Shifting from Management to Leadership:

A Procurement Model Adaptation to Project Management

By

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ABSTRACT

The construction industry is performing poorly regarding project management and service delivery. On average, global projects are over-budget, delayed, and met with unsatisfactory results according to buyers. To mitigate poor performance, the project management career path has been heavily researched and continually developed over the last century. Despite the published advances in project management approaches and tools, project performance continues to suffer. This research seeks to conduct an exploratory analysis of current project management and other approaches and determine how they affect project performance. Through a detailed literature search, the researcher identified a procurement model that is more heavily documented as high performing than all other approaches. The researcher proposed that this model may be a solution to assist project managers with the delivery of high performing services. The model is called the Best Value Approach (BVA). The BVA focuses on leadership, non-technical communication, quality assurance, and transparent project execution. To test the effectiveness of its practices, the researcher modified and adapted the BVA into a project management approach and tested it on a large-scale government project. During the case study test, the researcher observed that there were two primary project management roles in the supply chain; the buyer's and vendor's project managers. The case study resulted in the large government organization receiving more work and increased their satisfaction of the work received by 22 percent from the previous year. To further test the project management adapted BVA, the researcher conducted a classroom case-study in which students learned and implemented the BVA practices on real-time, small-scale industry

projects. Results include cost savings of $100,000 for 10 companies over 24 projects, cost avoidance of over $4.5M, and a 9.8/10 customer satisfaction [in terms of the companies' satisfaction with the deliverables produced on each project]. These results suggest that the BVA practices may effectively improve the performance of project delivery, and may be a viable new project management approach to train future project managers. Out of the two project manager roles, it is proposed that the buyer's project manager may receive the most benefit. Additional research is needed on the other approaches to compare quantitative project performance, and run repeated testing on the potential new project management approach.

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INTRODUCTION

General Introduction

Previous research within the construction industry has identified the performance in the delivery of services was poor [in terms of on time, on budget, with high customer satisfaction] (Lee, et al., 1999, Horman, M. & Kenley, R. 2005; Egbu, 2008; Rivera, 2014, PBSRG, 2017). Organizations throughout the world are experiencing similar performance (PBSRG, 2017). Interestingly, this issue is not unique to the construction industry (Bo-Jie, et al., 2010; Buntaine, et al., 2013; Cervone, 2011; Deming, 1982; Kashiwagi and Kashiwagi, 2014; Miller, et al., 2013; PBSRG, 2017). The issue is that the industry does not understand the source of the poor performance (Rivera, 2014).

This issue is not new. In 1994, a landmark study was conducted by Sir Michael Latham, identifying poor performance in the delivery of services. His research is credited as one of the first to expose the non-performance that had persisted for the past 30 years prior to his report. He identified that the current practices of management, direction, and control were the key reasons why the performance was poor and inefficient (Latham, 1994). In 1997, a second study was commissioned to identify the performance in the delivery of services. The researcher was John Egan. He identified that a lack of leadership and integration of standard processes and teams were key reasons for the poor performance (Egan, 1998).

These landmark studies sparked an interest in academic institutions to develop research solutions to improve the delivery of services. Academic research has responded, by developing numerous approaches and practices, but has still not been successful in significantly identifying the core issue or changing the approaches and practices performed by project managers, to support the improvement of services they receive (Kashiwagi, et al. 2008b).

Despite the minor improvements in the delivery of services, improvement is still encouraged. In fact, according to a recent study conducted in 2015 by the Construction Industry Institute, the following was identified regarding the worldwide construction performance (CII, 2015):

- 2.5% of projects defined as successful (scope, cost, schedule, & business).
- 30% of projects completed within 10% of planned cost & schedule.
- 25 to 50% waste in coordinating labor on a project.
- Management inefficiency costs buyers between $15.6 and $36 billion per year.
- Rework by contractors is estimated to add 2-20% of expenses to a contractor's bottom line.
- An estimated $4 billion to $12 billion per year is spent to resolve disputes and claims.

This is echoed by a recent presentation conducted by Bechtel President and COO Brendan Bechtel in the construction industry, which he identified that mega-projects

within construction services (projects larger than $100M USD) are 98% cost overrun and delayed, with an 80% average cost increase (HIS Markit, 2013).

Why is this important? According to the Pew Research Center, the global population is expected to reach 9.6 billion in the year 2050 from 7.1 billion in 2015. That is a 26% increase in population. With such a large increase in populations around the world, infrastructure development is also expected to increase (Kochhar, 2014). According to one of the Construction Industry Institute's experts, William Badger, there will be more infrastructure built in the next 30 years than in the last 2,000 (CII, 2015). With a massive increase in the delivery of services worldwide [including the subsequent non-construction services (e.g. IT, HR, Sales, Manufacturing, etc.)], it is in the best interest of organizations to identify how to improve their efficiency and cut cost, while still delivering high quality and receiving high customer satisfaction.

Importance of Project Management

Traditionally, project management has been the key mechanism to delivering services. Project managers have been responsible for managing, directing, and controlling projects. They are responsible for planning, coordinating between stakeholders, cost-estimating time and materials, and creating schedules (Sears, et al., 2008; Anantatmula, 2010; PMI, 2013; Dinsmore, 2014).

According to the Project Management Institute [1 of 2 project management major organization bodies] in 2010, the following was identified about the importance of project management across multiple industries (PMI, 2010):

- Shorthand for project, program and portfolio management.
- More companies are focusing on the utilization of project management to deliver business results.
- 80% of global executives identified that project management was critical to remaining competitive during the 2007-2008 recession.
- 60% of senior executives identified that a strong project management discipline is a top three priority.
- Adhering to project management methods and strategies reduced risks, cut costs and improved success rates.
- 90% of global senior executives ranked project management methods as important or somewhat important to their ability to deliver successful projects and remain competitive.
- The practice of measuring projects is helpful for companies to gain an accurate perception of project performance, and what is needed to improve.

In short, project management is considered a critical component to delivering professional services. In fact, there are currently nearly 1 million certified project management professionals from professional organization giants PMI and IPMA (IPMA, 2017; PMI, 2017). According to PMI, between 2010 and 2020, 15.7 million new project management positions will be generated worldwide (PMI, 2013). By observation, it

appears that the main objective of a project manager is to deliver a project on time, on budget, with high quality and customer satisfaction. By observation, from complex to simple projects, high performing project managers accomplish successful project delivery through the following (Rijt, and Witteveen, 2011, Sears, et al., 2008; Anantatmula, 2010; PMI, 2013; Dinsmore, 2014):

- Meeting with client upfront to identify their needs, constraints and requirements.
- Identify baseline performance on past projects that are like the current request.
- Identify success of the project in terms of metrics.
- Create a detailed plan from begin to end that includes a milestone schedule, stakeholder resource allocation, cost breakout and payment schedule, how the project will be measured, and a risk management plan.
- Submit a weekly project report to all the stakeholders that documents project cost and schedule deviations.
- Effectively and efficiently utilize and align expertise to drive cost down and increase performance.
- Self-perform quality control.
- Ensure all processes are effective and efficient.
- Maintain full accountability of the project and anything that interfaces with it from begin to end.

A project manager's role is to ensure effective project delivery, nevertheless, many project managers are having difficulty ensuring high project performance. This issue is not unique to project managers managing construction services. The researcher

was interested in the performance of service delivery in all the major industries that employ project managers. The industries that employ project managers are identified in Table 1-1.

Table 1-1 shows the performance of these services as measured by schedule, budget, customer satisfaction and reported quality. The percentages represent the average of the total number of publications collected for industry. These performance metrics summarize research done by the researcher (see Attachment C for references).

Table 1-1

Performance in Industry that Employes Project Managers

A Few Major PM Industries	On Time	On Budget	Customer Satisfaction	Quality
Information Technology	40%	43%	3.6/10	Fair
Construction	25%	32%	N/A	Poor
Health Sector	N/A	N/A	6/10	Poor
Aerospace and Defense	14%	38%	N/A	N/A
Manufacturing	67%	50%	7/10	N/A
Energy	59%	59%	7/10	N/A

The results shown in Table 1-1 suggests that there is room for improvement in each industry. Research has identified that many of the issues project managers are facing are due to the following (Ahern, et al., 2014; Elonen, et al., 2003; PBSRG, 2017):

- Services are too complex.
- Increased number of supply chain participants.
- Unclear roles of participants.

- Confusion over details, which increases decision-making.
- Misunderstood client expectations.
- Increased misunderstandings.
- Required to know every detail on a project.
- Poor-preplanning.
- Project environment is non-transparent due to a lack of performance measurements.
- Reactive environment due to client management, direction, and control.

The major role of the project manager is to efficiently and effectively deliver services. By observation, with the growing demand of delivering services in multiple industries project management is a major staple, project managers are expected to know more and have more experience to survive, making an already difficult job more difficult (Rivera, et.al., 2016). With the continued poor performance seen in these industries, it is difficult to see how project managers who manage the delivery of services will ensure they receive high performing and successful projects.

Evolution of Project Management

Preliminary research was conducted to identify the evolution of project management. While exploring over 90 publications about the history and evolution of project management, the researcher identified 5 major phases. Table 1-2 shows the major phases. Phases 2-5 were pre-identified from previous research conducted [see full details in Appendix A].

Table 1-2

Five Phases of Project Management A

Phase	Reason
Phase I (Ancient Mesopotamia to 1760)	Ancient
Phase II (1760-1958)	Industrial Revolution
Phase III (1958-1979)	Application of Management Science
Phase IV (1980-1994)	Information Management Development
Phase V (1995-Present)	Age of Technology

Table 1-3

Five Phases of Project Management B

Criteria	Phase I	Phase II	Phase III	Phase IV	Phase V	Analysis
Technology	Man-powered machinery	Steam Power, Light bulb, Telegraph, Telephones, Automobiles	Software Programing	Personal Computer	3D Technology, Internet, Robotics, Nuclear Power	Advances in technology create a more connected world
Major Projects (schedule/cost) *	Florence Cathedral (200 yrs.), Coliseum (8 yrs./57B)	Panama Canal (10 yrs./350M), Hoover Dam (5yrs/700 M)	Apollo Project (10yrs/100B) 24	Space challenger project (10yrs/450 M) 25	Palm Islands (10+/1.5B), Beijing Stadium (5yrs/360B)	Projects are completed faster. No trend in Budgets.
Major Project Types	Pyramids, Cathedrals, Castles	Dams, Canals, Railroads	Spacecraft projects, Advanced weaponry	Large public facility	Smart Buildings, Green Building	Evolved from basic structures to smart, sustainable facilities
Unique People	Machiavelli	Henry Gantt, Frederick Taylor	Bill Gates, Paul Allen	Gordon Moore, Bill Gates, Steve Jobs, Edwards Deming	Kent Beck, Stephen Devaux, Eliyahu Goldratt, Y.C. Chiu	Evolved from Authoritarian to Observant
PM Approaches/Associations	Master builder tradition (one designer, one manager)	Gantt chart, The American Association of Cost Engineers	Program Evaluation Review Technique, Product Data Management	Risk Management, Six Sigma	Critical Chain PM, Agile Manifesto, Best Value	Siloed to Best Value
Education	Skill-based (guilds, apprenticeships, workshops)	"Factory Model" of education - Children taught factory skills	Training in computer software, mass education	Emphasis on higher education	University utilization	Skill & Trade based to University utilization
Economy	Siloed kingdoms	Golden age of capitalism	Post WWII economic	Boom-Bust Cycle	Globalization	Siloed economies to a

			boom, heavy investing			globalized economy
Labor	Slave labor	Child labor, worker exploitation, machinery	Industrial workers, software-skilled labor	Outsourcing of skilled labor	Virtual based, lack of skilled workers	Reduction in skilled workers over time
Design	Pyramids & Cathedrals	Industrial	Suburban "cookie cutter" design	Family & Socially-conscious	Sustainable, Contemporary	Primitive to Sustainable "green" facilities
Materials	Mud, Brick, Stone	Iron, steel	Continuation of iron & Steel	Copper, plastic, concrete	Steel, Reinforced Concrete	Local materials to mass production of reinforced materials

According to Table 1-3 [See references in Attachment B], the following dominant information was observed:

- Technology has continued to progress, allowing humans to do more with less.
- The increase in technology has helped project managers deliver services faster.
- Structures have evolved from basic to smart and sustainable facilities. By observation, more maintenance is required to up keep the new technology.
- Project managers' approaches have moved from primarily authoritarian to more autonomous.
- Project managers' have improved the involvement of the entire supply chain when delivering a service.
- Education and training has increased significantly in the past 100 years.
- Project managers are using more skilled laborers.
- The materials used by project managers are less localized and more mass produced from reinforced concrete and steel.

Despite the technological advancements and increase in project management education and training over the past 30 years, the project performance of service delivery is still low across various industries. Despite the overall investment of time and resources, some question its payoff. One project manager, and recognized International Project Management Association Fellow, Stacy Geoff stated: *"… most people find it difficult to show improved PM performance; nor can they even show the improved competencies they hoped for."* In fact, he identified that in his discussions with executives, they identified the perception is that programs and projects are drastically less successful today than they were 25 years ago. And the executives asked: "What return on investment is this?" (Goff, S., 2014).

Best Value Approach

There has been only one project delivery approach that has repeated documented testing that has improved project performance (PBSRG, 2017). It is a procurement model, called the Best Value Performance Information Procurement System (BV PIPS), which was developed at Arizona State University by Dean T. Kashiwagi in the Performance Based Studies Research Group. The BV PIPS has been tested in the entire supply chain (construction and non-construction services). Its developments have 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 (IFMA) for the last 25 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 (Kashiwagi, 2013; Rivera, 2014; PBSRG, 2017):

- 2000+ projects and services delivered / $6.6B of projects and services delivered.
- 123+ unique clients [government and private sectors].
- 98% customer satisfaction / 9.0 (out of 10) client rating of BV PIPS model.
- Decreased the cost of services on average by 31%.
- Vendors were able to offer the client/owner 38% more value.
- Decreased client efforts by up to 79%.
- 57% of the time, the BV PIPS selects the highest performing experts for the lowest costing services.
- International recognition: Canada, Netherlands, Finland, Norway, Sweden, Botswana, Malaysia, Australia, Democratic Republic of Congo, and France.
- Largest projects: $100M City of Peoria Wastewater Treatment DB project; $53M Olympic Village/University of Utah Housing Project; $1B Infrastructure project in Netherlands.
- Only procurement model to be audited 4x: State of Hawaii; COE PARC; Zuyd University & University Twente; WSCA/NASPO Agreement (Duren and Doree, 2008; State of Hawaii PIPS Advisory Committee, 2002; Kashiwagi, 2016; PBSRG, 2017).

The BV PIPS is a procurement system that was founded upon from the advancements of the theoretical model Information Measurement Theory (IMT). It will

be referred to as the Best Value Approach (BVA) throughout this dissertation. The IMT is based on the theoretical premise that experts have more information about their area of concentration, which results in their ability to see it more simply than the buyer who is procuring their services. Using this logic, buyers that identify and utilize expertise to deliver services, should pay less for higher performance (Kashiwagi, 2017). Previous research has shown this to be true on over 50% of all procured services that used the BVA (PBSRG, 2017). The major objectives of the BVA are the following (Kashiwagi, 2017):

1. Minimize thinking and decision making in the supply chain through the identification and utilization of experts.
2. Maximize the use of all resources to increase efficiency and minimize effort.
3. Create transparency to minimize inefficient transactions.
4. Replace management, direction and control with the utilization of expertise to identify what is needed to be done and when.
5. Increase project profit and minimize cost through the identification and utilization of expertise.

The BVA consists of four major phases:

1. Prequalification: education of all vendors on the BVA, and its differences from other procurement systems.
2. Selection: vendors are prioritized based on their level of expertise, as it relates to the project they are proposing on. The vendors are shortlisted, and the highest

prioritized vendors are interviewed. Once the vendors are prioritized for the last time, the highest vendor is selected to move into the clarification alone.

3. Clarification: the highest prioritized vendor from the selection phase, is required to create their own contract. The items required are the scope of work, detailed and milestone schedules, price schedule, weekly risk report, risk mitigation and management plan, and performance metrics. Once completed, the buyer reviews the contract plan, and approves it if it is simple, understandable, and executable. If the buyer agrees with the vendor's contract plan, the award is made.
4. Execution: the awarded vendor performs the work according to the scope of work outlined in their contract. They are also responsible to submit a weekly risk report each week to the buyer, to create transparency on the project in terms of cost and schedule deviations and who was cause.

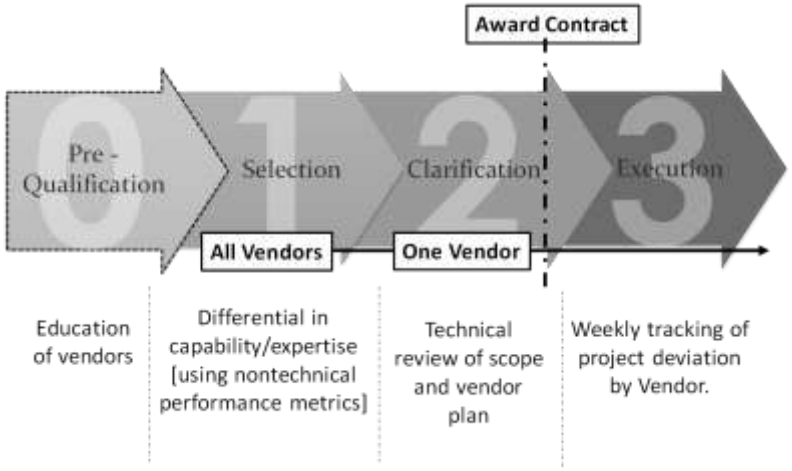


Figure 1-1: BVA Model (Kashiwagi, 2017)

This process has project management applications; however, it has not previously been used as a project management system before this research. This approach and methodology may be able to be used to assist project managers with the improvement of project performance.

Problem

Despite the PMI and IPMA continually developing and advancing the function of project management, performance of services being delivered has not significantly improved in the last 30 years.

Proposal

This research will analyze and test the Best Value Approach for appropriateness, modify and adapt it to project management, and test the developed adaptation within various project enviornments.

Proposed Contribution

This research is the first known attempt to take a procurement system and adapt it for the use of project management. This project management adaptation, may bring to the project management profession new practices that could help a project manager with the delivery of high performing projects. The results of this research could also help to direct new and future research into project management practices.

The impact of assisting project managers with the delivery of high performing services, will be great on the industry and society in general. High performing services will increase efficiency and create quicker delivery times, lower costs, and higher quality. It will provide society and businesses more resources for development and growth.

