable foundation system, designed for a one storey building. The advantage of this system is its flexibility, as it can be fabricated partially or wholly on-site as required depending upon the machinery available for erection. The paper consists of a comprehensive literature study on prefab foundation systems, followed by the description of the proposed foundation system and the methodology followed. The scope of future studies has also been outlined in this paper.

Review of Prevalent Prefabricated Foundation Technologies

A comprehensive literature research has been carried out to study the prevalent prefab foundation systems across the world. Studies published indicate that even though prefab techniques have been applied to the superstructure (modular framing system, panel system, tunnel and box-form construction and use of different lightweight alternative materials to traditional construction methods etc. (Girmscheid 2010), the substructure is still built according to conventional methods. Only a few innovations have been made in this area. One such technology is a foundation system using a number of concrete panels patented in 2003 (Davis 2008). The panels of rectangular shape are positioned end to end forming a wall-like structure

around the entire perimeter of a prefabricated structure. The lower surfaces of the panels are supported by precast posts and the upper edges are locked together to avoid any displacement from their position; thereby providing a stable platform for the superstructure. The joints between the panels are sealed with weather guard material. A modified prefab panel foundation technology employs lightweight element for construction of strip foundations in Denmark (Rasmussen 2007). The elements are made of Expanded Polystyrene (EPS) boards glued together to serve as strip foundation for buildings up to two storeys. The EPS element is designed such that the strip foundation represents the base of a traditional double-brick wall together with the ground deck, a traditional wood-stud wall, or combinations of lightweight concrete, brick and wood-stud walls with insulation. Instead of an excavation depth of about 900mm as needed for conventional foundation, an excavation depth of 400mm is sufficient for this element (Figures 1a, 1b, 1c). The process of its installation is described as follows:

1. Material up to a depth of at least 350mm underneath the top soil surface is dug up.
2. The excavated area is covered with a capillary breaking layer of gravel which is stamped in order to form the stable base for a building.
3. The strip foundation is mounted, fixed together with comb-shaped pieces of plastic and outer support of stamped gravel. 300mm of EPS in two layers is mounted inside the strip foundation working as insulation underneath the concrete floor slab.
4. Before casting the concrete, iron is mounted, as a net, preventing shrinkage crack development, inside the strip foundation and as wires along the moat formed by the two vertical boards of EPS in the prefabricated elements.
5. Wires of stainless steel rods, 5 mm in diameter are put through the inner vertical boards of the prefabricated elements of EPS every 600mm, in order to attach the concrete in the moat to the concrete floor slab.
6. Concrete is cast and levelled and after a few hours, when the concrete becomes stable in shape, the outer vertical boards of the prefabricated elements of EPS are removed exposing the outer surface of the concrete moat as the outer plinth.
7. The removed outer vertical boards of EPS are used as the outer insulation on the ground around the plinth.



Figure 1a): Prefabricated elements, made of EPS boards glued together and forming an element, are mounted as the strip foundation, fixed together with comb-shaped pieces of plastic.



Figure 1b): 300 mm EPS, mounted as two layers on top of the base of stamped gravel bordered by the strip foundation, working as the insulation layer underneath the concrete slab.



Figure 1c): Iron is mounted, as a net inside the strip foundation and as wires along the moat formed by the two vertical boards of EPS in the prefabricated elements before concrete is cast and levelled.

Similar types of prefabricated foundations using panels (concrete or EPS (This old House 2013)) with concrete studs have been in vogue under various patented systems of different companies catering prefab technologies all over the world. Precast pile foundations and precast rectangular foundation blocks have also been used as foundation systems. The process constitutes of driving the precast pile foundations in the ground after which reinforcing steel bars are inserted into the piles by drilling holes. The outstanding portion of the reinforcing bars is then fitted either in concrete pedestals or in beams (simple and post-tensioned beams, as the case may require) with in situ grouting by pouring concrete in the through holes of these elements; thereby connecting the elements in an integrated foundation system (Precast concrete piles. (n.d). retrieved 2016). The precast foundation blocks can also be used without piles in some cases, depending on the soil conditions. The tie beams are slotted in the wedges made in the foundation blocks and in situ grouting is carried out for connecting the elements in a monolithic system (Figure 2a-2f).



Figure 2a): Precast Foundation block.



Figure 2b): Foundation block placed in the trench.



Figure 2c): Precast foundation with Tie beam slotted in place.



Figure 2d): Soil filled till top of the foundation pier.



Figure 2e): Plinth beam inserted in the reinforcement slots over the foundation pier.



Figure 2f): Insitu grouting in the slots to make the system monolithic.

Reinforced concrete being heavy, the precast rectangular pedestal units are modified to manage the weight for ease of installing and handling. Hence, partial prefab foundations are used during installation and the remaining portion is cast in situ while connecting it with other elements to form a monolithic structure. This type of prefab systems have been used via a number of patented shapes like ring-shaped or rectangular box framed with reinforced hollow panels, where in situ concreting is done (See Figure 3).



Figure 3: RCC rectangular box framed Express Foundations: courtesy Contech Engineered Solutions (Solutions, C. E. (n.d.). EXPRESS Foundations, retrieved 2016)

A partial prefab modular foundation system has been developed for specialized applications to wind turbines, patented in 2008 (Phuly 2007). It consists of a central pedestal, a bottom support slab, and a number of prefabricated radial reinforcing ribs. The pedestal and support slab are poured in situ at site. When the concrete cures, the support slab is united to the prefabricated ribs and the ribs are also united to the pedestal. The result is a continuous monolithic foundation wherein loads are carried across the structure vertically and laterally through the continuous structure by doweled and spliced reinforcing steel bars which are integrally cast into the pedestal, ribs and support slab (See Figures 4 & 5). The slab thus behaves structurally as a continuous slab reducing deflections, improving fatigue conditions and increasing the stiffness of the foundation as well as allowing for the benefits of an economical design.

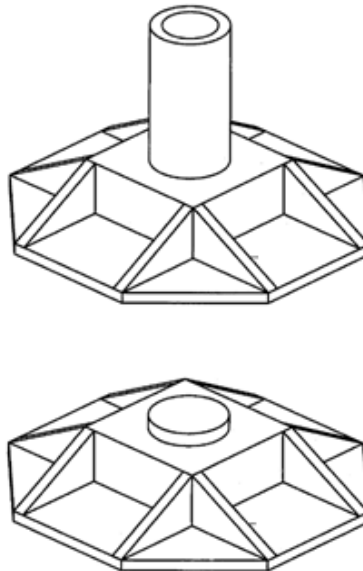


Figure 4: A perspective view of pedestal and ribs with (for offshore applications) and without pier, respectively.

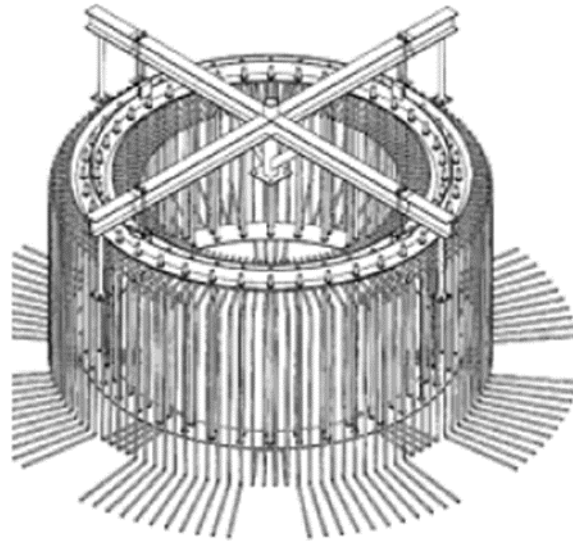


Figure 5: A perspective view of the foundation.

A modular foundation for monopole tower has also been developed and patented in 2012 (Clifton 2012). It is utilized to support a monopole, a central assembly with a number of legs. A proximal end of each removable leg is attached to the central hub. A mounting bracket is attached to a distal end of each leg and connecting members are secured to adjacent mounting brackets to form a perimeter around the hub. The connecting members are configured to receive ballast or other stabilizing mechanisms to stabilize the foundation to allow the monopole and the attached equipment to be raised and lowered. This invention also includes a lifting mechanism that attaches to both the modular portable foundation and the monopole to raise and lower the monopole and the attached equipment (See Figures 6a & b).

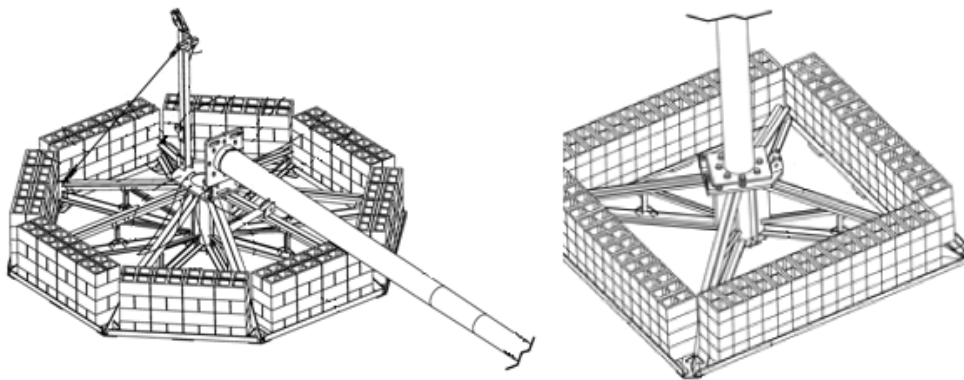


Figure 6a & b): Perspective views of portable and modular monopole foundations of different shapes.

Therefore, some of the prevalent prefabricated foundation presented indicates that the main principle is the reduction of manual labor, ease of handling and speedy construction. Similarly, areas where heavy cranes are not possible, the weight of the prefab elements is also to be taken care of. These underlying principles are followed in the proposed foundation system and elaborated in the following section.

Prefabricated RCC Hollow Spider Foundation

The proposed system of foundation consists of a reinforced concrete pedestal, cast in 4-legged spider projections from the central hollow column. The remaining part of the rectangular footing is a steel cage, over which in-situ concreting may be done. The pedestal is attached to a monolithic hollow column, interlaced with reinforcing bars which are protruded above (Figures 7a and 7b). In order to connect it to the precast column above, in situ concreting is done to fill the hollow portion, and simultaneously, the extended bars are embedded into the continuing column, thus making it a monolithic/unified construction.