Structure of Dissertation

This dissertation includes six chapters. They are the following:

1. Chapter 1 – Introduction: This chapter covers the overview, problem, purpose, proposal, and research contribution of this research.
2. Chapter 2 – Methodology: This chapter covers the structure of the research. It outlines the main research question and sub-research questions, and the methodology of how each question will be answered.
3. Chapter 3 – Literature Research: This chapter thoroughly outlines the methodology of how the literature research was conducted to identify the difference between the project management adapted BVA and the other traditional project management approaches.
4. Chapter 4 – State Agency Case Study Research: This chapter proposes the project management adapted BVA's practices as a potential project management model. It also identifies the current conditions of the State Agency that authorized the researcher to test the project management adapted BVA.
5. Chapter 5 – State Agency Shift in Project Management Approaches: This chapter discusses how the project management adapated BVA was implemented in the State Agency.

6. Chapter 6 – State Agency Case Study Research Results and Conclusions: The covers the final results and conclusions of the project management adapted BVA test.
7. Chapter 7 – Project Managers of the Future: This chapter identifies preliminary research testing with a graduate project management course, to identify if the project management adapted BVA can be used as a mechanism to overcome their inexperience, and to deliver small-scale services successfully for local companies. The results of the services are documented.
8. Chapter 8 – Conclusion: This chapter will review the research performed, identifying its value and weaknesses. Recommendations will be given on further research.
9. References
10. Appendix
11. Attachments – See Google Drive: https://drive.google.com/drive/folders/15dQaj06yP9q7avr8rfSDciYXQDNfYYPD?usp=sharing

Chapter 2

METHODOLOGY

Introduction

This chapter explains the research approach and the methodology used by the researcher to create new knowledge in project management. First, the scope of the research is discussed. Second, the main research question and sub-questions are identified, to help shape and focus the direction of the research. Finally, the method that the research was conducted, information to be collected, and how it will be analyzed is identified.

Scope of Research

This research was focused on identifying if the Best Value Approach (BVA) can be modified into a project management model to help project managers with the delivery of high performing services. This research was specifically focused on identifying the unique practices of the BVA that has generated a significant amount of documented high-performance results in the procurement of services. This research will also involve an analysis of current project management approaches to use as a comparison to the project management adapted BVA.

A project manager will be defined as "the person responsible for leading a project from its inception to execution close. This includes planning, execution and managing the people, resources and scope of the project (PMI, 2000; Techopedia, 2017)." A project

management approach will be defined as a philosophy, ideology, or methodology that a project manager employs in all aspects of their vocation. A project management practice will be defined as any tool, action, or strategy that a project manager adheres to or performs within an approach to deliver a service. As depicted in Figure 2-1, a project manager will typically adopt one approach which leverages numerous practices designed to deliver services.

Figure 2-1. Project Managers use of Approaches

The research will identify the unique BVA practices by comparing it with traditional documented performing project management approaches. The term traditional, will refer to any approach in this research that was not the BVA. Additionally, the differences between the BVA's practices and the documented performing project management approaches' practices will be identified. After the unique practices of the BVA were identified, a case study was conducted to test the effectiveness of implementing the BVA practices as a potential project management approach. The

performance of the project management adapted BVA, will be compared to the traditional project management approaches that were used.

The researcher's aim was to identify a set of project management practices that can help project managers manage the delivery of services more efficiently and effectively, and receive high performance more consistently. Additionally, specific project management skills and tools, such as project management software, scheduling or budgeting methodologies and tools were not part of the scope. The researcher was only looking at project management approaches of philosophies and not specific tools.

Research Questions

The main research question (MRQ) was formulated as follows:

Can the Best Value Performance Information Procurement System (Best Value Approach), be adapted into a Project Management Approach?

The MRQ was divided into the following sub-research questions (SRQ):

1. How does the Best Value Approach differ from all the other project management approaches, in terms of practices and performance?
2. Can the Best Value Approach practices be tested in an organization, and be successfully utilized by project managers to show high performance on projects?

The researcher recognizes that a full comprehensive study on approaches and practices has not been conducted to date in the breadth presented in this research. To add

to the body of knowledge in project management, and support the advancement of efficient and effective project management practices, the sub-research questions were shaped to ensure a thorough search and examination of the available information.

Research Approach

To identify the answers to each of the sub-research questions, two research methods were used. The methodology for this research was modified from Dul and Hak's (Dul and Hak, 2008) structure for theory building and theory testing. The major research techniques that were used were:

1. Literature Research
2. Case Study Research

The purpose of the literature research was to find "candidate propositions for testing" (Dul and Hak, 2008), which will be used to answer sub-research questions 1. The candidate propositions for testing were the unique BVA practices that will be identified and used in its project management adapted version. The case study research will assist in answering sub-research question 2. To conduct this research, the methodology steps were the following:

1. Perform a literature research on the BVA, and identify all the practices that it uses.
2. Perform literature research to identify traditional approaches and practices that have documented performance in the delivery of services.

3. Compare traditional approaches' practices that have documented performance, with the BVA's practices.
4. Identify the difference with the practices of the BVA and the traditional project management approaches.
5. Identify a case study test to verify if the performance of the BVA can be replicated on projects, by a project manager implementing its practices in a project management adapted version.
6. Compare the results of the project management adapted BVA case study test, with the previously documented performance that used the traditional project management approach.
7. Propose if further research can add value.

The research and methodology is outlined in Table 2-1. The columns identify each step in the research, and the location in this research where they will be addressed.

Table 2-1

Literature Research Methdology

Literature Research	**Case Study Research**	**Result**
How does the BVA differ from all the other project management approaches, in terms of practices and performance?	Can the BVA practices be tested in an organization, and be successfully utilized by project managers to show high performance on projects?	Can the BVA, be adapted into a Project Management Approach?
SRQ 1 Chapter 3	SRQ 2 Chapter 4	MRQ Chapter 6

Literature Research

A literature search was conducted to identify project management approaches and practices that have their performance documented, and how its practices differ from the BVA's practices. The literature research focused on both construction and non-construction services, due to project management being utilized in multiple industries. The sources used to obtain the research were from books, academic journals, conference papers, websites, organizational documents, and publications, proposed by Dul and Hak (2008).

The purpose of the literature research was to identify how the BVA and traditional project management approaches' practices differ.

Case Study Research

To validate if the BVA practices can support a project manager with the delivery of high performing services, case study research was performed. The case study was performed with an environmental state agency in the United States of America.

The case study documented the performance differential between the buyer's project manager's traditional practices with the BVA practices. The method used for the case study research can be found at the beginning of Chapter 5.

Research Deliverables

Through answering the research questions, this research aids in the exposure and advancement of efficient and effective project management practices that may potentially assist project manageres with the delivery of high performing services.

Chapter 3

LITERATURE RESEARCH

Introduction

This chapter explains the literature research conducted to identify the unique practices of the Best Value Approach (BVA), compared to the current traditional project management approaches and practices. The literature research was conducted as follows:

1. Perform a literature research on the BVA, and identify all the practices that it uses.
2. Perform literature research to identify traditional approaches and practices that have documented performance in the delivery of services.
3. Compare all traditional approaches that have documented performance with the BVA's practices.
4. Identify the difference with the practices of the BVA and the traditional project management approaches.

The remaining part of this chapter will describe in detail how the literature research was conducted.

Best Value Approach (BVA) Literature Research Methodology

The researcher was exposed to the BVA through a graduate research assistantship in the Del E. Webb School of Construction (DEWSC) at Arizona State University (ASU). A prominent research group founded by Dean T. Kashiwagi in 1992, within the DEWSC,

called the Performance Based Studies Research Group (PBSRG), is responsible for the research and development of the BVA. The BVA was initially formulated during Dean T. Kashiwagi's dissertation in 1991. The BVA was designed to respond to the traditional price based procurement approach in the construction industry. Due to the continuous low performance in the delivery of services, Dean T. Kashiwagi proposed that it may be due to the buyer's practice of management, direction and control over the experts they hired. Instead, Dean T. Kashiwagi created the BVA to help minimize buyer management, direction and control, by replacing it with the identification and utilization of expertise. The paradigm shift that the buyer is not the expert and should not direct experts on how to perform their work, is a unique proposal that Dean T. Kashiwagi chose to convince buyers to test out and identify if it can help them receive higher performance for a lower cost. The research results have been heavily published through the following literature resources:

1. 200+ academic publications.
2. Numerous white papers.
3. 2 websites [pbsrg.com; cibw117.com]
4. 3 manuals [Information Measurement Theory; Best Value Approach; How to Know Everything without Knowing Anything].

A thorough literature research was conducted on the BVA during the researcher's master's program and is documented in the "Impact of a Non-Traditional Research Approach: Case Study on the Performance Based Studies Research Group" master's thesis (Rivera, 2014).

The following BVA results were recorded (PBSRG, 2017):

- Founded in 1992 [25 years of operation] and has documented performance on over 2000 projects and services delivered (construction and non-construction).
- $6.6B of projects and services delivered with a 98% customer satisfaction and 9.0/10 client rating of process.
- $17.5M in research funding generated, due to the effectiveness of decreasing buyer cost of services on average by 31% [57% of the time, the highest performing expert was selected and was the lowest cost].
- Contractors/vendors could offer the client/owner 38% more value, and decreased client efforts by up to 79%.
- Change order rates were reduced to as low as -0.6%.
- PBSRG has worked with over 123 unique clients [both government and private sector] and received 12 National/International Awards.
- The BVA is the most licensed technology to come out of Arizona State University licenses [53].
- It is internationally recognized through repeated testing [Canada, Netherlands, Sweden, Norway, Finland, Botswana, Malaysia, Australia, Democratic Republic of Congo, France].
- Some of the largest projects documented were: $100M City of Peoria Wastewater Treatment DB project (2007); $53M Olympic Village/University of Utah Housing Project (2001); $1B Infrastructure project in Netherlands (2009).

- Some of the highest performing projects documented include: ASU tested BVA in their business services and procurement department, resulting in $100M of revenue. Changed the entire procurement service industry in the Netherlands through the success of a $1B infrastructure test that cut procurement cost by 50% and help the project finish 25% faster. As a result, the Rijkswaterstaat won the most prestigious procurement award in the Netherlands, the 2012 Dutch Sourcing Award, and now NEVI [Dutch Professional Procurement Group] is licensing BVA technology and certifying in the Netherlands (Rijt, J., Santema, S. 2012).

The BVA has been audited multiple times in the last 25 years. Two of the audits identified the impact and effectiveness of the BVA in detail:

- The State of Hawaii Audit (Kashiwagi et al. 2002; State of Hawaii Report 2002 (DISD)).
- The two Dutch Studies on the Impact of PIPS (Duren & Doree, 2008; Rijt & Santema, 2013).

These studies confirmed all BVA performance claims were accurate. Duren and Doree's study found the following results for projects performed in the United States:

- 93.5% of clients who worked with BVA identified that their projects were delivered on time.
- 96.7% of clients who worked with BVA 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.

The other groups that conducted audits were COE PARC, 2008; Zuyd University & University Twente, 2008; WSCA/NASPO Agreement, 2011.

Best Value Approach Practices

A literature research on the BVA was conducted, to identify project management practices. The BVA was derived from the principles of the Industry Structure (IS) model and Information Measurement Theory (IMT). The IS was developed in 1991, and proposed that the buyer or end user, may be the major source of project cost and time deviation. The Industry Structure model shown in Figure 3-1 identified that in the environment of high competition, the biggest difference in low performance and high performance, was the use of management, direction, and control (MDC) by the buyer over the vendor.

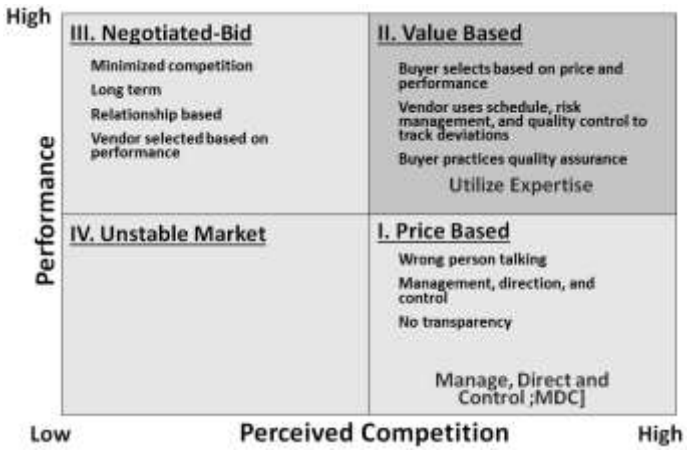


Figure 3-1 – Industry Structure

The IS proposes that a project manager should not manage, direct, and control others. They should utilize the expertise of others on a project. Utilizing expertise instead of MDC involves the following changes to a project manager's role (see Figure 3-2):

1. Identify an expert to perform the project.
2. The project manager is responsible for Quality Assurance and not Quality Control. The project manager is responsible for ensuring the expert has a plan, the plan is understandable to everyone, and they have a way to measure the quality of their work throughout the project.
3. Minimize the decision making of the project manager. The project manager requires the expert to take control of the project and make any decisions required. This will also increase the accountability of the expert.
4. Coordinate and ensure any tasks outside of the expert's scope of work were complete for the project.

The Information Measurement Theory (IMT), which uses natural laws and logic to explain reality and identify expertise and value, was also used to develop the BVA. The main idea IMT proposes is that one individual has no impact, influence, or control on other individuals, it supports the IS in minimizing management, direction, and control. It also identifies characteristics of an expert. The logic it uses to come to this conclusion is as follows:

1. Natural laws are not created. They are discovered.
2. Every set of conditions based on a location and time is unique. Each set of conditions has a different set of characteristics that makes it unique. Unique characteristics include time, location, resources, people's perceptions, and physical conditions.
3. Unique conditions change over time based upon natural law. Thus, unique conditions of the past are related to the unique conditions of the present and the future.
4. The more information (understanding of natural laws and knows the unique conditions) an individual has the more they can predict the future conditions.
5. If future conditions are predictable then any event can happen only one way.
6. The initial conditions of an event will determine the final conditions of an event.
7. Any attempt to change unique conditions that is not based on natural law is impossible.
8. The more information an individual has in an area the more expertise and value they can provide.

9. The more expertise an individual has the more they do not believe in the ability to control or influence other people.

An expert is identified as an individual with more information in a certain area. Hence, the more expertise someone has the less they believe in the ability to control or influence other people. The more they believe that they control their own life and have 100% accountability for it. Figure 3 shows the difference between the belief in influence and control and no-influence and no-control. On the left side, the arrows are facing out showing that the individual is accountable for his life and his environment. On the right side, the arrows are facing in showing that the individual believes their environment and life is responsible for what happens to them. The corresponding characteristics of each belief are also found in Figure 3-2.

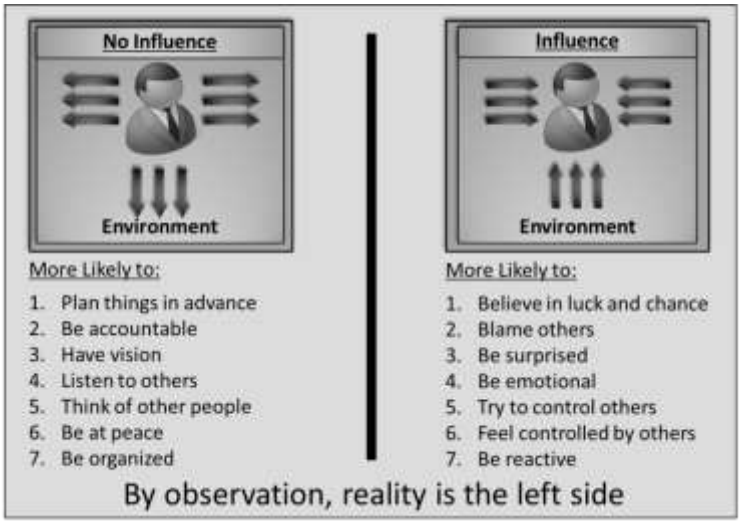


Figure 3-2: No Influence versus Influence Model

The IS and IMT identify that the more a project manager must MDC, the less efficient they are. Characteristics of MDC are the following:

1. Communications.
2. Meetings.
3. Reports.
4. Inspections.
5. Making decisions.
6. Requirements.

The project management adapted BVA identifies that the role of the project manager must change from being a manager to being more of a leader. A manager being an expert that directs others and makes decisions on project (PMI, 2000), and a leader being one that aligns expertise. The manager requires technical knowledge and understanding. The leader requires an ability to use the expertise of others. To make this transition the IS and IMT identify the following requirements for the adapted model:

1. Due to the project manager no longer being the expert, all communication must be non-technical.
2. The project manager must ensure and require the vendor to simplify the project and create transparency.
3. All efforts must be measured. Measurements must be simple, understandable, and non-technical. Measurement enables the project manager to know the level of performance of the expert.

The project management adapted BVA was developed through the identification of practices found in the BVA. To find the practices, the researcher did the following:

1. Reviewed BVA publications.
2. Documented any practice that was described.

In total, five practices were identified in the literature (PBSRG, 2017):

1. Utilize expertise – Align vendors and personnel with projects that fit their expertise.
2. Minimized MDC – minimize meetings, decisions, reports, inspections, and communications.
3. Weekly Risk Report/Director's Report – weekly measurement of deviation of all projects in terms of cost, schedule and quality.
4. Transparency – all stakeholders have access to all project information and can understand the information without an explanation.
5. Quality assurance – ensure that the expert has a plan before they begin a project and they can explain the progress and changes to the plan throughout the execution of the project.

To simplify, the researcher grouped the six practices into three major practices. They are the following:

1. Leadership: replacing MDC with the identification and utilization of expertise.
2. Non-technical communication: simple and non-technical performance metrics.

3. Quality Assurance: shifting all accountability of the project scope of work from the buyer to the expert vendor.

Best Value Approach Conclusion

The practices of the BVA have been documented to show high performance. In total, six practices were identified and grouped into three major practices. These practices were used as the framework for the project management adapted BVA.

Traditional PM Approaches Literature Research Methodology

After understanding the BVA model and the practices it uses to improve the delivery of services, a literature research was performed on the traditional project management approaches, to identify what practices they are using to improve service delivery. To identify all current traditional documented project management approaches and their practices, the researcher used the following research sources:

- Project management books.
- Academic search engines and databases.
- Websites devoted to project management topics.

To ensure that the research identified all available documented information on approaches and practices that could be used by project managers, the researcher set up the following parameters:

- Keyword and database searching.
- Filtering through relevant literature.

- Documentation of information.

Keyword and database searching

First, the researcher conducted internet research to identify all documented approaches. To ensure that all approaches and practices that a project manager could use to deliver a project was not discarded, multiple sources previously identified were researched. A decision was not made when identifying and documenting any approaches and practices that could be used by a project manager. The researcher used any approach and practice that could be discovered from the research sources that identified them. The researcher identified the following 19 approaches (see Appendix D):

1. Agile Family (Scrum 70%, Kanban, Extreme Programming (XP), Adaptive Project Framework (APF))
2. Benefits Realization
3. Business Process Modeling
4. Critical Path Method (CPM)
5. Critical Chain PM (CCPM)
6. Deming PDCA
7. Event Chain Methodology (ECM)
8. Extreme Project Management (XPM)
9. Lean
10. Lean Six Sigma
11. PMI: PMBOK
12. Prince/Prince 2

13. Prism

14. Process Based Project Management

15. Rapid Applications Development (RAD)

16. Six Sigma

17. Spiral

18. Stage Gate

19. Waterfall

Second, the researcher developed a list of keywords for each approach identified, to ensure a thorough search in the research sources used. A list of the keywords is identified in Table 3-1.

Table 3-1

Approaches, Key Words and Databases

#	**Approaches**	**Keywords**	**Databases**
1	Agile (Scrum 70%, Kanban, Extreme Programming (XP), Adaptive Project Framework (APF))	Kanban, Kanban Project Management; Kanban Methodology Analysis, Agile; Extreme programing, Extreme programing PM, EP metrics; Extreme programing statistics and performance; Adaptive Project Frame Work	ASU Library; Google Scholar; Science Direct, PMI Website; Google
2	Benefits Realization	Benefits Realization, BRM, Benefits Realization Management, Benefits Realization Data Results, Benefits Realization Project Management Model	ASU Library; Google Scholar; MIT Libraries
3	Business Process Modeling	Business Process Modeling	ASU Library; Google Scholar
4	Critical Chain Project Management	Critical Chain Project Management	ASU Library; Google Scholar
5	Critical Path Method	Critical Path Method	ASU Library; Google Scholar

6	Event Chain	Event Chain Methodology, Event chain research, Event Chain Results, Event Chain Success	ASU Library; Google Scholar
7	Extreme Project Management	Extreme Project Management	ASU Library; Google Scholar
8	Lean	Lean	ASU Library; Google Scholar
9	Lean Six Sigma	Lean Six Sigma	ASU Library; Google Scholar; ProQuest Database
10	PDCA	PDCA; PDCA Methodology	ASU Library; Google Scholar
11	PMBOK	PMBOK, Project Management Body of Knowledge	ProQuest Database
12	Prince/Prince 2	Prince, Prince 2	ASU Library; Google Scholar
13	PRISM	Prism, Performance of Routine Information System Management Framework, PRISM Metrics, PRISM Performance Case Studies, PRISM Case Studies.	ASU Library; Google Scholar; MIT Libraries
14	Process Based Project Management	Process Based Management/Model; Process Based Management in Construction; Process Based Management Metrics	ASU Library; Google Scholar
15	Rapid Application Development	RAD; Rapid Application Development	ASU Library
16	Six Sigma	Six Sigma	ASU Library; Google Scholar; ProQuest Database
17	Spiral	Spiral Project Management Model, Spiral Model, Spiral Project Management	ASU Library
18	Stage Gate	Stage Gate Management	ASU Library
19	Waterfall	Waterfall Methodology	ASU Library

The main research sources used in the literature research are the following:

- ASU Libraries
- Google Scholar
- MIT Libraries
- Google
- ProQuest Database

Filtering through relevant literature

The researcher chose not to add any approaches from the construction industry due to numerous studies and documentation identifying their poor performance (see full details are provided in Appendix C).

Due to the wealth of existing documentation on the poor performance of services delivered in the construction industry, the researcher looked outside this silo to be more complete when identifying traditional project management approaches.

Next the researcher researched each of the five major research sources, using the preidentified keywords to gain as much information on each approach and its documented performance.

To ensure a thorough search was conducted within each research source, the researcher first searched for a single approach, second, the researcher identified the number of related publications that appeared from the search. Third the researcher scanned all publications for relevance. The publication was relevant if 1) it described the approach (characteristics, reason for development, strengths, weakness, uniqueness) or 2) it identified any performance information in the form of numbers, tables or figures. Lastly, once a publication met the criteria, the researcher documented the publication and its relevant information into an excel spreadsheet database (see Attachment A).

In total, 10,503 publications appeared during the combined searches of the 19 project management methodologies. Out of the 10,503 of the publications, 800 were reviewed in more detail to identify if it could be used for the research. Out of the 800, 572 publications were used for the research.

Documentation of information

Each identified approach is unique. To gain a clearer description of each approach, and to differentiate between the performance of each approach, nine criteria were used. They are the following:

1. Model name & Grouping
2. Description of model
3. Developer
4. Year developed
5. Reason for development
6. Industry used
7. Major Strengths
8. Issue
9. Unique

A separate report was completed for most of the approaches (see Appendix D and Attachment D). When the researcher completed the in-depth analysis on each approach, they were prioritized from greatest to least amount of documented performance information. An index was created to provide a weight to each approach. Table 3-2,

shows the approaches in a prioritized order based on their index number. The prioritization does not consider the amount or the relevancy of the performance information found in each publication. It only considers the percentage of publications with performance information for each approach.

Table 3-2

Prioritized List of Approaches based on Performance Information

Approaches	# of Publications Viewed	# of Publications w/ Performance Information	Index
Agile Family (Scrum 70%, Kanban, Extreme Programming (XP), Adaptive Project Framework (APF))	1578	38	59,964
Six Sigma	740	39	28,860
Lean Six Sigma	675	17	11,475
Process Based Project Management	1263	7	8,841
Benefits Realization	970	9	8,730
Critical Chain PM (CCPM)	800	7	5,600
Deming PDCA	325	17	5,525
Prince/Prince2	220	16	3,520
PMBOK	190	16	3,040
Critical Path Method (CPM)	444	5	2,220
Lean	117	17	1,989
Rapid Application Development	120	16	1,920
Stage Gate	66	18	1,188
Spiral	50	17	850
Event Chain Methodology (ECM)	800	1	800
Extreme Project Management (XPM)	453	1	453
Business Process Modeling	25	16	400
Waterfall	17	15	255
Prism	1350	0	0

The researcher recognized that many of the publications with performance information could possess both objective and subjective measurements. The researcher recognized that few of the approaches had objective documented performance information. The researcher was only interested in further analyzing the practices of the project management approaches that possessed objective measurements, because they were observable and not up for interpretation. Objective performance information is defined in terms of non-survey data collected on projects [e.g. cost savings, on budget/schedule, and any dominant information].

Tables 3-3 and 3-4, shows a list of all the approaches. The approaches were separated into two tables [objective and subjective performance information].

Table 3-3

List of Approaches with Documented Objective Performance Information

Approaches (Documented Metrics)	**$$ Savings**	**OB/OS**	**CS**	**Dominant Information**
Agile Family	-	49% / NA	Very Satisfied	77% of respondents indicated that 75% or more of their agile projects were successful.
Business Process Modeling	-	- / -	-	One project was tested through a series of 8 field trials over 16-month periods. BPM reduced time by 75% over traditional PM practices.
Lean	41.5%	- / -	-	Boeing is four generations beyond that airplane now, and they have succeeded in cutting the time and cost by 50% for each new generation of airplane by using Lean.
Lean Six Sigma	$1.3M	- / -	-	One study on solar cells fabrication was reduced by 54%, all critical defects in the process were eliminated; the quantity of functioning solar cells fabricated was increased from 17% to 90%.

Prince/Prince2	-	- / -	-	In a study by the Standish Group in the IT field, they identified 1/3 or 4K (out of 13.5K) projects studied, had managed to achieve their objectives.
Rapid Application Development	30%	- / -	-	Joint Application Development reduced functionality error from 35% to 10%; Reduced time for logical design by 6 hours per functional point.
Six Sigma	Billions	- / -	-	Motorola reduced defects that quantified at $2 billion during a four-year period. Allied Signal was attributing six sigma to a savings of more than $600 million per year, GE published a savings of more than $750 million after their investments in six sigma.
Stage Gate	-	- / -	-	Nearly 60 percent of the firms in USA surveyed use some form of Stage-Gate.
Spiral	-	- / -	-	Projects using the system have increased their productivity at least 50%.
Waterfall	-	- / -	-	Success rates: Never-45%, rarely - 19%, Sometimes -16%, often -13%, Always - 7%.

Table 3-4

List of Approaches with No Documented Objective Performance Information

Approaches (Subjective/No Metrics)	**$$ Savings**	**OB/OS**	**CS**	**Dominant Information**
Benefits Realization	-	- / -	-	-
Critical Path Method	-	- / -	-	-
Critical Chain PM	-	- / -	-	-
Deming PDCA	-	- / -	-	-
Event Chain Methodology	-	- / -	-	-
Extreme Project Management	-	- / -	-	-
PMBOK	-	- / -	-	-
Prism	-	- / -	-	-
Process Based Project Management	-	- / -	-	-

These results do not provide conclusive evidence to suggest which approaches were most effective in practice. The results only suggest that the top approaches have the most documented objective performance information. The researcher recognizes that performance across all industries may not be documented. To minimize error, the research used all project management approaches with any objective performance information documented in the comparison with the BVA.

Practices of the Project Management Approaches with Documented Performance

After the traditional project management approaches with objective performance information were identified, a more in-depth analysis was performed on them to determine the practices that these models used to improve the performance of the delivery of services [see Appendix D]. Like the process of the identifying practices of the BVA, the researcher conducted the following:

1. Reviewed traditional project management approaches' publications.
2. Documented any practice that was described.

The practices identified from the ten project management approaches are listed below with a short description:

1. Decision Making – when there is a choice between two different outcomes.
2. Documentation – anything used to store all project related information.
3. Inspection – the act of someone reviewing another person's work.
4. Iterative Execution – adjusting a project continuously throughout a project, based on new information collected.

5. Incremental Execution – the iterative process of sequential processes.
6. Collaboration/Relationships – working together to solve a collective problem.
7. Autonomy/Freedom – a person's ability to manage themselves.
8. Communication – the result of two or more people speaking with each other through in person interactions, phone calls and email.
9. Management – telling people what to do.
10. Meetings – when people come together as a group to discuss something.
11. Statistical Analyses – a mathematical model to understand a project's or company's conditions.
12. Incentives and Penalties – tools that are used to motivate employees to improve their performance.
13. Long-term contracts – legal documents used to bind two parties together over a mutual agreement.
14. Measurement – using numbers to identify what is going on.
15. Accountability – taking personal responsibility over something.
16. Transparency – is created when the least expert person understands.
17. Control – managing to ensure what needs to be done is done.
18. Planning – trying to identify the steps required to complete a project after the contract has been awarded.
19. Risk Management Planning – identifying future risks that are planned to be avoided or managed efficiently if occurred.
20. Negotiation – compromising between two parties on certain project conditions such as price, timeline, quantity or quality.

21. Sequential Execution – step by step process that does not advance to the next step, until the one previous has been completed.
22. Programming – using computers to replace the efforts of humans.
23. Prototyping – running tests on hypotheses.
24. Observation Analyses – identifying what is going on through observation.
25. Certification – award of credentials due to the passing score of a technical examination.
26. Simulations – running tests using computer modeling.

To simplify, the researcher grouped the 26 practices into three major practices. They are the following:

1. Management – telling someone what to do.
2. Technical communication – language used in communications between buyer and vendor that only these parties understand.
3. Quality Control – any inspection or verification of the quality of the vendors' work.

Comparison of the Traditional Project Management Approaches and the BVA

The next step was now comparing the identified traditional project management approaches and BVA practices.

Table 3-5

Objective Documented Performing Approaches' Practices

Traditional	Best Value Approach
PMs are the subject matter experts (management)	Project success depends on PMs ability to utilize *others* knowledge (leadership)
Project success depends on PM's technical knowledge (technical communication)	Vendors are the subject matter experts (leadership)
Documentation uses technical jargon (technical communication)	Project success depends on PMs ability to utilize *others* knowledge (leadership)
Requires technical certification (technical communication)	Documentation should have no technical jargon (non-technical communication)
PMs plan as far as they can see (quality control)	No certification required (non-technical communication)
PMs inspect and verify quality of vendors' work (quality control)	PMs do quality assurance and ensure vendors conduct quality control (quality assurance)

It appears that many of the traditional approaches' practices are similar and different from the BVA (see Appendix D, Attachment A and D for more details). Table 3-6 shows the comparison of the approaches using the simplified version of the major practices.

Table 3-6

Objective Documented Performing Approaches' Practices Simplified

Traditional	Best Value Approach
Management	Leadership
Technical Communication	Non-technical Communication
Quality Control	Quality Assurance

The major difference in the practices identified is the BVA's primary use of leadership to minimize inefficiency through the use of identifying and utilizing expertise

to create simplicity and transparency on projects. By observation, the philosophy of an approach is the main driver behind its practices. When an approach is leadership based, the following logical observations can be made:

1. Leaders understand the big picture; they are experts in their area.
2. Leaders realize that everyone else are non-experts, that is why they are the leader.
3. Leaders realize that what they understand and is simple to them, may not be to others. They realize they cannot speak in technical terms because no one will understand them. For this reason, they use non-technical language and simplicity to increase transparency.
4. Leaders realize that the sum is greater than its parts. They realize that to be efficient, they must consistently measure and align resources. This takes consistently looking into the future and being proactive.

The opposite can be observed for those approaches that have a philosophy of management, direction and control (telling other people what to do). The traditional approaches were considered mainstream and used by most project managers in their respective industries, yet do not have as much performance information documented as the BVA which is not main stream.

The BVA was also the only approach to show consistent and clear high performance on projects and services through the primary use of leadership (utilization of expertise/alignment).

It appears that the heavy use of leadership as a project manager impacts the performance of the delivery of services. This is backed by numerous research conclusions:

- The higher the servant leader index a construction company buyer has, the more profit the company makes. Take care of your people, your people will take care of the client (Badger, et.al., 2008).
- Project managers should be using leadership 60% of the time and management 40% of the time, however the default setting in the construction industry drives their use to 50-50. The company procedures and the construction contracts mandates more management. The process drives management, the individual project manager must drive leadership (Badger, et.al., 2009).
- The higher the superintendent's leadership score, the more profit his project will make (Badger, et.al., 2012).

Literature Research Conclusion

A thorough literature research study was conducted to explore the derivation of the Best Value Approach (BVA) and its practices. Six practices were identified from the BVA to be used in the project management adapted BVA. Secondly, the researcher conducted additional literature research on all project management approaches that could be found, to identify how their performance and practices compared with the BVA. 19 approaches were identified and analyzed in detail to identify practices and documented performance. Out of 19 approaches identified, 10 had documented objective performance information, and were further analyzed for the practices they utilized [26 were identified].

An analysis was conducted to identify similarities and differences in practices between the BVA and traditional approaches. The BVA had little to no similarities with the other two approaches. The major difference between the BVA and the other approaches was its primary use of leadership to reduce cost and increase performance.

For the researcher to identify if the BVA performance results can be replicated, the researcher proposes to run a case study test of its practices with an organization's project managers as a potential project management approach.

Chapter 4

STATE AGENCY CASE STUDY RESEARCH

Introduction

The literature research in Chapter 3 identified that the Best Value Approach (BVA) has the most documented performance and the highest level of performance of all the approaches identified. The BVA has traditionally been used as a procurement model, by administration and procurement personnel. In the next three chapters (4, 5, and 6), the researcher will identify how the BVA was adapted into a project management approach that was tested in a buyer's organization with a select group of project managers in its largest department.

The goal for the researcher was to identify if the project managers can implement the project management adapted BVA, and if the BVA's previously documented high performing procurement results can be replicated. It is the researcher's hope that this case study test will serve as a forerunner in the advancement of project management science, and support any future case study replications and/or modifications. This case study will explain the following in detail:

1. Current conditions of case study test [chapter 4].
2. How the case study was executed [chapter 5].
3. Major findings, conclusions and recommendations [chapter 6].

Current Conditions

The case study examined in this chapter features a buyer's organization. The buyer's organization is a large government environmental regulatory state agency. Due to confidentiality agreements, the agency and the state will not be named. This should not be an issue in terms of being able to replicate the same results.

The State Agency is one of the United States' top 18 largest states, serving a population in the millions. Its mission is to protect and enhance public health, welfare and the environment in its state. The State Agency administers a variety of programs, to improve the health and welfare of its citizens and ensures the quality of its air, land and water resources meet regulatory standards. With 400 employees managing various contaminants and pollutions in the State's environment, the State Agency strives to lead its state and the nation in protecting the environment and improving the quality of life for the people in its State (Rivera, 2016).

Problem

Over the last decade, the State Agency has tried to make the changes necessary to accomplish its mission, but has been having difficulties with the performance of their environmental professional services. Through two interviews with upper management in the Water Quality Division at the State Agency, they identified the following problems:

1. Unable to identify performance and value of vendors [environmental experts].
2. Vendors were not meeting the quality expectations of the State Agency.
3. Management requirement of the vendors was too high.

4. Inability to spend all available resources.

This State Agency in general, experienced environmental projects that are expensive, complex in nature, and often require multiple testing and invasive investigations over a period of many years before the end goal of the project can be clearly defined. This makes it difficult to clearly set expectations and plan resource requirements, causing inaccurate expectations of the time, cost, and quality of projects. The lack of important pieces of information at the beginning of a project also increases the risk of the project. This is not unique to the State Agency, but has been an issue that has plagued the environmental engineering industry and many others worldwide for decades (Vaughn and Ardila, 1993; Filipovich, 2001; Esty & Porter, 2005; International Rivers, 2005; Macek, 2006; Reuters 2009; Bo-Jie, et al., 2010; Fu et al., 2010; Buntaine, et al., 2013; Fisher, 2013; IEG, 2013; Padgett, 2014; AFP 2014).

As a result, over the past few years the State Agency has become increasingly dissatisfied, with the delivery and project management requirement of environmental professional services. With the budget continually shrinking and increasing requirements, the State Agency was in search of a solution to help them improve their management, efficiency, and performance in delivering environmental services, and minimize the issues they have been facing (State Agency, 2014).

Water Quality Department

In January 2014, the researcher was authorized by the State Agency to conduct research. The researcher was backed by a world-renowned research group at Arizona State University, called the Performance Based Studies Research Group (PBSRG) to conduct the research. The researcher was authorized to train and implement the project management adapted BVA, for the delivery of professional services on their environmental engineering projects during their 2015 fiscal year [July 1, 2014 – June 30, 2015]. To receive high performing services, the project management adapted BVA proposed the replacement of management, direction, and control (MDC) with leadership [alignment/utilization of expertise]. The case study would test the project management adapted BVA, which uses performance information to create transparency, increase accountability, increase value of expertise, and increase efficiency of the entire supply chain of professional environmental services.

The State Agency chose to test the project management adapted BVA in their largest department, Water Quality (WQD). To learn more about the department, its current conditions, how it ran and measured projects, the researcher spent 6 months [January – June 2014] collecting information through the following:

- 3 meetings with its upper management.
- 1 meeting with its project managers.