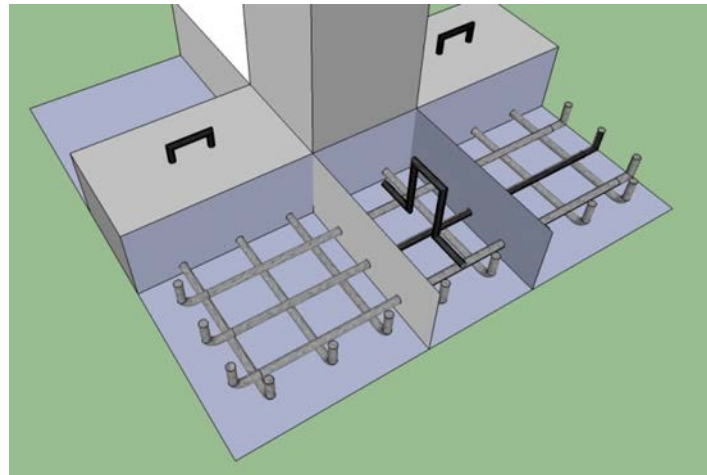
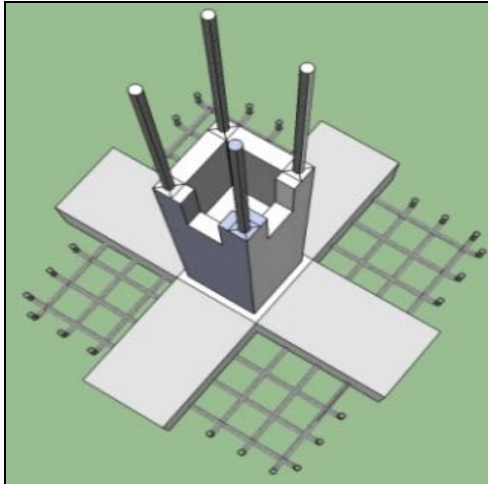


Figure 7a & b): Schematic views of the precast foundation system visualized in Google Sketchup.

Procedure Description

Firstly, the proposed system is modelled analytically and the design is done according to the Indian Standard Code for reinforced concrete design. Consequently, mix design of M25 grade concrete was prepared and tested according to the provisions prescribed by Indian Standard Codes. In the third step, the mold of the spider foundation was fabricated using plywood and finally the foundation was ready to be cast. After the casting of the foundation as an isolated component, it was necessary to build the other parts of the system and hence, various alternatives were considered for the plinth beam, columns, walling and roofing systems. The best fit of the alternatives of each element has to be considered for the test bed. However, although the design and visualization of the elements has been done, the connection details and fabrication of the entire system is yet to be completed. This section presents the details of the methodology followed till date.

Analytical model and design

A one-storeyed precast model room of size 3000 mm x 3600 mm (inner dimensions) has been considered at CSIR-CBRI, Roorkee. An analytical model of this room was prepared using SAP2000 software and the various forces obtained in the results of the analysis have been used

for designing the precast elements according to the provisions of the Indian Standard Code IS 456-2000.

Mix Design

The precast foundation is cast in-situ using M25 concrete and reinforcement of 10mm diameter steel bars of grade Fe415 @ 150 mm c/c. The loading and the design are done according to the provisions of Indian Standard Code IS456-2000. The mix design details of the M25 grade concrete used for casting of the precast pedestal is shown in Table 1, the provisions of IS 456-2000 and IS 10262-2009.

Table 1

Mix Design Details

W/C ratio	0.5
Maximum water content	208
Water content	178.88
Cement content	357.76
Volume of C.A.	0.6
Volume of F.A.	0.4
Volume of concrete	1
Volume of cement	0.114
Volume of water	0.18
Volume of admixture	0.0016
Volume of all in aggregate	0.71
Mass of cement	357.76
Mass of C.A.	1122.40
Mass of F.A.	735.56
Mass of admixture	1.7888
Slump in mm	85-90
Ratio	1:2.06:3.14
Reduction in water content by mixing super-plasticizer	14%
Super plasticizer	0.5
Maximum size of Aggregate	12.5

Tests for strength and workability

Consequently, the sample (cube of size 150mm x 150mm x 150mm) is checked in accordance to the various tests as prescribed by Indian Codes viz. IS 516-1959 for the 7- day compressive strength test and IS 1199-1959 for the slump test for workability. From the results obtained, it has been seen that M25 grade concrete with ratio 1:2.06:3.14 is most suitable for casting the precast components of the prefab model room because it is the best fit considering the properties of strength and workability. The results are shown in Table 2.

Table 2

Results of tests conducted for workability and compressive strength

Grade	Mix	Slump (mm)	7 days Compressive Strength (N/mm ²)	% of Admixture by weight of Cement	W/C ratio
M25	1:2.11:3.51	Nil	24.45	1.0	0.43
M25	1:2.13:3.53	Nil	26.43	0.3	0.43
M25	1:2.08:3.47	10-15	24.78	0.5	0.45
M25	1:2.06:3.14	85-90	16.55	0.5	0.5
M25	1:1.63:3.22	20-30	20.91	0.75	0.4

Foundation details up to plinth level

For casting of foundation up to the plinth level, a unique formwork has been prepared using plywood, battens, steel plate, hinges and nut bolts. The formwork is used for casting of the spider legged foundation as well as the hollow pedestal. The following figures show the schematic diagram and formwork preparations on site at Rural Park CBRI, Roorkee, respectively:

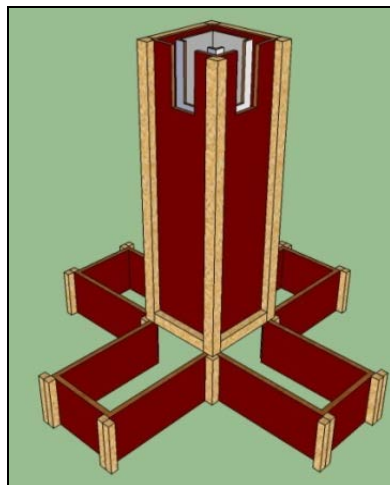


Figure 8: Schematic Diagram of the formwork.



Figure 9: Formwork preparations on site at Rural Park CBRI, Roorkee.

The pedestal system consists of footing and a stem column portion which is to be used for the foundation system of the prefabricated model room. The footing portion consists of a cross base which have four handles on each wing for placing the pedestal in the trench safely and easily. The pedestal system has to be placed manually in the trench. The following figures show the visualized and final product respectively:



Figure 10: Isometric view of the Foundation system.

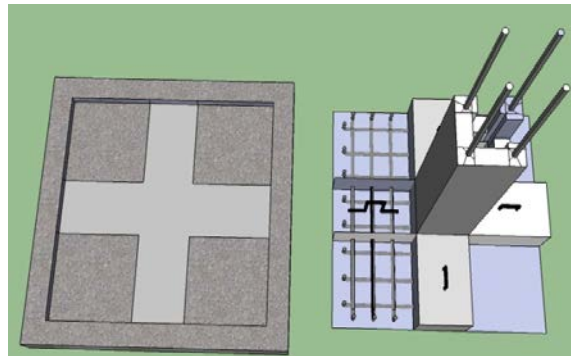


Figure 11: Schematic Diagram of the foundation system up to PL.

Since the pedestal system has to be placed in the trench manually, therefore the weight of the pedestal should be less. Hence a number of different alternatives had been considered in order to complete the handling with maximum ease. Apart from the one described above, another alternative was where the hollow pedestal portion had been used with fully cast footing. The footing portion of the pedestal casted fully with dimensions of 1250 mm x 1250 mm x 200 mm and the walls of the hollow stem column were of 75 mm thickness. As the weight of the pedestal in this case is very high, therefore further modifications are being done in the previous partially precast pedestal system for situations where the machines will not be available. Similarly, different alternatives of the precast hollow pedestal have also been considered.

Precast Plinth Beam

The plinth beam is provided on the levelled ground and serves as the connecting point of substructure and superstructure. The ends of plinth beam are provided with anchorage bars which are to be inserted in the notch provided in the stem column pedestal. The hollow portion is to be filled with in-situ concrete of M20 grade. The precast members are made of M25 grade concrete as they have to bear the higher stresses. The connection details of the stem column to the plinth beam are given in Figure 12. However, this portion has not yet been cast on-site and the schematic visualization has been shown in Figure 13.

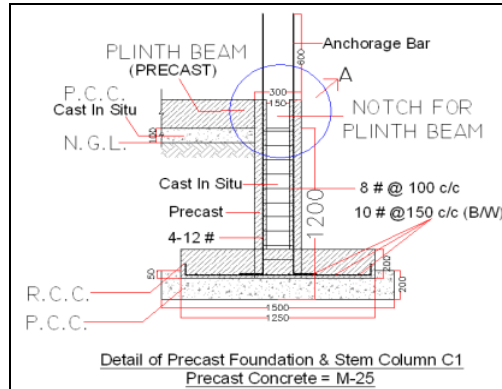


Figure 12: Joint details of the pedestal stem column and the plinth beam.

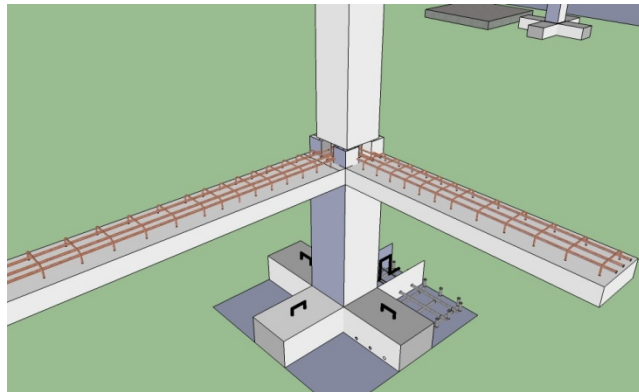


Figure 13: Schematic diagram of the foundation, column with the plinth beam.

Precast Plinth Beam

The precast system from the plinth to the roof consists of columns, walls and roofing elements, which has not yet been cast but only visualized. The connection details are also to be worked out.

Columns: Columns are provided to support a frame structure by transferring the load from the slab to the foundation. The precast column, 250 mm x 250 mm dimension is to be adopted with different wall thickness of the hollow column. The system consists of the hollow column are made of cross section of 250 mm x 250 mm and 75 mm wall thickness. As the weight of the column in this case is on a higher side, further modifications need to be made in the column

formwork. Of all the alternatives considered, the weight of the column in this case is less than the other two alternatives, so this can be used for construction.

Walls: The walls are to be made by using light weight fly-ash blocks and hollow concrete blocks of dimensions 600 mm x 300 mm x 150 mm and 300 mm x 300 mm x 150 mm. The roofing unit will consist of precast RC planks and joist system. Dimensions of the precast RC planks are 300 mm wide, 60 mm thick and up to 2.4 m long. It is to be used for economical and faster construction of floors and roofs of single and multi-storeyed buildings. The floor / roof will be constructed with precast RC joists and precast RC planks. The components are to be produced on a casting platform at construction site. As soon as the walls reach the floor / roof level, the components will be erected, assembled and partly filled up with concrete to form the floor / roof. This scheme results in saving 20% in overall cost, 25% in cement and 10% in steel as compared to conventional R.C. slab floor / roof.

Conclusion

In this paper, we have discussed the work done related to the prefabricated spider foundation system. However, the system is not yet complete and further studies are in progress. The future scope of work includes full scale casting of the Test Bed (Model Room) described above in CSIR-CBRI, Roorkee campus. This also includes the design of the different precast elements, preparation of formworks for different precast elements like plinth beam, columns, roof joist and working out the details of the connections between the elements. Also, full-scale testing of the entire system shall be carried out and validated with the analytical results for performance compliance satisfying Indian Standard Codes.

In addition to this, details of other non-structural elements/components in conjecture with the whole structure shall be worked out for the final fully prefabricated model room. It can also be envisaged that this study will prove to be useful to the countries in the Asia-Pacific regions having similar geo-climatic and socio-economic conditions.

Acknowledgement

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Using Satisfaction Ratings to Minimize Risk

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Warranties in the construction industry have become more prevalent in the last couple of decades. Moreover buyers in the construction industry rely heavily on the length of the warranties for the purchase of any product or service. The warranty is an agreement between the buyer and the manufacturer and has inclusions that if altered voids the warranty. Hence the length of the warranty has no correlation to the actual performance of the product or service being purchased. One of the manufacturers in the construction industry, in order to differentiate themselves from other manufacturers, approached the researchers to implement a system that can better assist and serve their end users beyond just providing a warranty. The purpose of this paper is to describe and analyse the warranty tracking program that tracks the installed roofing projects for the manufacturers providing an overall snapshot of the performance of all the installed projects. The warranty tracking program provides the manufacturer the risky projects (leaks, blisters, end-user dissatisfied) with the use of end-user customer satisfaction every year. The researchers also implemented the high performance roofing program and a performance-based licensure process to attract high performing applicators. Since the inception of the warranty tracking program the manufacturer has been able to resolve 69 out of 70 (98%) risky projects. In conclusion, the warranty tracking program provided the manufacturer a better way to assist and serve their end users through proactive resolution of risky projects.

Keywords: Applicator, Manufacturer, Performance information, Risk minimization, Satisfaction rating.

Introduction

The last two decades of research has revealed a poor documentation of performance in the construction industry (Cahill and Puybaraud, 1994; CFMA, 2006; Flores and Chase, 2005; Egan, 1998; Davis et. al., 2009). Every entity in the industry claims that their services / products are high performing, giving false promises to the owner. Expecting a high performing job, the owner buys a service / product, but due to poor documentation of performance, manufacturers and contractors sell products based on low price and long term warranties. The false expectation of a high performing job, the enticing low price and long term warranties incite clients to purchase products based on these contracts, which have no proven correlation to a system's performance (Kashiwagi 2011).

The manufacturer's warranty that is offered in the construction industry is provided by the manufacturer to the buyer (Agarwal et. al. 1996). The warranty is generated and written by the legal representatives of the manufacturer and contain certain exclusions that have the possibility to void the warranty (Murthy & Djameludin 2002, Christozov *et al.* 2009). Therefore if a product / service fails to perform as expected, the buyers have to prove that they did not violate the exclusions of the warranty and the manufacturer needs to also agree with the buyer (Kashiwagi, 2012). At the end, the contractor takes no accountability for their work, and the owner is dissatisfied with the service and the end product creating a "lose-lose" scenario.

This trend is dominantly seen prevalent in the manufacturing sector of the construction industry. The industry is flooded with manufacturers and contractors that sell products and systems based solely on the length of the warranties. The use of warranties for marketing is not a right approach and does not assist the end user in purchasing a quality product. Many researchers have suggested different types of risk minimization systems in attempt to change this trend. (Hillson, 1997; CII, 1995; Gibson et. al., 2006; Hamilton, 1996; Kashiwagi, 2009; Sullivan, 2010; Davis, et. al., 2009; Sweet, 2011).

The purpose of this paper is to propose a risk minimization tool with the use of warranties to improve the quality of the product and processes through the use of customer satisfaction. A coating system manufacturer in the construction study was used as a case study. The risk minimization tool proposed in this study measures the performance of the products and applicators that can minimize the risk of contractor non-performance and identify problem projects, proactively providing the end user with a quality end product.

Methodology

To minimize the risk of low performance and identify problem projects proactively three systems were developed as follows:

- A customer satisfaction performance tracking program on all warranted projects
- Creation of the elite contractor program for SPF roofing known as the Alpha Program
- Licensure process that checks the past performance of the contractors

Customer Satisfaction Performance Tracking

The researchers implemented a risk minimization program that measures the performance of all of their systems - Wall Coating, Flooring, Waterproofing, Direct Bond Roofing, and Spray Polyurethane Foam (SPF) Roofing and the performance of the applicators that install the products. In order to measure the performance of the system, clients/end users are contacted every year until the end of the warranty duration for satisfaction ratings on the product and the applicator who installed the roof system.

The risk minimization warranty program attempts to minimize risk by updating the information on:

1. Performance of the applicators
2. Performance of the products
3. Identifying dissatisfied end users
4. Identifying problem projects to mitigate the risk immediately

The risk minimization program consists of a warranty check process outlined in Figure 1. Upon finishing a project, the manufacturer initiates the warranty check process by communicating the warranty information to the research group. As soon as the warranty is issued to the end user, the research group surveys the end user with the following questions:

1. Customer satisfaction of the applicator (1 lowest– 10 highest)
2. Would you hire the applicator again? (Yes / No)

3. Customer satisfaction of the coating system (1 – 10)
4. Would you purchase the system again? (Yes / No)
5. Overall customer satisfaction (1 – 10)

The survey response information (performance information) is then reported back to the manufacturer. If dissatisfaction or an installation issue is identified in the survey, the manufacturer's customer service department is notified with the project information. This proactive risk minimization system enables the manufacturer to identify and resolve problems upfront, rather than becoming reactive to them as they materialize in the future.

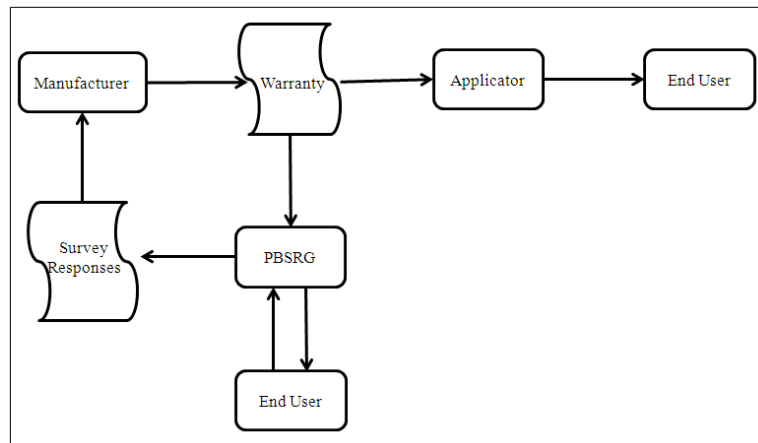


Figure 1: Warranty Check Process

Elite Contractor Program – Alpha Program

In order to attract high performance contractors a pilot program in the SPF roofing sector was created. A performance based SPF roofing program known as the Alpha program was developed for the manufacturer to motivate contractor performance and accountability. The program is the first contracting performance program that established by the manufacturer that qualifies and disqualifies applicators on performance measurements determined by the end users. The Alpha program minimizes the risk of the manufacturer by attracting and using high performing contractors. These high performing contractors eliminate rework and minimize the risk for the end user by providing a quality product installed by an expert. The Alpha program succinctly curtails litigation that is caused by improper application, motivates contractors to take accountability for their work and increases and creates a competitive market for ensured quality performance (Kashiwagi, et al. 2010).

The performance requirements for the Alpha program are:

1. Have a “good financial standing” and “be licensed” with the manufacturer
2. Roof inspections once every two years of a minimum of 25 roofs by a third-party inspector
3. Annual submission of newly installed SPF roofs over 5,000 SF to Arizona State University
4. 98% of roofs being tracked cannot currently leak.
5. 98% of surveyed roofs must have satisfied customers.
6. Attend the annual educational presentation

Licensure Process

Almost every manufacturer in the construction industry has a special licensing program that allows certain advantages for the contractors that are licensed. However, the licensure requirements are solely based on technical data like insurance requirements, credit, etc. which does not correlate to the actual performance of the contractor.

The manufacturer in this case study had a similar licensing program where the contractors that were licensed received “joint and several” warranties. Joint warranty contracts state that the responsibility to uphold specifications of the warranty is equally shared by the applicator and the manufacturer. The manufacturer identified that even some of the licensed contractors were not performing and needed a way to attract high performing contractors into the licensure program. The researchers proposed a licensing system that would severely minimize the manufacturer’s risk by disqualifying low performing applicators to receive joint warranty options. By creating a system that filters out low performing contractors, it mitigates the risk of failing warranties and litigation.