This department is responsible for identifying, assessing, and cleaning up soil, groundwater, and surface water sites contaminated with hazardous substances throughout

the state with support from state funds. In other words, the WQD identifies polluted underground water and cleans it up. The program also oversees privately funded cleanup efforts. The WQD was the only department the researcher worked with throughout the case study test.

The WQD is made up of the following:

- 2 upper management personnel [Section and Unit manager].
- 5 project managers [each has 15-30+ years of experience in environmental services, and holds at least a bachelors in geology, hydrology or environmental engineering. No other information was collected on the project managers].
- Use an indefinite delivery indefinite quantity contract (IDIQ) [multi-year contract that uses multiple vendors to deliver services].
- 26 contaminated sites throughout the state.
- Have another 28 sites that need to be verified for contamination.
- 10 vendors on the IDIQ contract.
- Have a budget of $7M for the 2015 fiscal year.

Types of Water Quality Department Work

The WQD's major responsibility is to purchase professional services to identify site locations around the state that have contaminated groundwater and clean it up. One site is considered a project. To clean up a site includes multiple phases (described below) that can take multiple years to clean up. Some sites have been ongoing for over 20 years. The researcher did not collect any specific information on how long any of the sites

lasted, nor compared their timeframes against one another. Due to the length of completing a project (site), the WQD breaks up the work into sub-projects called task orders that they issue to vendors. A single project can have one or multiple task orders ongoing at the same time. Each task order may work on one or more different phases on the path toward clean-up. The path toward cleanup is a specific process that is sanctioned by the Environmental Protection Agency. The clean-up phases are as follows (see Figure 4-1):

1. Preliminary Investigation (PI) – Conduct historical research on the past uses of the site, and review any information that may determine if there is contamination present (EnviroTools.org, n.d.).
2. List Site – When contamination of a site has been determined, the State Agency will officially add it to the list of clean-up projects.
3. Groundwater Monitoring and Assessment (GWMA) – Monitoring a site to detect if contamination becomes a factor (Encyclopedia.com, 2003).
4. Early Response Action (ERA) – Identifies human and environmental risk, and a clean-up action is performed prior to the remedial investigation (DefinedTerm.com, n.d.).
5. Remedial Investigation (RI) – Collection of site data to identify current conditions, type of contaminant, human health and environment risk, and treatment assessments to identify potential cost and performance of future clean-up activities (EPA.gov, 2017).
6. Feasibility Study (FS) – The analysis and identification of the best possible solution to conduct the site clean-up (EPA.gov, 2017).

7. Proposed Remedial Action Plan (PRAP) – Defining the purpose and objectives of the clean-up (Soilwatergroup.com, 2017).
8. Record of Decision (ROD) – Public document that identifies how a site will be cleaned up.
9. Operation and Maintenance – The construction, operation and maintenance of field tools that clean-up a site overtime.
10. Closeout/De-list – An EPA sanctioned approval that the contaminated site is no longer a threat or harmful to human life or the environment.

To complete one phase and move on to the next, vendors are required to complete clearly defined legal deliverables that must be approved by the state. Deliverables are draft and final reports, describing what was conducted on the site, what the status is, and if it met the specifications for moving on to the next phase. When a site is completely cleaned up, there is no more contamination in the ground. This is when the site is closed out and de-listed.

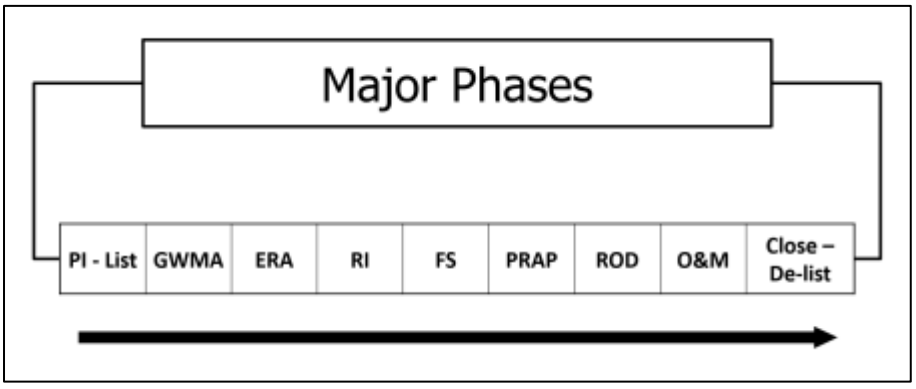


Figure 4-1 – Major Site Phases

Every fiscal year, the state will grant the WQD monies based on an initial budget request to procure vendors to perform task orders for each project. The average budget provided in a fiscal year historically ranged from $7-$14M. Task orders ranged in cost and services delivered.

The preliminary investigations are the cheapest, least work intensive and quickest phase to complete. On average the cost of the preliminary investigation ranges $10-$35K, which can last between 3-6 months. In general, vendors are expected to conduct an initial site visit to collect historical data on how it was used, take groundwater samples [use an instrument which penetrates the ground and collects soil and water for contaminant testing], and writes a less than 10-page report to identify the status of contamination.

On the opposite spectrum, a remedial investigation and feasibility study can range from $30-$300K, which can take 2-3 years to move on to the next phase. In general, vendors are expected to conduct a more invasive and thorough investigation of the site. This includes identifying the size of the contaminated water, how deep is it, the major human and environmental risks, and plan on what will be required to clean it up over a specific number of years. Often, formal reports can exceed 100 pages describing the efforts needed and vision for the clean-up of the contaminated site.

A breakout of the 54 sites and the number of phases performed have been identified below:

- 27 – Preliminary Investigation
- 3 – Environmental Response Action
- 7 – Groundwater Monitoring
- 12 – Remedial Investigation
- 12 – Feasibility Study
- 6 – Proposed Remedial Action Plan
- 1 – Record of Decision
- 8 – Operation and Maintenance
- 0 – Closeout/De-list

Benchmarked Performance Information

To know if the projects are successful each fiscal year, the WQD measures how many deliverables from each phase were produced. This is measured by counting the number of each deliverable produced for each phase per task order, then totaling them up. For the fiscal year prior to testing the project management adapted BVA, the WQD identified a total of 69 task orders that produced 9 deliverables at a cost of $5.5M, with 7 WQD project managers (see Table 4-1).

Table 4-1 – Major Phase Deliverables

No.	Criteria	FY15
1	PI sites listed	0
2	Total number of PI reports completed	0
3	Total number of RI reports completed	3
4	Total number of PRAP reports completed	1
5	Total number of FS reports completed	3
5	Total number of ERA reports completed	1
6	Total number of ROD reports completed	1
-	**Total**	**9**

In the next chapter, the researcher will describe in detail the project management approach practices the WQD project managers used prior to the implementation of the project management adapted BVA. Next, the researcher will describe what practices were changed from the original project management approach, and what new project management adapted BVA practices were used instead.

Chapter 5

STATE AGENCY SHIFT IN PROJECT MANAGEMENT APPROACHES

Introduction

In this chapter, the researcher will describe the shift in project management approaches that the Water Quality Department (WQD) experienced during the 2015 fiscal year. The process the researcher used to implement the project management adapted BVA at a high level was as follows:

1. Choose organization:
    a. Identify a willing buyer organization to test approach out with its project managers (see Chapter 4).
2. Identify Current Conditions:
    a. Meet with buyer organization upper management at least one time, to determine a department's project managers that the test will take place (see Chapter 4).
    b. Identify current conditions of the department's budget, type of work, vendors, contract system, methodology of project management, uniqueness of each project manager, policies and procedures (see Chapter 4).
    c. Identify the differences of how task orders are ran and the project management practices used, compared to the project mangement adapated BVA (see How State Agency Setup and Ran Projects section in this Chapter).

3. Provide Education:
    a. Provide education for chosen department project managers, and its list of vendors on the new approach of running task orders (see explanation on page 69).
4. Measure Performance:
    a. Document performance of task orders from begginning to end (see explanation on page 107).
5. Conduct Analysis:
    a. Collect all the documented performance and identify the differential between the previous year of the test and the test year (see Chapter 6).
6. Identify Conclusions:
    a. If the differential was significnat, the researcher proposes it was successful and a continuation of use of the project management adapated BVA was warranted for futher testing (see Chapter 6).

How State Agency WQD Setup and Ran Task Orders

Fiscal Year 2014

Prior to the test year (fiscal year 2014) of the project management adapted BVA, the WQD conducted their task orders as follows:

1. Project selection: upper management would review their alloted budget, and identify which of the 54 sites would be selected to provide task orders to vendors.
2. Project prioritization: upper management would identify which of the 54 sites were most important by priortizing them based on need.

3. Task order identification: once the projects (sites) were prioritized, upper management would identify the task orders they wanted to be completed.
4. Task order assignment: Once the task orders were identified, the upper management would assign them to the project managers.
5. Task order setup: The project managers were responsible to:
    a. Develop the scope of work for the task order, based on the needs identified by upper management.
    b. Identify how much they were willing to spend for the scope of work, and how long it should take.
    c. Select a vendor of their choice from the IDIQ contract.
6. Task order award and execution: The selected vendor would be awarded the task order and execute it collaboratively with the WQD project manager througout the entire task order.

The timeframe to conduct all these steps was not collected by the researcher. Interestingly, the researcher identified that there was not a standard process on the management and setup of the task orders. Each project manager developed and managed the scope of work, costs, and schedule differently. The researcher did not collect any detailed information on the differences of each way the project managers set up and managed their task orders. No comparison was able to be made; only generalizations by observations made by the researcher. Observational differences in management from each project manager are as follows:

- Some spoke more frequently to their vendors than others.

- Some requested task order status reports bi-weekly, and others monthly.
- Some were hands and visited the sites throughout the task order to inspect work, and others did not.
- Some used more information than others, when making critical decisions on the direction of the cleanup.

Fiscal Year 2015

During the test year (fiscal year 2015), the WQD implemented the following adjusted structure to identify and award task orders:

1. Project selection: upper management would review their alloted budget, and identify which of the 54 sites would be selected to provide task orders to vendors.
2. Project prioritization: upper management would identify which of the 54 sites were most important by priortizing them based on need. The priority of needs from greatest to least are the following:
    a. Groundwater contamination identified.
    b. Contaminated groundwater was used for drinking.
    c. Drinking water well has been affected or threatened.
    d. All other operational sites.
3. Task order identification: once the projects (sites) were prioritized, upper management would identify the task orders they wanted to be completed.
4. Task order assignment:
    a. Vendor: The task orders were issued to each vendor, using a round robin selection. This was due to every vendor being recognized equal at the start

of the test, and to ensure all vendors received equal amounts of work. The test would document perfomance during first year, to use as the differenting factor for task order selection and amount of work provided during the second year of testing.

b. Project Manager: once the vendor selection was completed, the project managers were assigned which task order they would manage.

5. Task order setup:
    a. The problem with the project (site) was provided by the WQD to the vendor.
    b. The vendor was expected to respond with a solution.
    c. The solution was a full plan that included the following set of documents:
        i. Scope of work.
        ii. Detailed and milestone schedule.
        iii. Risk mitigation and management plan.
        iv. Client action items.
        v. Performance measurements of success.
        vi. Weekly Risk Report.
    d. The vendor's plan had to be approved by the WQD upper management and assigned project manager in a clarification meeting.
6. Task order execution: Once the plan was accepted by the WQD, the vendor would execute the task order and report on the schedule and cost deviations on a weekly basis to their assigned project manager. Collaboration with the WQD project manager througout the entire task order was discouraged.

Using the new structure to run the task orders, the responsibility of the task order, its vision and what it produced, was shifted from the WQD project manager to the procured vendor. This allowed the WQD project manager's to rely more on the expertise of the procured vendors (in terms of scope, schedule, budget) than previously done.

State Agency Traditional Project Management Approach

Prior to the implementation of the project management adapted BVA practices with the WQD's project managers, a different set of practices were used to manage the delivery of environmental services. In this section, all WQD practices were verified by meeting with all 5 project managers and 2 upper managers (see Chapter 4). The traditional project management practices that was used by the WQD project managers are as follows:

1. Management, Direction and Control
2. Technical Communication
3. Quality Control

Defining Key Terms

In this section, the researcher will define each key practice. The information collected was through meetings with each project manager 10 times, to identify how they managed their task orders. Meetings were not formal, and did not use prevously formulated questions. The definitions are as follows:

1. Management, Direction and Control – WQD project manager telling the vendor what to do.

2. Technical Communication – any form of communication (verbal, written or tool) that was detailed and complex, which requires technical training/education or knowledge in a certain area to understand.
3. Quality Control – any inspection or verification of the quality of the vendors' work.

Management, Direction and Control

Management, Direction and Control consisted of the following practices by the WQD project managers:

- Choosing which vendor should conduct a task order.
- Determining the scope, cost, and timeframe of each task order based upon their technical experience and understanding of the site.
- Directing the vendor on how to carry out a deliverable for the task order.
- Directing the vendor on what to do if something unforeseen occurred on the task order.

Technical Communication

Technical communication consisted of the following practices by the WQD project managers:

- Were expected to know all the technical details of every task order.
- Were expected to discuss the technical details and detailed plan with the vendor.

- Were required to make technical decisions on the task order, and to explain it to the upper management. For example: how much or how many types of cleaning agents should be used on a site to clean it up.

Quality Control

Quality Control consisted of the following practices by the WQD task order managers:

1. Inspection of the vendor's work and directing them on how to adjust it.
2. Explaining to the vendor why a part of their work was not acceptable, did not meet the technical standard and ensure that they fixed the work in a timely manner.

Key Practices Conclusion

The success of this process was based off the WQD project managers' expertise and experience. The researcher did not collect any specific examples on each of the practices, but gathered the information through the informal meetings conducted with the WQD project managers (see Chapter 4).

State Agency Project Management Adapted BVA Implementation

During the 2015 fiscal year (test year), the researcher implemented the project management adapted BVA practices with the WQD's project managers. In this section, the researcher will describe in detail the change in practices from the previous year (before) to the test year (after), and what the difference was in terms of metrics (see Table

5-16 on page 107). The project management adapted BVA practices used by the WQD project managers was the following:

1. Leadership
2. Non-technical Communication
3. Quality Assurance

Defining Key Terms

In this section, the researcher will define each key practice.

1. Leadership – WQD project managers identifying and utilizing the expertise of their IDIQ vendors to deliver services.
2. Non-Technical Communication – any form of communication that was simple and easy (written, verbal, process or tool), which does not take previous education and training or knowledge in an area to understand.
3. Quality Assurance – ensure that the vendor has a plan before they begin a task order, and they can explain the progress and changes to the plan throughout the execution of it.

No other traditional project management practices were changed, other than the ones identified in this section.

Implementation of Project Management Adapted BVA

In order to implement the changes identified with the WQD project managers, the researcher had to conduct the test in two phases. They are as follows:

1. Education and training (January to June 2014).
2. Execution and monitoring (July 2014 to June 2015).

First the researcher provided education and training, during the last six months of fiscal year 2014 (January – June). The researcher provided the following types of education:

1. State Agency basic best value approach theory (two 2 hour trainings).
2. State Agency advanced best value approach theory (two 2 hour trainings).
3. Vendor basic best value approach theory (one 2 hour training).
4. State Agency project management approach shift and responsibilities (one 2 hour training).

The basic and advanced best value approach theory educations, explained to the WQD and their IDIQ vendors the logic behind the project management adapted BVA. The logic can be best understood by refering to the Information Measurement Theory and Best Value Approach manuals, authored by Dr. Dean Kashiwagi (Kashiwagi, 2016). The project management approach shift and responsibilities education to the WQD, provided them with the differences that will be taking place, and what they need to do to be successful. Success was suggessted through 1) not deviating from the prescribed practices, and 2) seeking help from the researcher if confusion arises. The education and

training provided the researcher with more insight into the ways each WQD project manager and vendor prefered managing their task orders, any reservations they had, and how best to help them overcome the discomfort of making new changes to their mode of operation.

Second, the researcher supported the initial set up of the changes and monitored for quality assurance. This next section will describe in detail how each shift in project management practices were conducted by the project managers. They will be explained in the following order:

1. Leadership
2. Non-Technical communication
3. Quality Assurance

Leadership

The project management adapted BVA identified that the vendors must now become the responsible party in terms of the direction a task order must move to be successful. This changed the WQD's project managers' responsibilities to the following practices:

- Vendor Selection:
    - Previous practice (before):
        - The State Agency did not have a standard system that identified which vendor should receive a task order. Vendors were chosen for task orders based on relationship. There was no written

documentation or explanation on how they chose vendors for task orders.

    - New practice (after):
        - A new structure to select vendors and distribute work was done through a round robin approach that could be modified only based on performance information (see page 75 for more details).

- Developing Scope of Work:
    - Previous practice (before):
        - The WQD project manager would develop a scope of work for each task order, and give it to the vendor when they were selected for a task order. For an example see page 75.
    - New practice (after):
        - The new practice after the test year started was the WQD project manager would not develop a scope of work, and would require the vendor to develop the scope of work after they were selected for a task order. The vendor would only be notified of the site the task order would take place on. (See page 76 for example).

- Direction:
    - Previous practice (before):
        - First, the WQD project manager would meet with the selected vendor at least 1 time, to identify how a deliverable for a task order would be carried out. The WQD project manager would usually meet with the vendor multiple times, however, no documentation

was kept determining exactly how many meetings the project managers would have.

- Second, the WQD project manager would send communication (email, phone call), if a submitted deliverable needed to be changed. They would explain what needed to be changed and the best method to change it.
- Third, the WQD project manager would send communication (email, phone call) to the vendor, when something unforeseen happened on the task order. They would identify what needed to be done.
- WQD did not measure how much these three actions would occur on a task order. All project managers and upper management agreed that they would take place, but the amount would vary depending on the project manager. One of the weaknesses of the study was that it identified a change, but does not measure the magnitude of the change from the traditional way the WQD would manage.

- New practice (after):
  - The WQD project manager would not meet with the vendor to identify how to carry out a deliverable. Instead, the vendor would clarify, during task order setup (see page 64), how they were planning on carrying out the deliverable.

        - Second, instead of the WQD project manager communicating with the vendor on what was wrong about their submitted deliverable and how to adjust it, they simply provided the vendor with a pass or fail measurement (see page 78 for more details).
        - Lastly, instead of telling the vendor what to do when something unforeseen happened on a task order, no direction was provided. It was now the responsibility of the vendor to identify what was going on, what their plan was to fix it, and the impact to schedule and cost (see page 80 for more details).
- Upper Management Support
    - Previous practice (before):
        - Upper management was unable to identify task orders' performance, progress and which task orders had the most risk. To find out information, they spoke to each of their project managers.
    - New practice (after):
        - Upper management was sent a Director's report each week that contained performance metrics on each task order; allowing them to identify the amount of risk on each task order using the metrics. This helped them prioritize which project managers needed the most help on their task orders, without having to discuss the details with the project manager.

Vendor Selection

Prior to the test year, the researcher identified that the WQD project managers did not have a set structure to select vendors. Therefore, the researcher was unable to conduct and analysis of the previous practice and the adjusted practice.

In this section, the researcher will identify the new structure that was developed. At the start of the implementation of the project management adapted BVA the vendors were unable to differentiate themselves by their performance. None of the vendors had documented sufficient performance information to differentiate themselves. Due to the inability of the vendors to differentiate themselves for the first year, the State Agency decided to assume all vendors had the same level of expertise and used a round robin (rotational) system to divide the task orders. The round robin system is depicted in Figure 5-1 and Table 5-1 (see Attachment F). The only reasons a vendor would not receive a task order was due to:

1. The vendor declined the task order.
2. The WQD had information that caused doubt in a vendor's ability to perform. An example is one vendor was in the middle of a lawsuit for actions taken on a previous site that work was performed. For this reason, the WQD could not legally allow that vendor to continue work on that specific site.

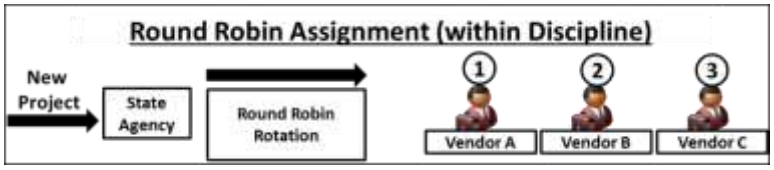


Figure 5-1. Round Robin Selection Tool

Table 5-1

Round Robin Selection Tool

Order	Vendors	Task Orders	Vendor
1	A	1st Street	A
2	B	2nd Street	B
3	C	3rd Street	C
4	D	4th Street	D
5	E	5th Street	E
6	F	6th Street	F
Next Vendor in Line:		7th Street	A
C		8th Street	B

The only way the round robin structure would be overrode, was if the WQD had dominant performance information that could be used as justification to keep a specific vendor on a site. Once all the vendors were assigned which task orders they would have, it was their responsibility to develop a scope of work for it. In summary, the State Agency went from no structured methods to select a vendor to one new structured method to select a vendor.

Development of Scope of Work

In the previous year prior to the test, the WQD would write the scope of work for the selected vendor to adhere to. It was expected that the selected vendor would rely on the expertise of the WQD project manager to clear up anything that they did not know

how to do, and collaborate as a team until the completion of the task order. The researcher has provided a sample scope of work below (modified to protect the identification of the State Agency and WQD) (see Attachment G):

Sample Scope of Work

Work will detail and evaluate environmental conditions at the property. This evaluation will utilize the collection and analysis of samples of media at the property such as: soil, sediment, soil vapor and/or groundwater. A determination of what media to sample will be dependent upon the RECs identified in the *work*. The results and data collected from sampling at the property will be used to confirm and quantify the presence of environmental contamination.

If contamination is confirmed and the levels of contaminants are known, an assessment of potential risks to human health and the environment may be conducted to determine how people and/or the environment could be affected. This assessment of potential risk will be based upon a comparison with state or federal cleanup standards. Such assessment will aid in evaluating whether or not contaminants on the property pose any unacceptable environmental or health risk. If an unacceptable risk is determined to exist, the vendor will be asked to propose potential costs to further delineate contamination. While the *work* may evaluate the degree of contamination and the potential impacts on health or the environmental by exposure to contamination, it is not expected to provide sufficient information to estimate the exact quantity of waste or the cost for cleanup.

The *work* will satisfy requirements under EPA *guidelines* Final Rule. *Work* will necessitate preparation of a Sampling and Analysis Plan that will be reviewed and approved by State Agency and EPA. The vendor performing the *work* is expected to use accepted industry practices such as *State guidelines* or its equivalent.

In the sample, the WQD was assuming the role of the expert, in terms of identifying what was required from the vendor.

In the test year, the vendor created the scope of work in the task order setup. The vendor created the scope of work through the following process:

1. WQD would send the vendor a notification of the site they would perform a task order on.

2. Vendor would visit the site and review historical data to get an understanding of what had been done, and what needed to be done to advance the site toward cleanup.
3. The vendor would contact the previous vendor who worked on site to collect more information.
4. The vendor would request any additional information from the WQD project manager that could only be accessed through the State.

This process took two weeks on average. Once complete, the vendor would develop the full scope of work (included scope, schedule and budget). An example of the vendor generated scope of work can be viewed in Attachment H.

Direction

In the previous year before the test, the WQD provided direction on:

1. How a vendor should carry out a deliverable.
2. What was required to adjust a submitted deliverable that did not meet their requirement.
3. How a vendor should respond when something unforeseen occurs on a task order.

The way that the WQD project managers would conduct these three items was through email or verbal communication. The researcher did not collect any samples of previous emails from the project managers, directing their vendors. All information was received from interviewing the project managers.

In the test year, the WQD project managers were not to use any written or verbal communication to direct the vendors on what to do. What they did was the following:

First, instead of telling the vendors how they should carry out a deliverable, the project manager now was only receiving how the vendor expects to do it. This was done before they meet in the task order setup. The WQD project manager uses a pass/fail form to identify if the proposed execution of the deliverable(s) was accepted (see Attachment I). The WQD project manager would fill out the pass/fail form in the meeting. Table 5-5-2, was the form that was printed and filled out by the WQD project manager during the task order setup meeting. The researcher was at every task order setup meeting to ensure the vendor was not directed on how to carry out the task order. To pass and receive an award, a vendor needed a 100% pass rate. If the vendor failed, they had one week to make any adjustments and try again. If they failed a second time, they were at risk of the task order being transferred to the next vendor in the round robin.

Table 5-2

WQD Task Order Setup Meeting Pass/Fail Form

Vendor Plan Pass/Fail Form	
Scope	**(Pass/Fail)**
Simple/Non-technical	-
Summary	-
Vendor's Plan	-
List of deliverables	-
Milestone Schedule	**(Pass/Fail)**
Major Deliverables	-
Major Milestones	-
Client Action Items	-
Performance Metrics	**(Pass/Fail)**
Understandable & Clear Metrics	-

RMP	(Pass/Fail)
Risk	-
Risk Vendor does not control	-
Estimated Impact	-
Timeframes	-
Plan of Action if Risk occurs	-
Mitigation Plan	-
Client Expectations	-

Second, instead of telling a vendor when a deliverable was not done correctly, and what was required to adjust it, the WQD project manager would rate the vendor's deliverable and identify the number of times it had to be revised in the Weekly Risk Report (see Attachment J).

Table 5-3 is a tab within a larger spreadsheet called the Weekly Risk Report. It is submitted weekly to the WQD project manager. When the project manager receives a deliverable, it either receives a pass or fail. If the deliverable was rated as a fail, the vendor was responsible to figure out what was required to adjust it to meet the pass qualification. Each week, the vendor was required to document in the Weekly Risk Report performance tab, how many deliverables they submitted, how many revisions were required to pass, and the project manager's overall satisfaction of their submitted work.

Table 5-3

Weekly Risk Report Performance Tab

No	Baseline Metrics	Metric
1	Milestone deliverables	
2	Revisions required on milestone deliverables	
3	Hours requiring ADEQ support	
4	Client Satisfaction	

Finally, instead of identifying how a vendor should respond when something unforeseen occurred on a task order, the vendor was required to submit detailed information on each occurrence in the Weekly Risk Report. Table 5-4 is what the vendors were required to submit to their project manager. It includes the date of the unforeseen occurrence, their plan to manage the occurrence, when they expect it to be completed, and what the time and cost impact of it was. By using this format, it allows the vendor to be more proactive and accountable over their task order.

Table 5-4

Risk Tab

Date Entered	**Risk Items**	**Plan to Minimize Risk**	**Date Resolved**	**Impact to Critical Path**	**Impact to Cost**	**Entity Responsible**
3/17/2015	Subject Matter of Risk	**(1)** Problem background - Why is this a risk for the task order? **(2)** What will be done to minimize this? **(3)** Who is responsible for the plan? **(4)** What kind of impact will this have?	3/25/2015	0	$ -	Client

Upper Management Support

In the previous year before the test, the upper management did not have a set structure to identify task order performance, progress and which one was at most risk. To figure out what was happening, they spent time in their weekly project management meetings discussing the details of project to try and identify which task order was at the most risk. Project management meetings lasted two hours.

In the test year, the researcher developed a Director's Report to help the project managers and the upper management at the State Agency WQD quickly identify the task order performance, progress, and which one was at most risk. This report was created once a week, and used as the structure for conversation in the weekly project management meetings. As a result, the project management meetings were minimized from two hours to thirty minutes. This was due to the upper management having the ability to focus on information that was most important and readily available through the report.

When all the WRRs were collected each week by the WQD project managers, they were compiled to create the Director's Report. The Director's Report was an excel spreadsheet that includes (see Attachment K):

- Overview Tab: identifies the overall task order performance (compiled budget, deviations, risks, change orders, and responsible parties).
- Discipline Tab: breaks each of the task orders by major type of work (discipline) and allows the State Agency to compare one against the other.
- Vendors Tab: identifies all vendor performance in terms of on time/on budget and compares them with each other.
- Budget Tab: identifies the entire WQD budget in terms of vendor budget, change order amount, budget spend rate and projected spend rate. High-level compilation of WQD budget.
- Riskiest Tab: identifies the riskiest WQD sites and vendors in terms of number of unresolved risks that have occurred on the task orders.

- Risks Tab: compilation of all the task order risks in one tab that was easily sortable. Upper management can quickly review detailed explanations from identified sites in the riskiest tab.
- Progress Reports Tab: compilation of the task orders last week of progress report entries. This allows management to see at a high level, what all the task orders have been doing in the prior week.

The Director's Report was created to ensure all the task orders were performing and can be easily seen together in one spreadsheet. Figure 5-2 shows the flow of the Director's Report. Every Friday, each vendor was responsible to submit an updated version of their WRR to the researcher for compilation and copy their WQD project manager. After the researcher compiled the DR, the researcher would attend each Monday morning project management meeting at the State Agency WQD. The researcher only participated when verification of information or additional details were requested by upper management. Following the project manager meeting, the DR would be published on the State Agency WQD/PBSRG website. Figure 5-2 shows the flow of the DR process.

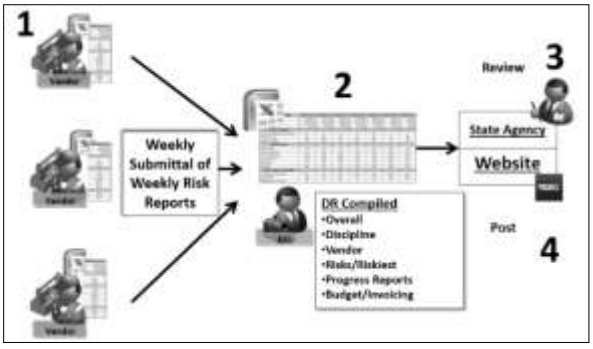


Figure 5-2. Director's Report Flow Chart

Table 5-5 shows how upper management was able to use the DR to now identify the major criteria of on time/on budget and major cause of deviation very quickly and compare each vendor.

Table 5-5

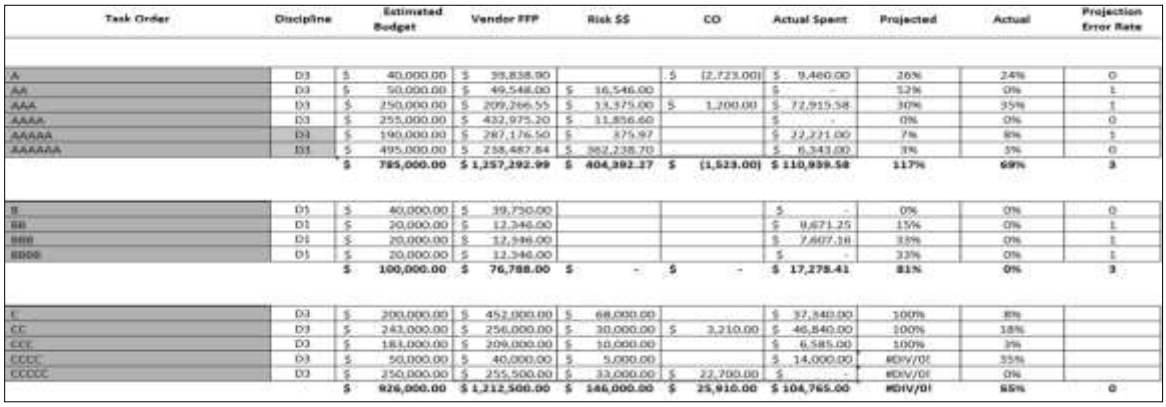
Vendors Tab

Vendor	A	B	C	D	E	F	G
Original projects budget	**$1,257,291**	**$150,329**	**$113,800**	**$1,212,500**	**$2,151,800**	**$287,529**	**$199,905**
Original project duration	**1568**	**624**	**597**	**1121**	**3589**	**1160**	**1023**
Project Performance							
Total Number of Projects	**6**	**4**	**5**	**5**	**15**	**7**	**5**
Customer Satisfaction	**8.0**	**6.3**	**4.8**	**9.9**	**9.2**	**9.6**	**8.0**
% projects on time	83%	100%	80%	100%	100%	100%	40%
% projects on budget	100%	100%	100%	80%	100%	86%	100%
Average Project Performance							
% Over Awarded Budget	**-0.29%**	**0.00%**	**0.00%**	**1.10%**	**-0.20%**	**1.37%**	**0.00%**
% over budget due to Client	0.00%	0.00%	0.00%	1.85%	0.00%	0.00%	0.00%
% over budget due to Vendor	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
% Delayed	**4.96%**	**0.00%**	**4.80%**	**-3.25%**	**0.00%**	**-3.42%**	**7.53%**
% Delayed due to Client	0.00%	0.00%	4.80%	-1.95%	0.00%	0.00%	6.65%
% Delayed due to Vendor	-0.36%	0.00%	0.00%	-1.30%	0.00%	-3.42%	0.00%

Additionally, Table 5-6 shows how upper management can quickly compare each of the vendor's costs, change orders, projected and actual spend rates, and vendor projection error rates with one another. This quickly allowed the upper management to spot any issues in their budget projections.

Table 5-6

Budget Tab



Task Order	Discipline	Estimated Budget	Vendor FFP	Risk $$	CO	Actual Spent	Projected	Actual	Projection Error Rate
A	D3	$ 40,000.00	$ 39,838.90		$ (2,723.00)	$ 9,460.00	26%	24%	0
AA	D3	$ 50,000.00	$ 49,548.00	$ 16,546.00		$ -	52%	0%	1
AAA	D3	$ 250,000.00	$ 209,266.55	$ 13,375.00	$ 1,200.00	$ 72,915.58	30%	35%	1
AAAA	D3	$ 255,000.00	$ 432,975.20	$ 11,856.60		$ -	0%	0%	0
AAAAA	D3	$ 190,000.00	$ 287,176.50	$ 375.97		$ 22,221.00	7%	8%	1
AAAAAA	D3	$ 495,000.00	$ 238,487.84	$ 362,238.70		$ 6,343.00	3%	3%	0
		$ 785,000.00	**$ 1,257,292.99**	**$ 404,392.27**	**$ (1,523.00)**	**$ 110,939.58**	**117%**	**69%**	**3**
B	D1	$ 40,000.00	$ 39,730.00			$ -	0%	0%	0
BB	D1	$ 20,000.00	$ 12,346.00			$ 9,671.25	15%	0%	1
BBB	D1	$ 20,000.00	$ 12,346.00			$ 7,607.16	38%	0%	1
BBBB	D1	$ 20,000.00	$ 12,346.00			$ -	33%	0%	1
		$ 100,000.00	**$ 76,788.00**	**$ -**	**$ -**	**$ 17,278.41**	**81%**	**0%**	**3**
C	D3	$ 200,000.00	$ 452,000.00	$ 68,000.00		$ 37,840.00	100%	8%	
CC	D3	$ 243,000.00	$ 256,000.00	$ 30,000.00	$ 3,210.00	$ 46,840.00	100%	18%	
CCC	D3	$ 183,000.00	$ 209,000.00	$ 10,000.00		$ 6,585.00	100%	3%	
CCCC	D3	$ 50,000.00	$ 40,000.00	$ 5,000.00		$ 14,000.00	#DIV/0!	35%	
CCCCC	D3	$ 250,000.00	$ 255,500.00	$ 33,000.00	$ 22,700.00	$ -	#DIV/0!	0%	
		$ 926,000.00	**$ 1,212,500.00**	**$ 146,000.00**	**$ 25,910.00**	**$ 104,765.00**	**#DIV/0!**	**65%**	**0**

Table 5-7 shows the Riskiest tab, which was one of the final ways the DR was used by the WQD upper management. A task order was considered risky depending on how many unresolved risks (deviations to task order schedule and budget) were not resolved. This would help upper management quickly see which task orders had issues, and could converse with their project managers on the vendor's course of action to resolve the issue.

Table 5-7

Riskiest Tab

No.	Vendor	Task Order	Risk Level
1	Vendor A	Task Order 1	1.34
2	Vendor B	Task Order 2	0.40
3	Vendor C	Task Order 3	0.13
4	Vendor C	Task Order 4	0.00
5	Vendor C	Task Order 5	0.00
6	Vendor C	Task Order 6	0.00
7	Vendor B	Task Order 7	0.00
8	Vendor B	Task Order 8	0.00
9	Vendor B	Task Order 9	0.00

Conclusion

In the WQD's traditional project management model, management, direction, and control (MDC) was a critical responsibility of the project manager (PMI, 2000). This was due to the project manager assuming the position of the expert (the project manager taking accountability for the performance of the task order). Now that the project manager was utilizing expertise, the vendor now becomes the expert that will take accountability for the success of the task order.

Under the project management adapted BVA, the WQD project managers were no longer responsible for any of the MDC activities identified on page 65. The responsibility for knowing what to do, how to do it, and ensuring that it was correct and acceptable was moved to the vendor.

The project management adapted BVA recognizes that to an extent the WQD project managers had information important to the task order that the vendors did not have. To shift from MDC to leadership, did not mean the project manager could not share information with the vendor; it only meant that the project manager did not tell the vendor what to do and how to use the information. The WQD project manager only relayed information to the vendor when:

1. The vendor requests the information.
2. The vendor had identified their plan of action and the project manager had questions or concerns with the plan or direction of the task order.

Table 5-8 summarizes the change results from shifting the management practices to leadership practices.