The following licensing requirements were proposed:

1. Submit a minimum of five references that validate a contractor’s credibility as a high performer. (One of the jobs must include the use of the manufacturer’s product)
2. Survey responses from the contractor’s references answering the following questions:
 - a. Customer satisfaction of the applicator (1 lowest– 10 highest)
 - b. Would you hire the applicator again? (Yes / No)
 - c. Customer satisfaction of the coating system (1 – 10)
 - d. Would you purchase the system again? (Yes / No)
 - e. Overall customer satisfaction (1 – 10)

Results

Table 1 shows the performance information of all manufacturers’ systems over the last four years. The total job area surveyed was 36.1 million square feet. The clients were satisfied with the manufacturer’s product and the applicators who installed the product. The overall customer satisfaction rating was 9.0 out of 10 with 1,412 warranted jobs surveyed.

Table 1

System Performance Information

No	Criteria	Unit	Overall	Flooring	Direct Bond Roofing	Foam Roofing	Wall Coatings	Water-proofing
1	Overall customer satisfaction	(1-10)	9.0	8.5	9.1	9.4	9.2	9.0
2	Oldest job surveyed	Years	10	5	7	6	7	9
3	Average age of jobs surveyed	Years	4	3	4	4	4	3
4	Customer Satisfaction - Coating System	(1-10)	9.1	8.3	9.2	9.5	9.2	9.0
5	Percent of customers that would purchase the product again	%	98%	90%	98%	99%	98%	98%
6	Customer Satisfaction – Applicators	(1-10)	9.0	8.4	9.0	9.3	9.2	9.0
7	Percent of customers that would hire same Applicator again	%	96%	87%	96%	95%	97%	96%
8	Total job area (of job surveyed)	SF	36.1 M	0.3 M	3.6 M	3.2 M	2.8 M	26.2 M
9	Total number of jobs surveyed	#	1,412	31	191	111	63	1,016

Table 2 shows the performance information for jobs that hold a potential risk. Jobs that have satisfaction ratings below a seven or clients that would not purchase the product again were categorized as risky. The data shows that 97% of jobs have no customer complaints and would purchase the product again. However, the risky jobs have a lower satisfaction rating of 4.1 for the coating system and 4.5 for the applicator. The risky jobs constituted only 4% of the total job area installed. The researchers send a quarterly report with a list of all identified “risky” jobs to the manufacturer’s customer service department. The customer service department then contacts the client for further investigation and takes action to satisfy the customer.

Table 2

Risky Job Performance Information

Criteria	Unit	Risky Jobs
Total number of jobs surveyed	#	1,412
Number of risky jobs	#	70
Percent of jobs that are risky	%	5%
Satisfaction rating- Coating	(1-10)	4.1
Satisfaction rating- Applicator	(1-10)	4.5
Percent of customers that would purchase the product again?	%	0%
Risky job area	SF	1.5 M

Table 3 differentiates high performing applicators from low performing applicators. Applicators that have either a satisfaction rating below a seven or a client that would not hire the applicator again, are deemed as low performing contractors. The data shows that approximately 10% of the applicators that install the manufacturer’s product are low performing applicators. Low performing applicators installed 5% of the total job area of

manufacturer's coating. Upon publishing the results, the manufacturer decided to stop selling their coating systems to the low performing applicators.

Table 3

High performing applicators vs. Low performing applicators

Criteria	Unit	High Performing Applicators	Low Performing Applicators
No. of Contractors	#	268	29
Satisfaction rating- Coating	(1-10)	9.2	7.4
Satisfaction rating- Applicator	(1-10)	9.3	6.1
Percent of customers that would hire the applicator again	%	100%	69%
Total Job Area	SF	17.2 M	1 M

High Performance Roofing Program

Applicators can be eliminated from the program if they do not meet the requirements of the Alpha program. Table 4 shows the performance ratings of the applicators currently involved in the program. The data reveals that all of the applicators are high performing applicators with 100% satisfied customers and 100% of jobs that are not currently leaking.

Table 4

Current Alpha applicator performance lines

Job	Unit	A	B	C	D	E
Overall satisfaction rating of the applicator	(1-10)	9.5	9.7	9.4	9.6	9.8
Oldest job surveyed	Years	8	13	25	29	25
Average age of jobs surveyed	Years	5	4	10	11	10
Age sum of all projects that never leaked	Years	374	161	139	391	397
Age sum of all projects that do not leak	Years	410	171	477	484	523
Percent of customers that would purchase again	%	100%	100%	100%	100%	100%
Percent of jobs that do not leak	%	100%	100%	100%	100%	100%
Percent of satisfied customers	%	100%	100%	100%	100%	100%
Average job area (of jobs surveyed and inspected)	SQ	40,038	28,941	50,927	40,111	47,481
Total job area (of job surveyed and inspected)	SQ	3.4 M	2.0 M	4.7 M	2.4 M	2.4 M
Total number of jobs surveyed telephonically	#	85	50	50	53	50
Total number of jobs inspected	#	31	52	27	28	26
Total num. of different customers surveyed & inspected	#	10	36	27	24	37

Job (cont'd)	Unit	F	G	H	I	J
Overall satisfaction rating of the applicator	(1-10)	9.7	9.6	9.7	9.8	10.0
Oldest job surveyed	Years	29	12	20	26	23
Average age of jobs surveyed	Years	11	5	10	11	13
Age sum of all projects that never leaked	Years	376	160	293	385	614
Age sum of all projects that do not leak	Years	493	232	477	598	655
Percent of customers that would purchase again	%	100%	100%	100%	100%	100%
Percent of jobs that do not leak	%	100%	100%	100%	100%	100%
Percent of satisfied customers	%	100%	100%	100%	100%	100%
Average job area (of jobs surveyed and inspected)	SQ	103,558	23,271	26,173	32,554	11,727
Total job area (of job surveyed and inspected)	SQ	5.2 M	1.7 M	1.6 M	1.8 M	0.9 M
Total number of jobs surveyed telephonically	#	50	50	50	55	50
Total number of jobs inspected	#	30	29	27	25	27
Total num. of different customers surveyed & inspected	#	11	38	27	9	28

Job (Cont'd)	Unit	K	L	M	N
Overall satisfaction rating of the applicator	(1-10)	9.8	9.5	9.8	9.8
Oldest job surveyed	Years	12	14	26	27
Average age of jobs surveyed	Years	3	6	6	18
Age sum of all projects that never leaked	Years	132	259	244	785
Age sum of all projects that do not leak	Years	159	278	258	863
Percent of customers that would purchase again	%	100%	100%	100%	100%
Percent of jobs that do not leak	%	100%	100%	100%	100%
Percent of satisfied customers	%	100%	100%	100%	100%
Average job area (of jobs surveyed and inspected)	SQ	21,561	11,363	17,126	19,489
Total job area (of job surveyed and inspected)	SQ	1.3 M	0.6 M	1.0 M	1.0 M
Total number of jobs surveyed telephonically	#	51	50	54	49
Total number of jobs inspected	#	52	47	29	51
Total num. of different customers surveyed & inspected	#	33	41	21	6

Table 5 shows the overall performance line of the applicators since the inception of the Alpha program. The data shows that the average overall satisfaction rating of the applicators is 9.4

out of 10 with 100% of jobs that are leak free and 99% of the customers satisfied with the job. The total roof area that have been surveyed and inspected since the beginning of the Alpha program has been 80 million square feet.

Table 5

Overall Performance Line

Job	Unit	Overall
Overall satisfaction rating of the applicator	(1-10)	9.4
Oldest job surveyed	Years	33
Average age of jobs surveyed	Years	8
Age sum of all projects that never leaked	Years	10,144
Age sum of all projects that do not leak	Years	14,166
Percent of customers that would purchase again	%	100%
Percent of jobs that do not leak	%	100%
Percent of jobs completed on time	%	99%
Percent of satisfied customers	%	99%
Total job area (of job surveyed and inspected)	SQ	80 M

Performance Based Licensure Process

The installed risk minimization system showed that 10% of the manufacturer’s applicators were low performing.

Table 6 shows that 72% of the applicators that applied did not get licensed after the introduction of the manufacturer’s licensing system. Many of the applicators were disqualified due to non-experience of using the manufacturer’s product.

Table 6

Applicator Licensure Analysis

Criteria	Data
Total number of applicators who applied for licensure	271
Number of applicators licensed	77
Percent of applicators that did not get licensed	72%
Average satisfaction rating of licensed applicators	9.5

Conclusion

The manufacturer has successfully identified itself as a manufacturer of a high performance coating system.

This manufacturer has implemented a performance based risk minimization program that not only measures the performance of their coating system, but also the applicators installing the coating system through the tracking of warranties. The manufacturer’s risk minimization program helps the manufacturer differentiate themselves from other manufacturers that sell products based on warranty and low price by organizing a database of vendor performance and end user satisfaction.

The high performance roofing program known as the Alpha program increased the accountability of the applicator through the use of documented performance information and

likewise minimizing the manufacturer and the client's risk. The research showed that 100% of the roofs installed by the Alpha applicators are leak-free and 99% of the end users were satisfied with the job. The Alpha program helps the manufacturer minimize litigation and risk through the use of performance check-ups, licensing practices and inspection programs. This program not only provides an on-going development feedback system to better serve clients, but helps contractors to compete in a high performance based environment.

The licensing system filtered out low performing applicators from installing the manufacturer's product. The references check requirement minimized the risk of the manufacturer by filtering out low performing applicators from using their product.

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Introducing Decision Free Solutions[©] - A Generic, Systemic Approach to Minimize Risk by Avoiding Decision Making

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“Decision Free Solutions” (DFS) is a generic, systemic approach to minimize risk in achieving an aim by avoiding decision making. Applying DFS will benefit those who have an aim, and those who have expertise. DFS is based on Information Measurement Theory (IMT) and the Kashiwagi Solution Model (KSM), and is congruous with the Best Value Approach (BVA). Despite BVA being an approach aimed at utilizing expertise (and thereby minimizing risk), and not a procurement system, BVA and its applications are very much intertwined with procurement. This makes it challenging to apply BVA to other fields. Establish a generic, systemic approach to implement the technologies of IMT/KSM in any field. Analyzing existing BVA and IMT/KSM documentation, identify the logic and the principles by which expertise is utilized. Define a generic, systemic approach to minimize risk and demonstrate it by applying it to a field other than procurement. Avoiding all types of decision making was identified as the core principle to ensure the utilization of expertise. An approach consisting out of four steps (labelled DICE) and the consistent application of five principles (labelled TONNNO) has been proposed. The approach has been applied to the field of Lean. A generic and systemic approach to minimize risk by avoiding decision making has been introduced which can be applied in any field. It has been applied in Lean, where it addresses several of Lean’s weaknesses as perceived in practice and where it was demonstrated to reduce the risk of project failure. DFS can be considered a risk minimization method to which risk management is integral. DFS makes expertise matter.