Table 5-8

Summary of Management vs. Leadership Change

Practices	Before	After	Documentation Support
Vendor Selection	WQD had 0 structured process.	WQD had 1 new structured process developed from project management adapted BVA.	Attachment F: Round Robin Selection Method
Developing SOW	WQD project manager developed 100% of the scope of work.	WQD project manager ensured the vendor developed 100% of the scope of work.	Attachment G: Sample PM Scope of Work Attachment H: Sample Vendor Scope of Work
Direction	WQD project manager directed the execution of deliverables, what to do if they were not completed correctly, and the plan to resolve any unforeseen occurrences on a project.	WQD project manager received from the vendor the execution of deliverables, what to do if they were not completed correctly, and a plan to resolve any unforeseen occurrences on a project.	Attachment I: Task Order Setup Meeting Pass/Fail Form Attachment J: Weekly Risk Report
Upper Management Support	WQD project managers did not have 1 report on the task orders' progress, performance, and which ones were at risk.	WQD project managers had 1 report on the task orders' progress, performance, and which ones were at risk.	Attachment K: Director's Report

The researcher realized that the main purpose and benefits of the leadership practice are as follows:

1. Moves accountability of who was the most qualified to complete the work to the vendor.
2. Moves accountability for the success of the task order to those that perform the work (vendor).

3. Requires the project manager to be informed of all changes to the task order.
4. Enables the project manager to voice any concerns with the vendor's actions before any work was performed.

Non-technical Communication

Previously, the WQD project managers were responsible to understand the technical work of the vendor's due to their responsibility to MDC. The project management adapted BVA now required the project managers to ensure that whenever the vendor relayed information it was simple and non-technical. Instead of caring about the technical details of the vendor's work, they now cared that the vendor could explain what they were doing to people who had no knowledge of the task order and the technical work being performed. The project manager now became more concerned with how the vendor's work interacted and affected anything outside of the vendor's responsibility. Technical information was identified as (Rivera, 2016):

1. Requires technical training/education to understand.
2. Requires knowledge in a certain area to understand.
3. Detailed and complex.
4. Focused on the technical work instead of the impact and interaction the work will have on anything outside of the vendor's responsibility.

The project management adapted BVA made certain the WQD project managers were also responsible to ensure that any information exchanged between parties in a task order was simple and understood by everyone. Thus, the project manager became the

mediator of information, ensuring that all stakeholders relayed information that was non-technical.

Non-technical Communication consisted of the following change in practices by the WQD project managers:

- Communication:
    - Previous practice (before):
        - The WQD project manager was required to know all the technical details of every task order, to understand what the vendor was doing. They also were the person in charge of making technical decisions on the task order.
    - New practice (after):
        - The WQD project manager no longer needed to know any technical information, since the project manager no longer made any technical decisions on the task order.
- Simplifying Administrative/Business Processes:
    - Previous practice (before):
        - The WQD project managers did not have a simple way to display their internal processes, so that all stakeholders understood the protocol without prior understanding or education.

- New practice (after):
    - The WQD project managers developed new internal process charts to help all stakeholders understand the protocol without any education provided.

Communication

In the previous year of the test, the WQD project managers were expected by upper management to be subject matter experts on each task order. They were expected to understand all the technical details, so they can ensure all technical decisions on the task order were in the best interest of the State Agency. This knowledge was gained through interviewing the project managers about the previous year.

The shift the State Agency project managers made in the test year, was no longer needing to know any technical details on the task order, because they were no longer making any technical decisions regarding the best way to execute the work performed. The vendor now was required to identify why their technical decisions were in the best interest of the State Agency, upfront before the task order was awarded in the task order setup meeting. For upper management to avoid any risk from the executive management (those in charge of all the State Agency departments) that the project managers no longer needed to understand the technical details of the task order, the researcher implemented the Weekly Risk Report (see Attachment J), which documented all technical information.

The Weekly Risk Report (WRR), is an excel spreadsheet that the vendor filled out to document the task order (see Attachment J). The WRR was used as follows:

- Submitted weekly by vendor to the WQD project manager.
- Includes a weekly progress report pertaining to major deliverables, milestone schedule, risks that occur on task order, risk management plan, invoice and price schedules, and a final report showing overall task order progress and performance.

The WRR does the following for the WQD project manager:

- Alleviates the WQD project manager from knowing any technical details of each task order and what responsibilities the project manager must do. All this information was included.
- Weekly informs the WQD project manager on progress and performance of task order.
- Helps the WQD project manager perform quality assurance to make sure the vendor was doing what they said they would (see next section on page 100).
- Increases accountability of the vendor, requiring the vendor to be proactive and notify the WQD project manager, instead of the WQD project manager having to MDC the vendor due to not knowing what was going on.

The WRR spreadsheet contains the following tabs:

- Task order Setup Tab: basic information of task order and contact information.

- Progress Report: a weekly report on the major activities the vendor conducted the week prior, and any major issues they believe the WQD project manager should be aware of.
- Schedule and Budget Tab: identifies the milestone schedule and any change orders on the task order.
- Risks Tab: identifies all risk (what the vendor does not control) that was occurring on the task order. It provides a description of the risk and how the vendor will manage it, date expected to resolve the risk, and impact to cost and schedule.
- RMP Tab: identifies the plan of the vendor's foreseen potential risks on the task order and how they will mitigate and manage it, and an estimated impact to cost and schedule.
- Performance Metrics Tab: identifies the performance metrics the client wants the vendor to track, as well as any additional metrics the vendor tracks to differentiate themselves and show high performance.
- Invoice and Price Schedule Tab: identifies the cost break out of each major deliverable, and when and how much the vendor will invoice the client.
- Final Report Tab: identifies the initial cost and schedule, and reflects any deviation to it, as well as what party was responsible (vendor, client, unforeseen, other).

Table 5-9 shows an example of a milestone schedule that includes the major tasks on a task order from beginning to end including stakeholder responsibilities. This helps the WQD project manager quickly see what the vendor expects from them, what major

tasks were being completed, the progress of each task, and when they can expect final deliverables. Additionally, if a deviation occurs, the actual schedule quickly assists the WQD project manager to see if the critical path has been affected.

Table 5-9

Milestone Schedule

#	Activity	% Complete	Initial Schedule	Actual Schedule	Risk Sr.#
1	Start Ground Water (GW) Sampling	100%	03/02/16	03/02/16	-
2	End GW Sampling	100%	03/30/16	03/22/16	1
3	Draft Monitoring Memo	100%	05/16/16	05/16/16	1
4	Monitoring Memo Comments	80%	05/23/16	05/23/16	1
5	Finalize Annual Memo	25%	06/10/16	06/10/16	1
6	TO Completion Date	81%	06/30/16	03/22/16	1

Table 5-10 is an example that shows a weekly progress report on all vendor activities relating to task order completion and any upcoming State Agency responsibilities.

Table 5-10

Weekly Progress Report

Task Order Weekly Update History Log		
Week #	**Date**	**Notes**
1	2/5/2016	~ task order administration ~ preparation for field sampling ~ laboratory coordination
2	3/11/2016	~ task order administration ~ received TO#88 on 3/3/2016 ~ Conducted groundwater sampling ~ laboratory coordination
3	3/18/2016	~ task order administration ~ received TO#88 on 3/3/2016 ~ Conducted groundwater sampling
4	4/8/2016	Final invoice sent 4/6/16, final WRR

As discussed in the sub-practice *"upper management support"* of the leadership section on page 80, the Weekly Risk Reports were consolidated into a single Director's Report for upper management by the researcher. The Weekly Risk Report was not referred in the weekly project management meetings, unless the upper management wanted to consider the technical details that was documented.

Simplifying Processes

During the previous year before the test, the WQD's administration processes and business procedures with the vendors were not displayed in a simple way that did not require education to understand. Additionally, the processes were understood differently from each project manager, upper management, vendors, and other stakeholders. This caused confusion of the processes. The following three processes were not being conducted properly due to this issue:

1. Submitting invoices to the State Agency.
2. Submitting change orders to the State Agency.
3. Documentation and updates of accurate budget projections.

In the test year, the researcher did the following to correct this issue:

1. Met with all the stakeholders at least one time (project managers, procurement, upper management, vendors), to understand what they understood about the way the process was to be implemented correctly. Anything changes that were made, were those that upper management overrode.
2. Created business process charts to summarize processes.

3. Presented the new business process charts to all the stakeholders during the project management meetings (see Attachment L).
4. Collected any new comments and adjusted.
5. Finalized the simplified process charts and released to all the stakeholders.

Invoicing

The invoicing process originally was lacking uniformity. Invoicing was an important WQD project management function, because they were responsible for submitting all the invoices for their task orders for payment. Interestingly, there was not set process by which the project managers would deal with invoicing. Vendors submitted invoices to whomever the WQD project manager identified, which deviated from one department to the next. Sometimes it was the project manager themselves who collected the invoices, others would direct different locations for their vendors to submit for payment.

Figure 5-3 shows the adjusted system the WQD put in place to create uniformity amongst vendors. All vendors were now required to submit their invoices to the accounting department for processing, and may copy their WQD project manager and business specialist for internal documentation. Once processed, the accounting office would notify the WQD project manager and/or business specialist of payment receipt. It is worth noting that the researcher is not proposing that the current State Agency accounting system was not sophisticated or lacking in any way. The researcher understands that there may be many sophisticated software's the State Agency could

purchase to handle their invoicing. The researcher is simply identifying that the process by which vendors knew what steps to take when invoicing the State Agency was not simple and varied. By mapping out each process, it provided both the WQD project managers and vendors a more orderly manner of conducting business.

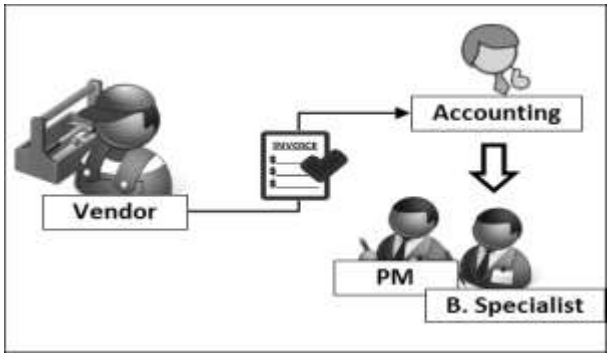


Figure 5-3. Invoicing Process

Submitting Change Orders

Second, the WQD project managers did not have a simple way to track each change order and whether it was justified. Each change order was handled slightly different depending on the WQD project manager. In the new process (see Figure 5-3), there were four major steps:

1. Each vendor was required to fill out a pre-made one-page change order template that included impact to cost and schedule, and attach their WRR with proper justification documented.
2. Submit to the WQD project manager for approval.
3. The WQD project manager submits to procurement for processing.
4. Vendor receives payment.

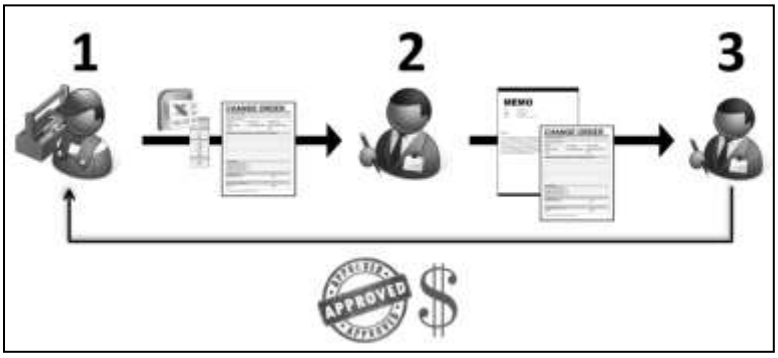


Figure 5-4. Change Order Process

Budget Projections

Lastly, in the traditional system, vendors were required to submit detailed time and materials cost breakouts that were confusing and difficult for the WQD to compile for accurate budget projections. In the new approach, vendors were required to simplify their time and materials to a price schedule which identified the major tasks on a task order, cost of each task, and what month they would charge the State Agency. Table 5-11 shows an example of a simple price schedule.

Table 5-11

Price Schedule

Task	Description	September 2015	October 2015	November 2015
	Project Management and Sub Markup	$950	$950	$913
Reporting Activities				
	Finalize PI Report; FY2015 data submittal	$4,895	$0	$0
PI Activities				
	Kengla bottled water	$300	$200	$140
	Groundwater sampling and analysis of 15 private registered exempt wells and up to 8 unregistered exempt wells; Preparation of technical memo; Hand deliver fact sheets; Identify additional drinking water wells	$9,000	$10,000	$5,481
	Database submittal FY2016 data	$0	$0	$2,850
	SUBTOTAL	***$15,145.00***	***$11,150.00***	***$9,384.00***
	BUDGET TOTAL			***$35,679.00***

In order to get a better understanding of how the vendors and WQD project managers felt about the shift in processes from the traditional to the project management adapated BVA, the researcher surveyed them (scale was 1-5-10; 1 being low performance/do not agree, 5 being do not know, 10 being high performance/agree). Table 5-12 shows the agreeance of the vendors. From this table, 2/7 vendors agreed the new process was more simple, 1 disagreed, and 3/7 could not tell a difference (see Attachment M).

Table 5-12

Process Survey Traditional vs. Project Management Adapted BVA

Survey Question	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 6	Vendor 7
The process is simple and easy to implement.	Agree	Same	Agree	Disagree	Same	Same	Same

Interestingly, one out of the two upper managers for the WQD also provided a rating. They identified that they agreed with a more simplistic approach.

Conclusion

The major difference between the previous and test year was the shift from the WQD project manager having to understand and communicate technical information to not having to do it. A Weekly Risk Report system was used to document all technical information on the task order as a protection to the WQD project managers from the executives not feeling they did not have sufficient information radially available. Second, gaining a consensus on the processes allowed the researcher to map them all out for the benefit of all stakeholders.

Table 5-13 shows the test results from the implementation of the Non-Technical Communication practice. The vendors went from having to know more to knowing less technical information. They went from communicating more to less in terms of technical information. They spent less time discussing task orders in their weekly project management meetings. They went from performing multiple administrative and business process variations, to a single process for each that all stakeholders could understand.

Table 5-13

Summary of Technical vs. Non-Technical Change

Practices	Before	After	Documentation Support
Communication	1. WQD project manager was required to understand 100% of the technical details on each of their task orders, and was responsible for ensuring 100% of the technical decisions were made in the best interest of the State Agency. 2. Had 0 structures to document technical information. 3. Project management meetings took 2 hours.	1. WQD project manager was no longer required to understand 100% of the technical details, because they were no longer responsible for making any technical decisions on the task order. 2. Had 1 structure to document technical information. 3. Project management meetings were reduced to 30 minutes.	Attachment J: Weekly Risk Report
Simplifying Admin/Bus. Processes	WQD project managers did not have 1 of their processes mapped out simply.	WQD project managers had 3 processes mapped out simply.	Attachment L: Process Charts Attachment M: PM/Vendor Survey Data

The main purpose and benefits of the non-technical communication practice are as follows:

1. Ensure the buyer receives what they want.
2. Ensure the vendor understands what are the buyer's expectations and requirements.
3. Minimize cost and schedule deviations due to miscommunication.

Quality Assurance

Due to the shift in practices by the WQD project managers from management, direction and control to more leadership based, they no longer needed to perform quality control activities (see page 66):

Before the previous year, the WQD project managers did the following:

1. Did not ensure the vendor had a task order plan. The researcher verified this through the WQD's task order historical information.
2. Did not ensure the vendor tracked performance metrics.
3. Inspected the vendors' work performed.

In the test year, the shift in practices by the WQD project managers were:

1. Ensure vendor creates a full plan for the task order.
2. Ensure vendor tracks their performance metrics.
3. Ensure vendor can explain any deviations that occur to their work, quality, cost, or schedule (replaces inspection of work).

The main concern they had was: How do you ensure the vendor's work meets the minimal quality standards? The project management adapted BVA does this through quality assurance (QA). Quality assurance was ensuring that the vendor has a plan, was following the plan, and was documenting the performance of the task order, throughout the entire task order, not just at the end. If the WQD project managers perform QA correctly, the vendor will always produce high quality work.

The difficult part for the project managers was how used to being informed on the technical details of a task order they were, and how things were being performed every week. When their role switched to QA and they no longer were required to understand any technical information on a task order, the project managers became confused on what their function was.

To execute the three adjustments in practices, the following was conducted:

First, ensuring the vendor has a full task order plan. The WQD project manager did not help the vendor with their plan. The new task order plan that was required from the vendor was conducted and clarified in the task order setup meeting. Please see Attachment N, to see the new task order plan.

Second, ensuring the vendor tracked performance through metrics. This was conducted through the Weekly Risk Report Performance Metrics tab explained on page 79.

Third, no inspection of vendor's work was performed. Instead, the vendor reviewed the Weekly Risk Report to ensure the work was being performed. If they had any questions related to the task order, the vendor was expected to clarify any confusion.

Due to the shift in practice, it created confusion amongst the WQD project managers. For this reason, the researcher developed training to help them understand how

to perform QA. The researcher held a one-time two-hour training on the following QA activities and responsibilities that the project managers were required to perform:

1. Require the vendor to turn in a plan before they start working on a task order. The plan should include a scope of work, milestone and detailed schedules, price schedule and cost breakout, risk they do not control, risk mitigation and management plan, and performance measurements of success.
2. Understand and review the weekly risk report each week to ensure the plan was being followed.
3. Check any dependencies with related task orders /activities and see whether deviations affect the critical path of the general plan.
4. Ensure vendor main deliverables are completed before payment was sent to the State Agency.
5. Compare the invoices of the vendors with their price schedules (budget projections).
6. Document and track all support and correspondence with vendors.
7. Ask questions whenever they are uncomfortable with any aspect on the task order.

The following detailed steps and processes were developed for the project managers to help them understand how the above activities would help them know if the vendors were following their plan and were on schedule and budget:

1. Review of milestone schedule on WRR to identify progress of task order.
2. Comparison of invoices to actual progress of task orders.

3. Review of risk documentation on WRR to ensure change orders and adjustments to the task order are justified.
4. Requesting of information from vendor before any approvals or changes are made.
5. Use of performance information to identify if a vendor was meeting expectations.

When the WQD project managers received the vendor's WRR each week, one of the first QA activities was to look at the milestone schedule. The milestone schedule shows the WQD project manager's five major sections: major activities, percent complete, initial (baseline) and actual schedules, and any identified risks. There are only two major items of concern to the WQD project manager: what was the percent complete of the upcoming tasks, and was there any deviation in the actual schedule from the initial schedule marked by a risk serial number? If that was the case, they can immediately follow the risk serial number tracked in the risks tab, and now review a detailed plan on how the vendor will manage the risk, when they expect to complete it and what the potential impact to cost and schedule was. This minimizes the WQD project manager's communication with the vendor, by only focusing on any concerns they have regarding the vendor's risk plan.

Table 5-9

Milestone Schedule Tab

#	Activity	% Complete	Initial Schedule	Actual Schedule	Risk #
1	Milestone 1	100%	11/25/14	11/25/14	
2	Milestone 2	100%	12/05/14	12/05/14	
3	Milestone 3	50%	1/25/15	2/25/15	1
4	Milestone 4	35%	2/10/15	3/10/15	
5	End Milestone 5	20%	2/26/15	3/26/15	

The second major QA activity the WQD project manager conducted was to compare the vendor price schedule with both the milestone schedule and submitted invoices (see Table 5-9). In the price schedule, the WQD project manager was able to quickly see which major tasks were going to be completed, for how much, and when the vendor would bill the WQD. It was also the responsibility of the vendor to update and notify the WQD project manager if there was any deviation. This allowed the WQD project manager to quickly ensure the vendor was being efficient.

The third major QA activity (see Table 5-4) the WQD project manager conducted was to look at the risk tab in the WRR and verify the vendor had a simple plan that identifies a planned resolution date and impact to cost and schedule. This quickly allowed the WQD project manager to understand if the vendor was taking the most efficient steps to resolve the issue. The value of the risks tab was its ability to document all deviation and identify the responsible party. It was a tool to increase accountability and proactivity.

Table 5-4

Risks Tab

Date Entered	**Risk Items**	**Plan to Minimize Risk**	**Date Resolved**	**Impact to Critical Path**	**Impact to Cost**	**Entity Responsible**
3/17/2016	Subject Matter of Risk	**(1)** Problem background - Why is this a risk for the task order? **(2)** What will be done to minimize this? **(3)** Who is responsible for the plan? **(4)** What kind of impact will this have?	3/25/2016	0	$ -	Client

The fourth major QA activity done by the WQD project manager after checking the vendor's WRR, was to identify any upcoming deadlines the vendor was close to and requesting milestone information from the vendor. It was the responsibility of the vendor to know when they should turn in information periodically to the WQD project manager before approvals or changes are needed, however sometimes the vendors do not. The WRR was a mechanism that aids in the protection of the WQD project manager to foresee any issues and minimize them before they become one.

Conclusion

The major shift that took place was the WQD's project manager going from not requiring the vendors to prove that they have a thorough understanding of the task order they were selected for, how they will measure it, and what they will produce, to ensuring the vendor was accountable for it now. Table 5-14 shows the summary of the shift from before and after the test year of implementing the QA practice.

Table 5-14

Summary of Quality Control vs. Quality Assurance Change

Practices	Before	After	Documentation Support
Task order planning	0% of the time the PM did not ensure the vendor had 1 full plan for each task order.	100% of the time the PM ensured vendor created 1 full plan for each task order.	Attachment N: Task Order Setup Full Plan Attachment M: PM/Vendor Survey Data
Task order performance tracking	0% of the time the PM did not ensure vendor tracked performance metrics.	0% of the time the PM ensured vendor tracked performance metrics.	Attachment J: Weekly Risk Report
Understanding quality of work	100% of the time the PM checked all the vendors' technical work.	0% of the time the PM checked the vendors' technical work.	

In the same survey conducted by the reseacher for vendors (see page 97) on their perception between the tradiational and project management adapated BVA, the researcher identified that 7/7 vendors agreed the new process was more simple, forced them to pre-plan, identify and minimize risk before the task order began (see Table 5-15 below and Attachment M).

Table 5-15

Process Survey Traditional vs. Project Management Adapted BVA II

Survey Question	Vendor 1	Vendor 2	Vendor 3	Vendor 4	Vendor 5	Vendor 6	Vendor 7
The process forces the vendor to pre-plan, identify, and minimize risks before the task order begins.	Agree	Agree	Agree	Agree	Agree	Agree	Agree

The main purpose and benefits of the quality assurance practice are as follows:

1. Give the vendor full control over the task order.

2. Shifted the accountability of the task order from the WQD project manager to the vendor.

Chapter Conclusion

The major shift from the traditional project mangement approach to the new approach was the replacement of the project managers' expertise to determine scope, schedule and budget for the procured vendors. It was shifting from being the expert to utilizing expertise. It shifted from the WQD project managers requesting technical information in the vendors' documents, to only requesting performance information that identified success at the end of the task order. Table 5-16 identifies a high level summary of all the major changes in practices and documentation support provided in Attachments.

Table 5-16

Summary of Changed Practices

Practices	Before (FY2014)	After (FY2015)	Documentation Support
Management vs. Leadership			
Vendor Selection	WQD had 0 structured process.	WQD had 1 new structured process developed from project management adapted BVA.	Attachment F: Round Robin Selection Method
Developing SOW	WQD project manager developed 100% of the scope of work.	WQD project manager ensured the vendor developed 100% of the scope of work.	Attachment G: Sample PM Scope of Work Attachment H: Sample Vendor Scope of Work
Direction	WQD project manager directed the execution of deliverables, what to do if they were not completed correctly, and the plan to	WQD project manager received from the vendor the execution of deliverables, what to do if they were not completed correctly, and a plan to	Attachment I: Task Order Setup Meeting Pass/Fail Form Attachment J: Weekly Risk Report

	resolve any unforeseen occurrences on a project.	resolve any unforeseen occurrences on a project.	
Upper Management Support	WQD project managers did not have 1 report on the task orders' progress, performance, and which ones were at risk.	WQD project managers had 1 report on the task orders' progress, performance, and which ones were at risk.	Attachment K: Director's Report
Technical vs. Non-Technical Communication			
Communication	1. WQD project manager was required to understand 100% of the technical details on each of their task orders, and was responsible for ensuring 100% of the technical decisions were made in the best interest of the State Agency. 2. Had 0 structures to document technical information. 3. Project management meetings took 2 hours.	1. WQD project manager was no longer required to understand 100% of the technical details, because they were no longer responsible for making any technical decisions on the task order. 2. Had 1 structure to document technical information. 3. Project management meetings were reduced to 30 minutes.	Attachment J: Weekly Risk Report
Simplifying Admin/Bus. Processes	WQD project managers did not have 1 of their processes mapped out simply.	WQD project managers had 3 processes mapped out simply.	Attachment L: Process Charts Attachment M: PM/Vendor Survey Data
Quality Control vs. Quality Assurance			
Task order planning	0% of the time the PM did not ensure the vendor had 1 full plan for each task order.	100% of the time the PM ensured vendor created 1 full plan for each task order.	Attachment N: Task Order Setup Full Plan Attachment M: PM/Vendor Survey Data
Task order performance tracking	0% of the time the PM did not ensure vendor tracked performance metrics.	0% of the time the PM ensured vendor tracked performance metrics.	Attachment J: Weekly Risk Report
Understanding quality of work	100% of the time the PM checked all the vendors' technical work.	0% of the time the PM checked the vendors' technical work.	

In chapter 6, the researcher will identify the results from the shift in project management practices.

Chapter 6

STATE AGENCY CASE STUDY RESEARCH RESULTS AND CONCLUSIONS

Introduction

This chapter will conclude the project management adapted BVA case study test the researcher performed at a buyer's environmental state agency. The final results, major observations, conclusions and recommendations will be identified. Through the case study test, the researcher was only interested in the overall result, and not in any individual impact from a single practice. The researcher did not collect data on the successes and failures of each practice before and after the case study test was performed. Perhaps, in future replications of this study, it would be appropriate to identify more details on the effectiveness of each practice compared to one another. What was clear was the overall improvement of the performance from the vendors delivering the environmental services in fiscal year 2015.

Table 6-1 identifies the shift in project management practices in the State Agency's Water Quality Department (WQD), from fiscal year (FY) 2014 and 2015.

Table 6-1

Paradigm Shift in Practices

FY2014 **Project Management Practices**	**FY2015** **Project Management Practices**
Management, Direction and Control	Leadership
Technical Communication	Non-Technical Communication
Quality Control	Quality Assurance

The WQD Unit Manager, identified the project management adapted BVA as a success. Although the State Agency attempted to implement the project management adapted BVA on their projects, traditional practices of management, direction, and control was still a factor. Despite the use of traditional practices, Table 6-2 identifies the following observations.

- WQD project managers increased work capacity by 43% as a whole [calculation is ((FY15 Total cost / # of PMs) - (FY14 Total cost / # of PMs)) / (FY14 Total cost / # of PMs)]. The individual hours spent by each project manager from the previous year and test year was not collected.
- WQD received more work (98% more scope of work completed by vendors) in 33% less time [more work was measured by identifying the percent change of scope of work completion from the previous year to the new year (calculation equals: similar amount of work ($5.5M vs $5.6M) and there was a 98% increase in amount of work done (50% → 99%)). 33% less time was the amount of time the vendors received less to complete their work then the year before. Vendors were able to start work in August the year prior, and the year of the test, they started in November].
- WQD project management satisfaction of the quality of work produced increased by 22% [measured by taking the percent increase of satisfaction from the previous year to the test year [calculation equals: (FY15 satisfaction rating – FY14 satisfaction rating) / FY14 satisfaction rating)].
- Similar number of projects were conducted at similar amounts of cost.

Table 6–2

Overall State Agency Performance

No.	Criteria	FY2014	FY2015
1	# of WQD PMs to manage projects	7	5
2	Total # of projects	69	60
3	Total cost of projects	$5.5M	$5.6M
4	% of projects scope of work received by WQD	50%	99%
5	PM satisfaction of vendor work quality	6.9/10	8.4/10

Table 6-3 shows the difference in deliverables produced for each of the major steps in the site cleanup process.

Table 6-3

Water Quality Department Major Deliverables

No.	Criteria	FY14	FY15
1	Total number of PI sites increased	0	26
2	PI sites listed	0	4
3	Total number of PI reports completed	0	8
4	Total number of RI reports completed	3	7
5	Total number of PRAP reports completed	1	5
6	Total number of FS reports completed	3	6
7	Total number of ERA reports completed	1	3
8	Total number of ROD reports completed	1	0
AVERAGE REPORTS COMPLETED		1.5	4.8

The researcher is hypothesizing that the project management adapted BVA has a significant impact on project deliverables; the null hypothesis is that the project management adapted BVA has no effect on project deliverables. To further test the validity of this hypothesis, the researcher conducted a Paired Two Sample for Means t-

test using Microsoft Excel on the deliverables from FY14 and FY15 (see Table 6-3 and Attachment O). The Two Sample method is appropriate when examining one subject at two different times. In this instance, the subject is the Water Quality Department in FY14 and FY15 (the year in which the project management adapted BVA was fully implemented). The mean number of deliverables in FY15 is significantly greater than FY14, but the t-test helps to examine whether these differences are statistically significant or random occurrences.

The results of the t-test yield a P value of 0.04, a t-value of 2.77, and a t-critical value of 2.57. Given that the P value is less than 0.05, it can be assumed that this data has greater than a 95% confidence that it is *not* random. The t-value is greater than the t-critical value, suggesting that there is a hypothesized mean difference greater than 0. This further validates the statistical difference between sample means, and permits the researcher to reject the null hypothesis. The researcher proposes that the significance of the data may be due to the project management adapted BVA implemented in FY15. Further data analyses may be warranted to identify what was the actual cause of higher performance in FY15.

Major Conclusions, Observations and Recommendations

The project management adapted BVA did the following for the State Agency Water Quality Division, through introducing a new project management approach:

- Identified and utilized vendors to deliver services.

- Required vendors to take full control over the project and become accountable for it.
- Required the vendors to create a plan that included performance metrics to identify how they knew their task orders would be considered a success.
- Implemented a new project tracking system that measured the schedule and cost deviations of a project on a weekly basis, to include who was the responsible party.
- Implemented a Director's Report for the WQD upper management, to see their projects, progress of work, and any major risks that needed to be addressed.

The project management adapted BVA has identified the following observations:

1. Successful implementation shows that the project management adapted BVA may be a resourceful solution for a buyer's project managers to use to manage and receive high performing services.
2. Using the leadership practice of identifying and utilizing expertise to lower cost and increase performance appears to be an impactful idea.
3. A vendor may be able to identify a project's scope and cost more accurately then a buyer's project manager.
4. Measurement brings transparency and minimizes decision-making.
5. The project management adapted BVA has been identified by the State Agency as the only option proven to transform its agency's environment from a management, direction, and control to an alignment, win-win, and leadership based environment.

The researcher proposes the following recommendations to strengthen this study:

1. Create structured documents when collecting the initial conditions of an organization.
2. Every person that will be used in the test should be interviewed.
3. All interviews should collect detailed information on the person, their qualifications, their role, the processes that they use to perform their work, and how they feel about everything.
4. The effort of each person involved should be measured.
5. Each practice should be analyzed in detail to identify its impact.

Conclusion

The State Agency Water Quality Division has continued to implement the project management adapted BVA. The project management adapted BVA is an advanced and theoretically sound potential project management approach that may transform the traditional approach of project management from a management, direction and control to a leadership based environment, if the steps in this study are followed properly. It may be a management approach that can best support a buyer's organization project managers manager and receive higher performing services.

A core group of visionaries are continuing to transform the organizational approach from one of management of personnel to a systems management, where performance measurements drive alignment of resources. This was a significant effort for

a large federal organization that normally was management based and has difficulty in minimizing bureaucracy.

Case Study Research Conclusion

The results of the case study performed showed that a buyer's project managers can use the BVA procurement model as a potential project management approach, based upon its practices that have had documented performance. It identified that the practices in the new approach are difficult for senior project managers to accept and adhere to. The principles of replacing management, direction and control with the identification and utilization of expertise are drastically different than usual approaches used by project managers. The implementation of those practices was counter-intuitive to the project managers' regular mode of operation. It identified that industries that may be struggling with performance, can look outside their area to find solutions.

The case study also verified that the project management adapted BVA enabled the project managers in the State Agency to manage the delivery of higher performing projects more efficiently and effectively than their traditional approach practices.

Chapter 7

THE PROJECT MANAGERS OF THE FUTURE

Introduction

Due to the successful implementation of the project management adapted Best Value Approach (BVA) case study test, of it being applied as a potential project management approach at a State Agency, the researcher was interested in conducting preliminary testing results with students. Students are the future project managers. Unlike the State Agency project managers, students have little to no experience with service delivery. Though not part of the researcher's initial research scope, he wanted to test the simplicity and effectiveness of the project management adapted BVA with less experienced people.

To test the project management adapted BVA with college students, the researcher approached a research professor at Arizona State University in the construction depart that was teaching a graduate project management course. The research professor approved of the study and allowed the researcher to be a research assistant for the course to conduct the research testing from fall 2015 to spring 2017.

On average 15-20 graduates and undergraduate honor students enrolled for the course. Most of the students came from engineering and construction programs, however, some students have come from business or communication backgrounds. Very few students had any industry experience or training.

At the beginning of each new course, the researcher coordinated with local companies and professional organizations like the International Facilities Management Association (IFMA), who has over 300 members that represent numerous companies around the Phoenix valley, to provide semester long projects. Due to the number of students (20+) per semester, only 5-6 industry projects were accepted by the researcher at a time. All projects were unique and range in disciplines from construction, IT, education, data analysis, health and fitness, to marketing, financial and supply chain management. The students choose which project they wanted to work on and would form a team of 3-4 members. Students normally choose projects based on level of expertise and interest. Once the projects and teams were finalized, each team went through the following BVA structure to run their projects:

1. Pre-planning Phase [weeks 1-3]:
    a. Students have three weeks to create a full plan and clarify it to the client before the project starts.
    b. Full plan consists of creating a full scope of work, identifying baseline metrics, detailed project schedule, risk mitigation/management plan, project metrics of success, and weekly risk report which measures weekly performance.
    c. Align each team member's duties based on their level of expertise.
    d. Identify an expert in project's field to utilize and seek mentorship from regarding plan.
2. Clarification Phase [weeks 3-6]:
    a. Students coordinate with client and clarify plan.

b. Students address and resolve any client concerns.

c. Students start project upon acceptance of their plan.

3. Execution Phase [weeks 6-15]:

    a. Students begin project.

    b. Submit weekly risk reports to course instructor and client for project progress and performance tracking.

    c. Completion of all project tasks and major deliverables. For example, a project would be students conducting a market analysis for a client. The deliverable would be a final report of the market analysis.

By actively applying the BVA structure to deliver graduate research projects, the students were more likely to adhere the project management adapted BVA practices and produce value on projects. During this process, students have pre-planned upfront to align and utilize expertise, and use the weekly risk report to measure and post project progress and performance to create transparency. The project management adapted BVA practices ensured the student teams minimized all MDC practices.

Because of the course, the students were exposed to the Information Measurement Theory Logic (IMT), and showed more efficiently and effective practices. In the span of one semester, students could understand seemingly complex concepts that were outside of their degree concentration. They became leadership oriented. They understood themselves, their peers, their clients, and their industry in a new light. They learned how to set up a project, manage and measure performance, and deliver high performing

results. In total, over 4 semesters, the course worked with 10 companies [PLS, ASU Newman Center, CPG Data, Foundation EON, Century Link, Verizon, Sundt, IFMA Foundation, ON Semiconductor, City of Tempe]. At the end of each semester, the companies would rate their student teams. The following measurements were recorded from the company ratings (PBSRG, 2017):

- 24/24 small-scale projects were successfully completed [in terms of on time, quality, and client satisfaction] by student teams.
- Average rating of graduate team's professionalism was 9.6/10.
- Average rating of quality and usefulness of the final deliverables [reports, presentations, blueprint drawings] produced was 9.7/10.
- Average client satisfaction rating of projects is 9.7/10.
- Average rating of client interested using the graduate students again on future projects is 9.7/10.
- Average rating of project recommendations reducing client risk was 9.5/10.
- Cost realization of $100K and cost avoidance of $4M+.

Research Project Case Studies

This section will identify dominant case studies that added significant value to industry partners:

1. Large Semiconductor Company: Global Facilities Gas/Chemical Inventory Assessment
2. Large Construction Company: ADA Compliant Small Renovation
3. Large Construction Company: Headquarter Building Energy Assessment

4. City Government: Facilities Management Computer Maintenance Management System (MMS)

Large Semiconductor Company: Global Facilities Gas/Chemical Inventory Assessment

The large semiconductor company recently acquired multiple semiconductor facilities around the globe and did not have an accurate inventory of the gas, chemical, and connections in each. They were going to hire a consultant for $4M to travel to each country and hand count the inventory. It was projected to take up to a year. Our students proposed that they can do it faster and not have to travel to each country. The large semiconductor company decided not to hire the professional consultant, and used the student team to collect the data. The student team's plan was to do the following:

1. Contact each facilities manager for each location.
2. Collect a preset amount data from the facilities manager.
3. Create an excel inventory database for each location based on the information provided by the facility managers.
4. Conduct a logistical analysis for transporting excess or lacking inventory in each location.

Results of the project were the following:

- Developed 1 inventory database.
- Contacted 16 FMs from different countries.
- Collected 600+ gases, chemicals, and connections.
- Database was used by large semiconductor company.

- Database helped large semiconductor company identify gaps or excess material.
- Database helped support the logistical plan for cheaper transportation to balance each facility.
- Cost realization of $100K; Cost avoidance of $4M.