Keywords: Decision Free Solutions, DICE, TONNNO, Lean.

Introduction

The concept of Best Value Procurement (BVP) was immediately recognized as the way forward in purchasing complex, innovative medical technology worth several tens of millions of euros. With a group of clever physicists, we were working on a list of about 400 technical requirements for equipment designed to treat cancer using protons. Everybody understood the futility of writing often interdependent requirements for extremely complex equipment that already existed. None of the physicists ever doubted the logic of using BVP as a procurement methodology.

After attending the Best Value Conference, and with the assistance of an A+ certified Best Value (BV) expert, I (the project leader) was able to successfully argue for running a BV-tender to procure the equipment. In preparing for the start of the tender I was asked many questions with respect to the underlying theories of BVP (the team did not doubt the procedure of BVP, but they did want to understand its underlying logic). Many of these questions challenged my actual “understanding” of the procedure. When attending the Best Value Conference a second time my focus had shifted from how to run a BVP process to understanding Information Measurement Theory (IMT) and the Kashiwagi Solution Model (KSM), on which BVP was based.

Getting a better understanding of IMT/KSM concepts (explaining how you identify an expert by observing certain characteristics, why the behavior of individuals and organizations is predictable, why decision making increases risk), its appeal and its application became universal. It was clear that decisions increased risk not just in procurement, but in any field, and thus also in project management. While I tried to avoid decision making by the steering group, one steering group member objected to having had a meeting because “there were no decisions to be made”. At another meeting another member perceived a risk that was not there and insisted on making a decision (going against the substantiated choice of the project team) which cost the hospitals a quarter of a million euros. Why did he do that? What had I missed? How could I have prevented that?

Attending the Best Value Conference a third time I was actively looking for the “universal” principles of BVA, which could be applied in any field. From procurement, to project management, to Lean to management, to sales, to how to determine the holiday destination when going on holiday with two families. I did get pointers, but overall I failed to separate BVA from procurement. Both at the conference and in the conference’s textbook titled “Best Value Approach” (Kashiwagi, 2016).

But I did take one challenge home with me. Following the documented success of BVP, its wider adaptation resulted in “hybrid” versions of BVP and traditional procurement. These hybrid tenders were often still labelled as BV-tenders. Predictably, many of these hybrid versions strayed too far from the underlying principles of BVP and failed to replicate BVP’s success. This was as unfortunate as it was predictable for the buyer’s organization. But this non-performance by so-called “BV-tenders” damages the reputation of BVP and could have serious repercussions on the wider proliferation of BVP and BVA. What if there would be a simple checklist, requiring no BVA-expertise, to assess whether a tender actually followed the BVA-principles?

In working on a Best Value Quality checklist, (Verweij, 2016) I developed the approach of Decision Free Solutions (DFS) as introduced here. This article takes BVA as its starting point. This is a logical place to start, but may also considered to be a weakness. To a large extent this introduction assumes a familiarity with BVA. What is missing is an analysis of how Decision Free Solutions, or an application like “Decision Free Management”, compares to existing decision making or management philosophies. Which is, perhaps, to say that this is only an introduction. For the same reason a discussion is also not provided.

As DFS follows from IMT/KSM, it is fully congruous with BVA. It provides a generic, systemic approach to minimize risk in achieving an aim by avoiding all types of decision making. In this article, to demonstrate it is indeed a generic approach, it has been applied to Lean. I have chosen Lean as there are some obvious parallels with the BVA-approach (utilization of expertise), and because I am, by training and by observation, familiar with both its strengths and its weaknesses. Weaknesses that the approach of DFS addresses. I have also applied DFS to “birthing” (avoiding decision making to empower the expectant mother to achieve her personal birthing aim), which can be found elsewhere (see Verweij, 2016a).

Problem

The technologies of IMT/KSM can be applied in each and every field. The Best Value Approach applied the technology first in procurement in the construction industry. While BVA is not exclusively a procurement system, BVA is still very much linked to procurement, both in the used definitions and terminology in the founder's text books. This association, combined with the absence of a generic approach as to how to apply the technologies of IMT/KSM in other fields, is perceived to be a hindrance to the further proliferation of BVA and its application in other fields.

Proposed Solution

Analyze BVA to find the underlying principles by which decision making and management, direction and control (MDC) is replaced with the utilization of expertise. Based on these principles develop a generic and systematic approach to minimize risk by utilizing expertise in any field. Demonstrate the generic and systematic nature of the approach by applying it to a field other than procurement.

An Analysis of BVA

The Best Value Approach is based on IMT and KSM, first published in 1991 by Dr. Dean Kashiwagi, and documented in annually updated textbooks (Kashiwagi, 2016; Kashiwagi, 2016a). The analysis is performed on these textbooks.

BVA Replaces Decision Making, MDC, and Thinking

The Best Value Approach “replaces the owner/buyer’s decision making and management, direction and control (MDC) with the utilization of expertise” (p.1-1, Kashiwagi, 2016). In this definition “thinking” is not included as something that needs to be replaced, but it is often mentioned in conjunction with decision making (e.g. on the topic of metrics, stating that it “[stops] the non-experts from getting involved in thinking, decision making, and attempting to direct and control experts”, and one of the main objectives of the PIPS process is to “minimize decision making, thinking, and participation of all parties”). A critical function of BVA is to also minimize the non-expert’s “thinking” by better utilizing expertise.

Decisions, Manifestations of Decision Making, and Types of Decision Making

A purpose of IMT is to “minimize subjective decision-making through the use of dominant information” (p.2-2, Kashiwagi, 2016a). In IMT the term “decision” is not explicitly defined. Referring to “what is more commonly known as decision making” it defines “decision making” as: “when an individual uses personal experience rather than accurate information to draw conclusions, [...] applying their personal, subjective bias which is incomplete and limited” (p.2-1, Kashiwagi, 2016a). A “decision maker” is defined as “an individual who does not have enough information to identify or predict the future outcome” (p.3-2, Kashiwagi, 2016a).

The term “decision” is pivotal in both IMT and BVA. Within BVA a decision is associated with risk, unlike in almost any other approach or management philosophy. For this reason, it is felt that a clear definition of the term “decision” is required in establishing a generic and systemic approach centered on replacing “decision making”.

The Oxford Dictionary definition of “decision” is “a conclusion or resolution reached after consideration”, and the definition of “choice” is “an act of choosing between two or more possibilities”. A decision may thus be regarded to be a choice, as, after consideration, the one or the other may be concluded (yes or no, act or not act, option one or option two, etc. etc.).

The word of interest in the definition of “decision” is “consideration”. Libraries have been written about what, when, how and by who “to consider” in making decisions. Again from the Oxford Dictionary, the definition of “consider” is to “think carefully about (something), typically before making a decision”. Consideration directly implies that ‘something’ is not transparent. When it would be transparent, no decision would have to be made. Then, instead of having to conclude or resolve, one would merely have to “approve”, “acknowledge”, or “give the go ahead”.

When something is “not transparent”, then by definition it is “not transparent” to the non-expert. As a result the non-expert needs to think. When the non-expert then comes to a “conclusion or resolution”, in absence of transparency, risk is introduced. The risk is that the choice made by the non-expert may not contribute to achieving an aim a person, a project, or an organization is set out to achieve. Because of a lack of transparency, the conclusion reached after consideration cannot be substantiated to contribute to achieving an aim.

From this follows that a “decision” may be defined as “a choice not substantiated to contribute to achieving the aim”.

Providing this definition carries consequences. According to this definition there can be no such thing as a decision when there is no aim. A choice that does not have to be substantiated to contribute to anything (as there is no aim) remains simply a choice. The aim comes before the decision.

Furthermore, all that which is to replace by the utilization of expertise (decision making, MDC and thinking by the non-expert) cannot be substantiated to contribute to achieving the aim. Decision making (unsubstantiated choices), MDC and thinking can thus be regarded to be different manifestations of “decision making”.

Following the definition of “decision” as proposed here, three different types of decision making can be identified: “decision making” itself (i.e. an unsubstantiated choice), “decision making from the past” (e.g. protocols) and “a precursor to decision making” (i.e. thinking).

The most easily recognized form of decision making is a non-expert making a choice which is not substantiated to contribute to achieving an aim. When a non-expert applies MDC, it restricts the expert in utilizing its expertise fully. When the expert is told to follow “company policy” or

existing protocols, these can be characterized as “decisions made in the past” as the aim the expert is to achieve was not considered when the policy or protocols were drafted.

Thinking, when done by the non-expert, can be characterized as a precursor to decision making. Experts eliminate decision making for all parties by making things simple to understand, and assisting others to “see into the future” by using “dominant information” (defined as “information [that] can be understood by almost everyone due to its simplicity and it does not require technical detailed knowledge that only a few may possess” (p.2-1, Kashiwagi, 2016a). The expert is to make it as simple as is required to prevent non-experts from thinking.

In support of defining “thinking” as a precursor to decision making two natural laws are to be considered: humans are predisposed to think in terms of causality (cause and effect), and humans are social animals who are both highly perceptible of and interested in their place in social hierarchy. In other words, humans will start to “think” in response to an observed effect when the cause is not fully understood, and humans are acutely aware of who is “entitled” to make the decisions. KSM recognizes that different people have different capacities in perceiving information, and from this follows that their thinking will automatically result in different outcomes (with every individual perceiving to her/his capacity). As humans tend to operate in hierarchical structures, where it is generally well-established who is entitled to make a decision, decision making will be swift. When the non-expert starts to think it leads to more decisions.

Decisions, Manifestations of Decision Making, and Types of Decision Making

Experts do not need to make decisions. KSM defines an “expert” as “someone who perceives all initial conditions and natural laws” and thus “knows there is only one outcome [and there] will be no decision making” (p.4-4, Kashiwagi, 2016a). In other words, an expert makes no decisions (only non-experts do).

BVA recognizes that the expert makes no decisions, and that it is also the responsibility of the expert to avoid the non-expert from decision making (often in the form of MDC) in achieving the aim. Decision making by the expert is often the result of emotional discomfort when something remains unclear. The expert is to be transparent in communicating its expertise to the non-expert (to be identified as the expert). The expert is to be transparent in explaining how the aim will be achieved (making a plan). The expert is also to be transparent in communicating the status of the plan during “plan execution”.

It is easy to observe an expert; the expert-in-achieving-the-aim is to be identified

From IMT/KSM it follows that in order to become an expert one has to be able to accurately perceive information. The more information is perceived, and the quicker it is processed, the higher the rate of change, resulting in a still higher perception of information. Different people (and organizations) have varying abilities to perceive information and different processing speeds. While these abilities are difficult to measure, IMT states that all characteristics (of a person or organization) are relative and somehow related to the capacity (of a person or organization) to perceive, process, and apply information.

In KSM, the IMT concepts are used to show the relationship between different characteristics, many of which are easy to observe. For example, an organization that is late in replying, is inefficient, uses many resources, relies on contracts, has many management layers, and thinks in win-lose, such an organization will make many decisions. This means that simply by observing a person's or an organization's characteristics it is possible to identify whether they are an expert (i.e. capable of avoiding decision making).

Whether an individual or an organization is an expert (highly capable of perceiving and processing information) is relatively easy to observe.

The task at hand in order to minimize risk is to identify the expert who is the expert-at-achieving-the-aim.

Analysis of BVA

Summarizing the analysis of BVA above:

1. "Decision making", "MDC" and "thinking" are different manifestations of the decision process.
2. Decisions are choices not substantiated to contribute to achieving an aim.
3. Experts avoid making decisions and have a responsibility to avoid non-experts from making decisions.
4. To become an expert, one has to be able to perceive information and to process this information.
5. Experts share characteristics linked to the ability to perceive information, many of which are easy to observe.
6. To achieve an aim against minimal risk (i.e. by avoiding all types of decision making), the expert capable of achieving an aim should be identified.

In studying BVA and IMT/KSM the following observations were made:

1. While BVA is an approach and not a procurement system, the annually updated textbook on BVA (Kashiwagi, 2016), does not clearly make this distinction. The first chapter, "The Best Value Approach", is entirely focused on procurement. The definition of the Best Value Approach in fact includes the terms "owner/buyer" and "vendor". In practice the term BVA is often believed to be synonymous with a procurement system, and often even "misused" to the extent that it used as a label for tenders which do not follow the IMT/KSM principles upon which BVA's application in procurement is based. As a result, it has become practically impossible to disassociate BVA from procurement in practice.
2. In absence of a generic approach, the application of IMT/KSM principles to other fields become singular exercises with little to no distinguishable parallels. In other fields in which BVA is applied, notably risk management and project management, the terminology used is still from procurement (e.g. referring to "vendors"), embedding them within this field (Kashiwagi, 2016; Rivera, 2016).
3. The aim as defined by its owner (the "non-expert"), is used to identify the expert-in-achieving-the-aim, and the aim is what the identified expert will set out to achieve. This

makes the aim, arguably, the single most important element determining ultimate success in the eyes of the non-expert. From this follows that it is pivotal that the aim is unambiguous, understood the same by expert and non-expert alike, and that the “initial conditions” affecting the achieving of the aim are identified. Within BVA’s current written documentation, however, the definition of the owner’s aim is not prominently identified as a crucial step. It is stated that the owner is to identify what they “think” they are looking for (p.5-3 and 5-5, Kashiwagi, 2016), and when, in chapter 12, the “requirement statement” is introduced, it provides only a descriptive explanation (p.12-5, Kashiwagi, 2016).

4. Risk is minimized if: the initial conditions are known, the aim is unambiguous, the expert-in-achieving-the-aim is identified, and the conditions are in place to maximally utilize the expert’s expertise in achieving the aim. In BVA there is no role defined with the overarching responsibility of ensuring all of these conditions are fulfilled. Within the Best Value Approach, a “logical, visionary project manager” (p.1-5 and 12-3, Kashiwagi, 2016) would fit this role, but no responsibilities for such a role have hitherto been defined.

Constructing Decision Free Solutions

From the analysis follows that in order to utilize expertise all types of decision making have to be avoided. For this reason, and in recognition of the fact that humans are demonstrably bad at decision making because of behavioral biases (Kahneman, 2011), the approach has been called “Decision Free Solutions”.

Decision Free Solutions (DFS) is based on IMT/KSM and congruous with BVA. As DFS addresses the observations as described in the previous sections, and as its approach is systematic, DFS is still more rigorous in avoiding decision making than BVA.

Experts avoid decision making, for themselves and for non-experts. By avoiding all types of decision making the risk that the aim will not be achieved is minimized. DFS, like BVA, can thus be regarded to be a risk *minimization* method.

DFS, as it is described below, is a generic, systemic approach to avoid all types of decision making. The approach identifies four steps (DICE: Definition, Identification, Clarification, Execution), the need for the consistent application of five principles (TONNNO: Transparency, Objectivity, No details, No requirements, No relationship), and the role of a “Decision Free Leader” who is to ensure that decision making is avoided during all steps and at all times.

DICE: the Four Steps of DFS

Decision Free Solutions identifies four steps: Definition, Identification, Clarification and Execution.

The logic of DFS is that if there is “something” the “non-expert” needs to have accomplished, the “expert in something” will do so with minimal risk. As the expert will achieve “something”

(and not “something else”), it shall be ensured that “something” is clear and understood the same by all stakeholders (Definition). For the non-expert to be able to identify the “expert in something”, the expert has to demonstrate his expertise in a way that is totally transparent and easy to understand by the non-expert (Identification). Once the non-expert has identified the expert, the expert will make a “plan-from-beginning-to-end” and explain to the non-expert how “something” will be achieved (Clarification). Finally, in executing the plan, the expert keeps the non-expert up to speed with respect to any changes to the plan-from-beginning-to-end, and whether or how this affects accomplishing “something” (Execution).

The four steps are briefly described below.

Definition

The definition step is the step which defines the aim. This is the single most important step: the expert will be identified based on the aim, and the aim is what the identified expert will achieve. The following observations can be made in regards to defining the aim:

- DFS is labelled a “systemic” approach as it follows the same four steps (DICE) in every application. Furthermore, it stresses the importance of defining the aim within the “system” in which the aim is to be achieved. The “initial conditions” shall be as clearly “mapped” as possible, as to allow the expert to make the better plan to achieve the aim. Depending on the field of application this may include access to technologies, services and finance, existing policies, the legal and political situation and the environment, dynamics of the market, available expertise within the organization, how the aim relates to the system’s vision, mission and or strategy, its dependency on the availability of key-personnel or current priorities, and etc.
- In defining the aim, the non-expert may already inquire with prospective-experts (e.g. in a market consultation). Observing the characteristics of these prospective-experts during the inquiry process will yield valuable information towards positively identifying a prospective-expert as an expert. Whether and to what extent an expert is also an expert-in-achieving-the-aim is assessed in the Identification step.
- The aim may be accompanied by functional requirements reflecting the available expertise of the non-expert (part of the “system”), but is to avoid the inclusion of requirements or details which merely restrict the use of the expert’s expertise.
- For an expert to be able to substantiate his expertise in achieving the aim, the aim shall be unambiguous (transparent and objectifiable (measurable)) and understood in the same way by both expert and non-expert.
- The aim is always “owned” by the non-expert. Experts may provide insight on defining the aim, but the non-expert remains responsible for the final definition.
- When the aim contains several elements to be achieved, the non-expert is to prioritize these elements, as the expert is to demonstrate his expertise in relation to the most important elements of the aim.
- The aim is not to be confused with deliverables, as these are to be defined by the expert (in the Clarification step).

Identification

In the Identification step, the non-expert is to identify the expert who is best able to achieve the aim. The expert is to demonstrate the availability and relevance of his expertise in making substantiated claims in support of achieving the aim. The substantiations shall be easy to understand by the non-expert to avoid the non-expert from having to think. The expert does so through the use of “dominant information” (e.g. metrics).

The expert can demonstrate his expertise by listing relevant performances, identifying risks and risk mitigation measures, and identifying opportunities pertaining to the aim.

It is emphasized that in this step the expert is identified, and not how (the method by which) the aim is to be achieved.

Clarification

In the Clarification step the identified expert will explain how (with which tools, scope, activities, performances etc.) he will achieve the aim. The expert will define concrete goals or targets, and make it transparent to the non-expert how these will result in achieving the aim. Typically, the expert makes a milestone plan, a plan from-beginning-to-end, and a risk management plan detailing the risks in achieving the aim, and how these risks will be mitigated. Only when it is absolutely clear to the non-expert how the expert will achieve the aim will the expert be allowed to execute the plan.

Execution

In the Execution step the expert executes the plan. To avoid decision making by the non-expert (e.g. in the form of MDC), the expert keeps the non-expert informed on the status of plan-execution by periodically reporting on any deviations to the plan and or risk mitigation plan which might affect the achieving of the aim. When there are no deviations to any of the plans, then this is reported also. The frequency of reporting (and the information provided when reporting on deviations) shall be such that decision making is avoided.

TONNNO: the five principles of DFS

Decision Free Solutions is an approach to minimize risk by avoiding all types of decision making in achieving an aim. Decisions are made by non-experts. To avoid decision making thus:

1. An expert must be identified who is able to achieve the aim.
2. The identified expert must avoid decision making by the non-expert.

Five principles are proposed which are to be observed at all times in order to avoid decision making. These principles, within DFS collectively labelled as TONNNO, are:

- Transparency
- Objectivity

- No details
- No requirements
- No relationship

Ad i: Identification of the expert

One important principle in maximizing the likelihood that an expert will be identified, is by not excluding potential experts by pre-selection based on some form of relationships. For example: project team members selected based on availability within the organization, physicians always referring patients to the nearby hospital, vendors selected based on existing purchasing history. In all these instances choices are made based on an existing relationship and not substantiated to contribute to achieving the aim (principle: no relationship).

As experts are to be identified in relation to the aim, the aim shall not exclude experts by containing decisions made by the non-expert. Aims shall not include requirements or details which restrict the use of the expert's expertise. When the non-expert includes requirements and details the expert best suited to achieve the ultimate aim may not be identified (principles: no requirements, no details).

As the aim is used to identify the expert the aim shall be unambiguous. The aim is to be transparent, and it shall be possible to determine when the aim has been achieved (principles: transparency, objectivity).

Ad ii: Avoiding decision-making by the non-expert

All manifestations of decision making by the non-expert need to be avoided: decision making, MDC, and thinking.

The expert may avoid decision making by the non-expert by inquiring after substantiations that the choice the non-expert is suggesting contributes to achieving the aim (principle: transparency).

Frequently MDC is, in part, a result of a lack of transparency by the expert. The expert is to first try to avoid the non-expert from using MDC. When it does occur, it can come in the form of decisions by the non-expert (telling the expert what to do), or in the form of insisting on the expert to abide by policies or protocols. The expert is to make transparent when, and to what extent, imposed requirements restrict the utilization of the expert's expertise (principles: transparency, no requirements).

It is the expert's responsibility to prevent the non-expert from starting to think. When the expert uses details and or technical language instead of dominant information, or when it remains unclear whether an aim will be achieved, the non-expert will start to think (principles: transparency, objectivity, no details).

Unavoidable Decisions

A decision is a choice not substantiated to contribute to achieving the aim. Each decision thus entails a risk. When a decision cannot be avoided, the associated risk is to be mitigated. Identifying risks and providing mitigation measures are the responsibility of the expert. DFS, like BVA, can be considered to be a risk minimization method to which risk management is integral. Describing risks and how they will be managed is integral to making transparent how the aim will be achieved.

There can be many causes why decisions cannot be avoided. Decisions will be made when the aim is not clear, when no expert can be found or a specific expertise is not available, when not all relevant conditions are known and assumptions need to be made, when external developments have an impact on the process, when existing policies and protocols cannot be changed, and etc.

When it comes to risk management three types of risk can be identified: internal risk, external risk, and assumptions.

Internal risks are the risks the expert has when executing his expertise. These internal risks, within the control of the expert, do not concern the non-expert.

External risks are risks that lie outside of the control of the expert. The expert is best positioned to both identify, estimate the impact of, and mitigate these risks. Even though the expert is to actively mitigate these risks, he can never totally rule them out as they are outside of his control.

Assumptions are substantiated choices made by the expert in absence of conclusive information. Assumptions are made when the required expertise, or the required information to substantiate the choice, is not available (or simply does not exist, i.e. long term weather forecast). Each assumption made carries a risk.

In the Clarification step the identified expert does the following:

1. The expert identifies all assumptions made and identifies all the external risks in achieving the aim.
2. The expert determines the impact of the external risk occurring, or the assumption to be false, on achieving the aim.
3. The expert defines the corresponding mitigation measures.
4. The expert substantiates, wherever possible, the effectiveness of the mitigation measures.

In the Execution step the expert executes the mitigation measures and identifies any new external risks or assumptions to be made (each time stepping through the points 2 to 4 above).

Responsibilities of the Decision-Free Leader

The role of the Decision Free Leader (the DFL-role) is introduced to ensure that decision making is avoided in all the four steps of DICE. Risk is minimized if all the conditions are in place to

identify the expert who will achieve an unambiguous aim, and to ensure the expert can fully utilize his expertise. The perceived challenges are:

- The non-expert may not be aware of all of the conditions which may impact achieving the aim, while many of these initial conditions may not be directly accessible to the expert (which may result in failing to identify the right expert, or the expert not being able to take certain risks into account).
- The non-expert, the eventual non-expert's stakeholders, and the expert may not understand the aim in the same way, and this may go unnoticed until the expert has "achieved" the aim.
- The person(s) responsible for the identification of the expert may not be able to identify (and avoid) the various types of decision making.
- The identified expert may not succeed in preventing the non-expert from thinking in explaining the plan.
- The identified expert may not transparently communicate the status of the plan and or deviations to the plan during plan-execution.

The responsibilities of the DFL-role can be listed per DICE-step:

Definition

- Identify as many "initial conditions" as possible (especially those pertaining to the "system" to which the expert might not have access).
- Ensure the aim is unambiguous and understood the same by all involved.

Identification

- Ensure all types of decision making are avoided in identifying the expert to achieve the aim.

Clarification

- Ensure all types of decision making are avoided in the expert explaining the plan and how progress will be communicated.

Execution

- Ensure the expert frequently and periodically communicates the status of the plan, deviations to the plan, and how the deviations are going to be resolved.
- Ensure the non-expert does not make decisions.

Having defined the DFL-role it shall be clear that these responsibilities can be taken on by an existing role in a particular field, such as e.g. the role of project leader, or procurement officer. The pre-requisite is that they are they able to avoid all types of decision making. In practice, as is the case for the Best Value Approach, assistance of "Decision Free experts" may be essential.

The A+-certified Best Value experts will come closest to providing this expertise as they have been trained in applying IMT/KSM.

Decision Free Lean

To demonstrate that the approach of DFS is both generic and systemic it has been applied in a field other than procurement. Here DFS has been applied to the system's approach of "Lean" (Womack, 2003), resulting in the methodology of Decision Free Lean (DF Lean). This methodology has been applied (in part) in practice.

The application of DFS in the field of Lean is of interest because both DFS and Lean are systemic approaches, BVA and Lean are both sometimes presumed to be similar or complementary approaches (Fiksinski, 2014), and, as will be demonstrated, Lean has several weaknesses which the methodology of DF Lean addresses.

Analogies and Differences between Lean and DFS

Lean and DFS are both systemic approaches but they do not compete with each other as they each have their own conceptual focus: "maximizing value to the customer" and "avoiding decision making". There are, however, striking analogies to be made as both approaches hinge on the perception of available information and the success of each approach is defined by how well value, or aims, are defined and understood. Furthermore, a Lean expert and a DFS expert are cast from the same mold. In Table 1 Lean and DFS are compared on various aspects.

Table 1

Comparing Lean and DFS on various aspects

	Lean	DFS	Comment
Paradigm shift	Considers the entire system, involves everybody	Considers the entire system, involves everybody	IMT/KSM explicitly recognizes that not everybody is able to "grasp" the paradigm shift
Starting point	Value to the customer	Aims	Needs to be defined in a non-ambiguous way to result in the desired (best outcome)
Achieves	Removal of muda, muri, and mura while delivering value to the customer	Aims against minimal risk	Focus is on value/aims. When these are poorly understood / defined the outcome will be equally poor
Decision Making	Generally reduced (e.g. 5 Why's, Gemba, Six Sigma, etc.)	Avoided	DFS rigorously enforces the identification of the expert and provides the conditions for the expert to fully exploit his expertise
The expert	The Lean expert is not the one with the right answers but the one with the right questions	The DFL-role recognizes all forms of decision making and applies the TONNNO-principles at all times	From IMT/KSM follows that it takes the same skill of perceiving initial conditions to become a Lean or DFS expert

Weaknesses of Lean

There is a vast amount of literature describing Lean. Among these many sources, the weaknesses of Lean are often discussed, but the author has not found research that effectively mitigates these weaknesses. The most significant weaknesses can be described as the following:

- Lean takes into account the entire “system” on the premise that optimizing the individual parts does not (logically) lead to optimizing the whole. But in practice the “system” is defined in a somewhat narrow sense, and often fails to take the broader system’s dynamics into account. A frequently recognized risk is that Lean is somewhat blind to innovation coming from outside of the system it considers, and thus the impact this may have on the processes it is targeting for optimization.
- While many Lean tools are data driven, and thus minimize decision making, Lean does not clearly identify that decision making is a source of risk. This includes any decisions made in the process from the definition of Value to defining concrete goals to be achieved.
- As implementing Lean will modify an existing process, Lean may encounter resistance from the people in this process when either the selection of their process, or the proposed changes to it, are not transparently substantiated. As long as some ambiguity remains as to how or why, resistance to Lean can be strong and also hamper implementation of proposed changes.
- Lean recognizes the critical importance of involving process-expertise in identifying and resolving the many different sources of “waste”, but it does not provide any guidance how to select and positively identify the people who are the experts in doing so.

How DFS addresses Lean’s weaknesses

DFS enhances Lean’s performances by:

- Emphasizing the importance of obtaining a broader view of the (dynamics of the) “system” within which the processes live.
- Removing any ambiguity in the definition of “value” (Lean’s equivalent of the aim).
- Avoiding decision making in the selection of the process(es) to be optimized.
- Ensuring the right experts are identified to work towards increasing value and identifying the waste to be removed.
- Avoiding decision making in determining the goals to be achieved.
- Having a transparent plan-from-beginning-to-end approved by the “owner” prior to start of implementation.
- Ensuring the experts can maximally utilize their expertise executing the plan.

The Ten Steps of DF Lean

Applying the approach of DFS to Lean results in the methodology of DF Lean. In DF Lean ten individual steps are identified, distributed over the four steps of DICE (see Table 2).

Table 2

The ten steps of DF Lean across the four steps of DICE

DICE	Step	Description
D	1	Define the System (the environment in which the processes live) and the overarching Value the organization unit (to which the process(es) belong) is to deliver
D	2	Determine the process(es) to be considered for optimization in relation to the element of the overarching Value targeted for optimization
I	3	Identify the process' experts in relation to optimizing the element of the overarching Value targeted for optimization, and include them in the project team
C	4	The project team defines the Value of the process(es) to be optimized
C	5	The project team maps the Value Stream and benchmarks it
C	6	The project team defines concrete goals to achieve the aim of optimizing the element of the overarching Value by improving the Value of the selected process(es)
C	7	The project teams make a detailed plan with milestones and a risk management plan, and makes it transparent to the project owner the aim will be achieved
E	8	Following approval by the project owner the project team executes the plan and reports any reports any deviations to the plan and or risk management plan
E	9	The project team continuously monitors the System to detect and identify any changes in Value
E	10	After implementing changes the project team measures the process(es)' performance and compares against benchmark to ensure the goals have been reached

DFS in practice: reducing lead time at a pathology department (DF Lean)

In this section, the project and the implementation and results of DF Lean's step 1 and 2 (Definition) is described.

Background

Trees with Character was contracted by the Netherlands Cancer Institute/AVL (Amsterdam, the Netherlands) to be the project leader of the "Lead time Pathology" project (one of several projects part of the hospital's "Healthcare Logistics Program"). The program requires the project owner to define project goals up front to assess whether the project is aligned with the program's ambition of improving several logistical aspects in healthcare.

The project owner of the "Lead time Pathology" project was the operational manager of the department of pathology. The pathology department itself consists out of various laboratories and a number of specialized pathologists to make a diagnosis (yes/no cancer, type of cancer) based on the analysis of a patient's tissue (histology) or cells (cytology). The "customers" are predominantly the hospital's medical specialists. An important element in the process is the dependence, in some cases, on receiving the patient's sample from the hospital that referred the patient to the Netherlands Cancer Institute/AVL - these type of investigations are called "revisions".

Defined project goals

The project owner stated what the current lead times were (no source provided), and defined the goals to be a lead time improvement of 20% for "regular" histology procedures and improvements of up to 50% in the lead time for revisions. It was assumed that any improvement

in the lead time, from requesting to making the diagnosis, will have a positive effect on i) how the quality of the department is perceived by the medical specialists, and ii) patient treatment outcome.

Situation as found in the department

The department had no definition of the services it was providing or supposed to provide (no “value” defined). The department has registered time-stamps of all process steps from receiving the sample to filing the pathologists report in a database since 2007. This database was not used to assess performances. In introducing the project to the people working in the labs they were skeptical about yet another “Lean” effort. The pathologists saw the project as a threat, feeling already pressured by their workload not no seeing room for improvement over and beyond perhaps 5%.

Explaining the DF Lean approach

As there was no substantiation provided for the project goals, and as it was unclear whether achieving these goals would in fact increase the “value” the department provided to the medical specialists in the hospital, the project’s goals had to be redefined from scratch. In this process, all decisions were going to be avoided in order to eliminate resistance from within the department. The Trees with Character’s project leader would assume the responsibilities of the Decision Free Leader-role. The activities to be undertaken by Trees with Character were the following:

- Describe the environment and its dynamics surrounding the pathology department (the system).
- Define the overarching Value of the department (to be approved by the project owner and the head of the department) and do a survey among the medical specialists to determine their priorities.
- Analyze the development of the work load of the department from 2007-2015
- Identify the main process for further analysis.
- Use the database to determine existing lead times of all the involved sub-processes of the identified main process.

Describing the department’s environment

The department’s internal and external environment was analyzed and visualized (figure 1). To visualize the potential impact on the department a “Dynamic-Impact diagram” was developed (see figure 2). Several IT projects were identified which would affect some of the sub-processes in the department, excluding them a priori from optimization. Other factors, such as the “competitive edge” and technological developments were tagged for monitoring by the department.

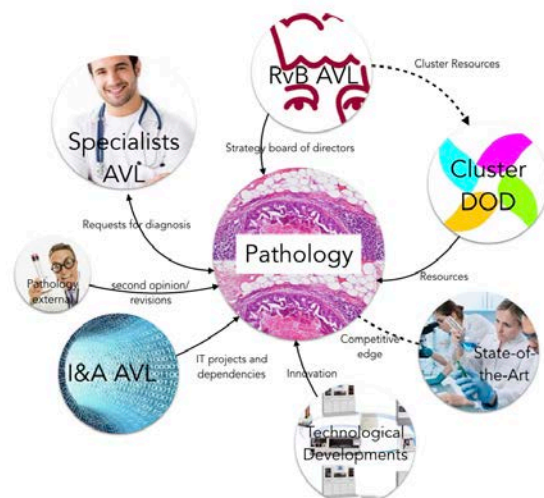


Figure 1: Graphical depiction of the various stakeholders and their relation to the department.

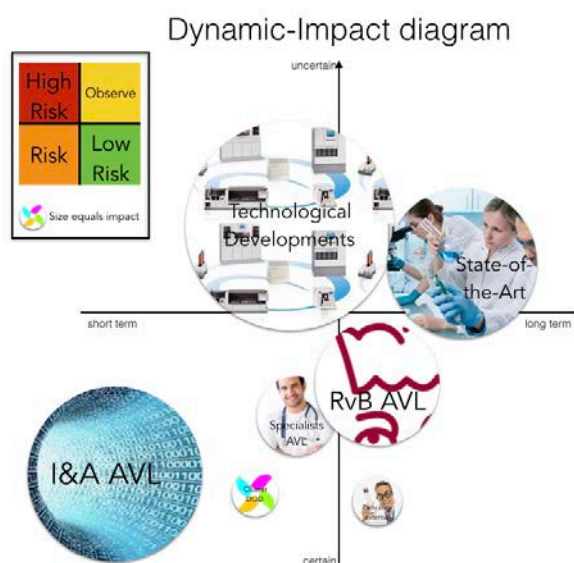


Figure 2: Dynamic-Impact diagram showing the relative risk of development to the department as a whole

Defining the Value and survey results

Trees with Character defined the value and after approval a survey was made. In total 53 medical specialists took the survey. The main results were the following:

- The expected and desired services to be provided by the pathology department depended strongly on the particular specialism (e.g. gynecology and thorax oncology departments have different needs).
- Respondents felt that it was somewhat more important to have a reliable schedule of a diagnosis report than to speed up the process overall (8.1 to 7.5).
- The specialists expressed a strong desire to be informed on developments within the pathology department (9,4).

- The reason for reducing lead times had a stronger link to improving patient experience (9, 1) than to improving patient outcome (5, 7).

Analysis of workload development and identification of main process

While the number of requests by specialists had remained largely the same from 2007 tot 2015, the actual number of samples to be made and analyzed had increased from 62,000 to 130,000 in this time frame. The number of medical trials associated with the requests had increased from 120 to 1,500. It was shown that the number of histology analyses was twice as large as the number of cytology analyses, and that the number of histology analyses grew by 7% annually, whereas the number of cytology analyses remained the same.

Identifying the process with largest lead times

The work load analysis suggested that the histology process was the top candidate to reduce lead times. The lead times of the involved sub-processes were statistically analyzed (including mean and lead time to process 80% of requests) and are shown in Figure 3. The largest lead times concerned i) the waiting time until a patient’s sample arrived from another hospital (revision), and ii) the processes following the preparation of the samples in the laboratories (LT-H, G and I).

It was also established that the lead times as defined at the beginning of the project were not corroborated by the data. The first estimated lead time turned out to have been underestimated by a factor two, and the second lead time turned out to be so much shorter in practice that it outperformed the predefined goal.

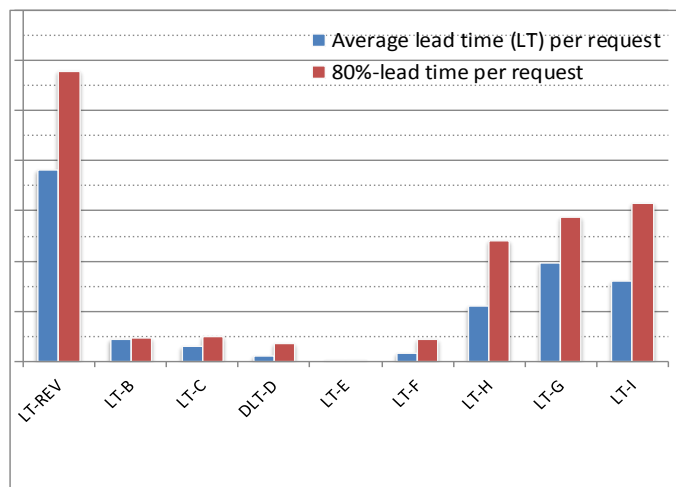


Figure 3: De-lead times for the various sub-processes of the histology analysis process. REV stands for revision, processes B till F take place in the lab, H, G and I involve pathologists.

Impact of DF Lean’s Definition-Step on Resistance within the Department

Following the analysis of the environment, the definition of the Value and the response of the survey, and the analysis of workload and of the lead times of the various sub-processes, it was now clear which sub-processes to target in order to reduce lead times. It was also clear that,

depending on the department doing a request for a diagnosis, having an accurate prediction of when the diagnosis will be ready is more important than actually reducing the lead time itself.

In coming to these conclusions Trees with Character had taken great care to avoid any decision making, and the data presented left little to no room for interpretation. The impact of the data on the department was that resistance against the project disappeared.

Impact of Avoiding Decision Making on Risk of Project Failure

By avoiding decision making in identifying the process to be targeted for optimization the following was found:

- Between 2007 and 2015 the department's work load had increased a factor 2, considerably more than the increase in number of FTE's.
- The survey results showed that overall the hospital's medical specialists valued a *reliable estimate* of date of at least as much as receiving the diagnosis "as quickly as possible".
- The survey identified the departments for which shorter lead times were expected to result in better patient treatment.
- Improvement of the department's Value was likely to be achieved by a different *prioritization* of the work.

As a result of avoiding decision making the project goals as well as the method how to achieve it have been redefined. Avoiding decision making had also avoided project failure by identifying the original project goal would not increase value.

Conclusion

Decision Free Solutions, a generic, systemic approach to minimize risk by avoiding all types of decision making, is based on IMT/KSM. DFS is congruous with BVA, but not identical to it.

In this article it is proposed that BVA (and thus DFS) replaces not only the non-expert's decision making and MDC with the utilization of expertise, but also the non-expert's thinking. A further proposition is that "decision making", "MDC", and "thinking", are merely manifestations of decision making - where a "decision" is defined as "a choice not substantiated to contribute to achieving an aim - and that a distinction can be made between three types of decision making. These three types are "decisions" (unsubstantiated choices), "decision making from the past" and "a precursor to decision making".

DFS emphasizes the importance of the definition of the aim as the aim is what the non-experts uses to identify the expert (an expert is always an expert in relation to an aim), and it is what the expert will achieve for the non-expert.

DFS identifies four steps labelled DICE: Definition (of the aim), Identification (of the expert), Clarification (how the expert is to achieve the aim) and Execution (the expert achieving the aim).

Five principles have been derived which are to be observed during all steps to identify and avoid decision making. These principles are labelled TONNNO: Transparency, Objectivity, No details, No requirements, No relationships.

DFS identifies the role of the Decision Free Leader to avoid decision making in all of the steps of DICE.

In practice not all decisions can be avoided, but every decision increases the risk that the aim will not be achieved. By identifying decisions, the corresponding risks are identified and can be mitigated. DFS can be considered a risk minimization method to which risk management is integral. Risk is minimized by utilizing expertise. DFS makes expertise matter.

In support of DFS being a generic and systemic approach, the methodology has been applied in Lean, resulting in the methodology of DF Lean. Its application in practice (in part) has been described.

DFS has since been applied in “birthing”, as well as in management, project management, and sales.

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