Large Construction Company: ADA Compliant Small Renovation

The large construction company was considering remodeling its classroom area on the first floor. The issue was the size of the existing restrooms, and adhering to the ADA requirements. With an increase in occupancy of over 100 people, the 1-person restroom in-place needed to be remodeled. The large construction company did not know what was required to receive ADA compliance. The student teams plan was to do the following:

1. Conduct inspections and blueprint drawings of existing building.
2. Draft floor plan drawings of new classroom and bathroom.
3. Contact the ADA compliance representative in local area to discuss requirements.
4. Finalize drawings using AutoCAD and present to client.

Results of the project were the following:

- Developed a city approved set of floor plans with new classroom and restroom.
- Floor plans were ADA compliant.
- Client was satisfied with the drawings and value add of getting them city approved.
- Student team saved client $7500 if they paid for a designer.

- Client gave the student team a 10/10 rating for customer satisfaction.

Large Construction Company: Headquarter Building Energy Assessment

In a previous team project to identify what it would take to utilize solar to offset the cost of the buildings existing energy usage, it was identified that the large construction company's building was consuming more energy than the industry average for its type and occupancy. The large construction project enlisted the services of another student team to conduct an energy usage assessment to identify how much more they were over the industry average, and what they need to do to resolve the issue. The student team did the following:

1. Verify the industry standard energy usage claim.
2. Requested a blueprint of the building.
3. Conducted site visits to inspect major building components.
4. Research building components to identify the standard usage and compare against the records of the large construction company.
5. Compile analysis into a report to be used by management when making financial decisions.

Results of the project were the following:

- Verified that the building energy consumption average was lower than the existing building.
- Added value by coordinating with a local utility to conduct an energy assessment for the building for free.

- Identified the building is consuming 81% [$76K] more than the industry average.
- Identified that the source of the energy consumption was caused by the state of the art underfloor air distribution system. This system was designed for buildings near the ocean and not the current location of a desert.
- Management identified that the findings were dominant, are willing to pay for services to identify how to resolve the issue.
- The company saved $3500 by using the student team instead of a consultant.
- Management rated the student team 10/10 for their customer satisfaction.

City Government: Facilities Management Computer Maintenance Management System (MMS)

The city government has a large issue with mismanaging work orders. There are over 500 buildings the city is responsible for, and many work orders get lost due to a lack of organization. The city government tried to rectify this issue by purchasing a computerized maintenance management system (CMMS), which was designed to help bring order to how many work orders were being submitted, for what, from where, and the level of criticality. The issue is that the city government facility management department did not know how to use the CMMS system and was only using 5% of its intended function. The task for the student team was to do the following:

1. Get hands on experience with the CMMS program.
2. Figure out what it is and how to operate it to accomplish the function of managing work orders.

3. Develop an easy to read instruction manual that the facility management department.

Results of the project were the following:

- Worked with 7 members of the facility management department.
- Interviewed facility technicians that interface with CMMS program.
- Developed a simple instructional manual for the facility management department.
- Facility management department was totally satisfied and rated the team 10/10.
- The facility management department has requested to conduct more projects from the student teams in the future and is willing to offer internships.
- The lead facility manager has become an advocate in city meeting to identify additional professionals to expand the leadership program and provide these students with future opportunities.

Summary of Project Management Research Projects

What makes this leadership program unique is the ability for students who have little to no information at the beginning of the semester, to utilize logic and natural laws to quickly identify what is going on and how to produce value for the clients. The real value the industry participants are getting is the mentorship of the class instructor [20 years of best value approach experience] and research assistant [4.5 years of best value approach experience], who help guide and shape the project throughout the semester. By utilizing students, local companies can significantly cut the cost of running projects, and use the experience of the PBSRG research team to add value. It is a revolutionary new

approach to delivering services. The value of one person who understands how to be a leader and utilize the expertise of others, is more valuable and takes less resources than the traditional project management role of being the expert.

Conclusion

Due to the project management adapted BVA's minimal requirements on project managers to be able to use the potential project management approach, when it was tested on a graduate project management course at Arizona State University, it was found that the student project managers with minimal training and no experience, were able to perform very highly on projects with industry clients. Unlike the State Agency project managers, the students seemed to be able to accept and implement the concepts of the no-influence and utilizing expertise quicker and with more consistency. This could be due to their inexperience. These preliminary tests showed that the college students also could deliver high performing results with their projects as well as the professionals at the State Agency.

Chapter 8

CONCLUSION

Introduction

Performance in the delivery of services worldwide has been suffering. The project management role was identified as a critical component to managing the delivery of high performing services. After looking at six different industries that employ project managers, the documented performance for all of them was similarly suffering. In an attempt to identify an approach that could help project managers with the delivery of services, the researcher identified a revolutionary model outside of project management that could help. The model came from procurement, and is called the Best Value Approach (BVA), which has been tested on over 2000 projects to show high performance (98% success rate) in the delivery of services.

This dissertation focused on understanding the practices of the Best Value Approach, how it can be adapted into a project management approach that could help project managers with the delivery of high performing services, and testing it to identify potential impact and value add in project management. To gain a better understanding of the differences with traditional [non-BVA] project managmenet approaches, the researcher conducted a separate analysis on the practices of the BVA and compared them with the highest performing project management approaches with objective performance information. It was concluded that the major difference between the practices, was the BVA's primary use of leadership to decrease cost and increase performance. The

practices of the BVA were used to create a project management adaptation. It was proposed that by identifying the BVA practices and packaging them into a potential project management approach experienced project managers could use to manage, it may improve the performance on projects and services all around the world. Additionally, the researcher was interested if the potential project management approach could help project managers with less experience with the delivery of high performing services.

The results of this research could help to direct new and future research into project management practices. Identifying which practices, would have a higher probability of improving performance.

The impact of improving project managers' ability to manage and receive high performing projects will be great on the industry and society in general. High performing services will increase efficiency and create quicker delivery times, low costs, and high quality. It will provide society and businesses more resources for development and growth. To ensure the results of this research were valid, questions were formulated to help better define the objectices and structure of the study. The main resarch question proposed was: *Can the Best Value Performance Information Procurement System (Best Value Approach), be adapted into a Project Management Approach?*

The answer to this question was divided into two major sections, each represented by the following sub-research questions (SRQ):

3. How does the Best Value Approach differ from all the other project management approaches, in terms of practices and performance?
4. Can the Best Value Approach practices be tested in an organization, and be successfully utilized by project managers to show high performance on projects?

This research officially started in 2014. This section reviews each SRQ. The SRQs were related to the methodology of the research as follows:

1. SRQ 1: literature research was conducted, to identify how the BVA differs from the traditional project management approaches.
2. SRQ 2: A case study test was performed, to identify if the practices of the BVA can add value to project managers within an organization [in terms of manageing and receiving higher performance on projects].

The answers to the questions resulted in adapting the BVA into a project management approach that assisted project managers with the management and reception of high performance services.

Answers to SRQ 1

SRQ 1 was answered through literature research. First, the BVA was researched to identify its major practices. Second, a search for all project management approaches was conducted. The literature identified 19 project management approaches:

1. Agile Family [Scrum 70%, Kanban, Extreme Programming (XP), Adaptive Project Framework (APF)]
2. Benefits Realization
3. Business Process Modeling
4. Critical Path Method (CPM)
5. Critical Chain PM (CCPM)
6. Deming PDCA
7. Event Chain Methodology (ECM)
8. Extreme Project Management (XPM)
9. Lean
10. Lean Six Sigma
11. PMI: PMBOK
12. Prince/Prince 2
13. Prism
14. Process Based Project Management
15. Rapid Applications Development (RAD)
16. Six Sigma
17. Spiral
18. Stage Gate
19. Waterfall

After the project management approaches were identified, an analysis was conducted to identify which ones had the most objective documented performance

information. Ten approaches were identified, and a further analysis was conducted to identify their major practices. Once those practices were identified, they were compared with the BVA practices to identify any differences.

Interestingly, the major difference the researcher identified in practices is the BVA's primary use of leadership to minimize inefficiency, by identifying and utilizing expertise upfront to create a simple plan from begin to end. The BVA was also the only approach to show high performance on projects through the primary use of leadership [utilization of expertise/alignment].

The researcher identified that the heavy use of leadership may be the key to helping a project manager impact the performance of the delivery of services. Numerous researchers identified this to be an accurate idea:

- The higher the superintendent's leadership score, the more profit his project will make (Badger, et.al., 2012).
- The higher the servant leader index a construction company buyer has, the more profit the company makes. Take care of your people, your people will take care of the client (Badger, et.al., 2008).
- Project managers should be using leadership 60% of the time and management 40% of the time, however the default setting in the construction industry drives their use to 50-50. The company procedures and the construction contracts mandates more management. The process drives management, the individual PM has to drive leadership (Badger, et.al., 2009).

Answer to SRQ 2

SRQ 2 was answered by running two case study tests using experienced project managers from an environmental state agency, and graduate students at Arizona State University who had little to no experience.

State Agency

A test was conducted by an environmental State Agency, who were having difficulty with the following:

1. Unable to identify performance and value of vendors / environmental experts.
2. Vendors were not meeting the quality expectations of the State Agency.
3. Management requirement of the vendors was too high.
4. Inability to spend all available resources.

The State Agency was unable to identify the quality of their environmental services. This made it very difficult to identify what the issue was and how to improve it. The State Agency desired to have a way to help their project managers accurately identify the quality and performance of the environmental work being completed, and promote their vendors and internal personal to be more proactive and accountable for their work.

In January 2014, the State Agency partnered with Arizona State University, for training in the implementation of the project management adapted BVA, for the delivery of their professional services on environmental engineering projects. The project management adapted BVA proposed the replacement of management, direction, and

control (MDC) with the utilization of expertise. The State Agency chose to test the project management adapted BVA in their largest department, the Water Quality (WQ), on an indefinite delivery indefinite quantity (IDIQ) contract.

After testing through fiscal year 2015, it was identified as a success. The project management adapted BVA assisted the State Agency WQD with the following:

- Reduced the amount of preparation needed to select and monitor vendors.
- Reduced the risk of the State Agency WQD's management, by implementing a decision-less structure to identify the level of the expertise of competing vendors.
- Forced the vendor to become accountable and identify their level of expertise.
- Required the vendor to make things simple enough that even non-experts can understand.
- Required the vendor to take control over their project, which was to their benefit in the end by reducing client MDC.

Table 8-1 shows the summary of practices that were changed from fiscal year 2014 (year before test) to fiscal year 2015 (test year).

Table 8-1

Summary of Changed Practices

Practices	Before [FY2014]	After [FY2015]	Documentation Support
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Upper Management Support	WQD project managers did not have 1 report on the task orders' progress, performance, and which ones were at risk.	WQD project managers had 1 report on the task orders' progress, performance, and which ones were at risk.	Attachment K: Director's Report
Technical vs. Non-Technical Communication			
Communication	1. WQD project manager was required to understand 100% of the technical details on each of their task orders, and was responsible for ensuring 100% of the technical decisions were made in the best interest of the State Agency. 2. Had 0 structures to document technical information. 3. Project management meetings took 2 hours.	1. WQD project manager was no longer required to understand 100% of the technical details, because they were no longer responsible for making any technical decisions on the task order. 2. Had 1 structure to document technical information. 3. Project management meetings were reduced to 30 minutes.	Attachment J: Weekly Risk Report
Simplifying Admin/Bus. Processes	WQD project managers did not have 1 of their processes mapped out simply.	WQD project managers had 3 processes mapped out simply.	Attachment L: Process Charts Attachment M: PM/Vendor Survey Data
Quality Control vs. Quality Assurance			

Task order planning	0% of the time the PM did not ensure the vendor had 1 full plan for each task order.	100% of the time the PM ensured vendor created 1 full plan for each task order.	Attachment N: Task Order Setup Full Plan Attachment M: PM/Vendor Survey Data
Task order performance tracking	0% of the time the PM did not ensure vendor tracked performance metrics.	0% of the time the PM ensured vendor tracked performance metrics.	Attachment J: Weekly Risk Report
Understanding quality of work	100% of the time the PM checked all the vendors' technical work.	0% of the time the PM checked the vendors' technical work.	

The overall WQD program performance of implementing the project management adapted BVA, had the following documented performance results:

- WQD project managers increased work capacity by 43% as a whole
- WQD received more work (98% more scope of work completed by vendors) in 33% less time.
- WQD project management satisfaction of the quality of work produced increased by 22%.

Graduate Project Management Course

The project management adapted BVA was tested in a graduate project management course at Arizona State University. The students came from engineering and management backgrounds, and very few students had any industry experience or training. At the beginning of each new course, the researcher coordinated with local companies and professional organizations to provide semester long small-scale projects.

Due to the project management adapted BVA structure, the graduate research projects went phenomenally. 10 companies [PLS, ASU Newman Center, CPG Data,

Foundation EON, Century Link, Verizon, Sundt, IFMA Foundation, ON Semiconductor, City of Tempe] partnered with the course. At the end of each semester, the companies would rate their student teams' project deliverables. The following measurements were recorded from the company ratings (PBSRG, 2017):

- 24/24 industry small-scale projects successfully completed [in terms of on time, quality, and client satisfaction].
- Average rating of graduate team's professionalism was 9.6/10.
- Average rating of quality and usefulness of the final deliverables produced was 9.7/10.
- Average client satisfaction rating of projects was 9.7/10.
- Average rating of client interested using the graduate students again on future projects was 9.7/10.
- Average rating of project recommendations reducing client risk was 9.5/10.
- Cost realization of $100K and cost avoidance of $4M+.

Case Studies Conclusion

The results of the case study tests identify potential impact project managers may have on the delivery of services, through the implementaiton of the project management adapted BVA.

Answer to Main Research Question

The research was able to answer the SRQs, by identifying the BVA's practices, which was packaged into a potential project management approach and tested in a

buyer's organization with its project managers, and graduate level project management course to identify impact and value in the delivery of services.

The answer to the main question "*Can the Best Value Performance Information Procurement System (Best Value Approach), be adapted into a Project Management Approach"?* is yes.

Weaknesses of Research

The researcher recognizes that though this research has shown value added in the area of project management with a large government agency and a graduate level course at the university level, there are weaknesses that the reader should be aware of. They are as follows:

1. The literature research was conducted majorly using U.S. academic databases, websites, and articles. The research can be strengthened using more global sources.
2. The case study test was with one organization that documented the first year of its implementation of the project management adapted BVA. More testing with different organizations and types of work would increase the legitimacy of this research.
3. The exact changes of the project management approaches were not clearly measured for further analysis.
4. It is not known if the impact on the delivery of services was due to all the changes in practices, minimal or a combination of them. For example, it is not known if

the Weekly Risk Report was any better than the round robin selection of vendors, or both were of equal value.

5. The only thing known is that when all the practices of the project management adapted BVA were implemented, high performance was documented.
6. The changes of the vendors were unknown when the project management adapted BVA was implemented by the buyer's organization. Subsequently, the impact of the changes the vendors made is unknown. More research can be done on what the impact and changes are on the vendors side when this approach is used.

Contribution and Further Research

This research was intended to service the role of project managers in the supply chain, to identify successful practices that can help them with the management and reception of high performance services. The researcher proposes that this research contributed to the project management body of knowledge the following:

- Identification of all available project management approaches and practices.
- First known attempt to take a procurement model and adapt it for the use of the project management discipline.
- Tested the project management adapted BVA with experienced and less experienced project managers to show potential that the approach can be used to show high performance.
- Compiled a list of best practices currently used by project management professionals.
- Developed a brief reference guide to current project management approaches.

The contributions identified have the following impacts:

- Help current project managers with many years of experience, especially those with less experience, better identify practices that they could use with the delivery of high performing services.
- High performing services will increase efficiency and create quicker delivery times, lower costs, and higher quality.
- It may provide society and businesses more resources for development and growth.

The results of this research could also help to direct new and future research into project management practices. To further validate if the project management adapted BVA is a viable option for project managers to deliver services successfully, a grounded theory methodology of consistent and repeated testing may be necessary. According to grounded theory, an approach is considered viable, if the data collected through testing is saturated to a point that it is true (Martin and Turner, 1986).

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APPENDIX A

PROJECT MANAGENT EVOLUTION

Introduction

Project management has been in practice since before the building of the tower of Babel in 2000 B.C. The researcher was interested in learning more about the evolution of project management, so preliminary literature research was conducted to identify the major established phases of project management. While exploring over 90 publications about the history and evolution of project management, the researcher found that little information was available about how project management evolved from an early historical perspective (1760 Industrial Revolution). Most publications limit their analysis by starting at the industrial revolution. Furthermore, a clear and consistent comparison of the major phases of project management is lacking. Without an in-depth analysis of project management evolution from the earliest use, the industry may find it difficult to understand more fully the major changes of improvement over time.

To better understand the major phases and what dominant changes and improvements were made throughout history, the researcher conducted a more in-depth analysis. This was not part of the researcher's research scope of work. All citations for this appendix can be referred to in Attachment B. This additional research is added value for the body of knowledge. The researcher conducted literature research on the major phases of project management, using a set of 10 criteria to compare each with one another.

The intent of this appendix is to provide readers an easy reference on the differences and reasons for the evolution of project management. Tracking how project

management evolved into what it is now, provides a clear understanding of its improvements and shortcomings over time. This also allows academics to further analyze poor-performance in the industry today, and provide a reference for finding successful project management practices utilized in the past.

To conduct this research, the researcher first considered the currently available project management phase classifications. In total, out of 90 publications, 32 were found to be related to the research topic, and were reviewed in more detail. The study reflected that whenever a major change or event took place throughout the history of mankind, a transition occurred which separated it from all the other phases. For example, industrial revolution was the transition to new manufacturing processes. Prior to this phase, goods were manufactured by hand. The shift from hand production methods to machines and manufacturing units exhibited unprecedented sustained growth.

Second, the study looked for major discoveries and developments that are responsible for bringing a revolutionary change in the world and could be the mark of a new phase.

All the publications reviewed broadly categorized project management into four major phases [II – V]. The phases found are the following (see table below):

No.	Phase	Reason
1	Phase I (3100BC to 1760)	Ancient
2	Phase I (1760-1958)	Industrial Revolution
3	Phase II (1958-1979)	Application of Management Science
4	Phase III (1980-1994)	Information Management Development
5	Phase IV (1995-Present)	Age of Technology

After analyzing all the data collected, the researcher added another phase to the classification - Ancient Mesopotamia to Renaissance [Phase I]. This period marks the time frame before the mass production and vast utilization of machinery were developed, and is thus what separates this phase from the others.

The researcher identified criteria that can portray the differences among the phases. Each of these criteria can be found in all phases, unless specified otherwise, and tracked over each phase to demonstrate its evolution over time. The criteria were chosen based on the major characteristics that influence the project management field in the construction industry. The criteria are the following:

- Technology - Major technological developments that allowed for advancement.
- Major Projects – Relevant case studies that embody most, if not all the ten criteria used to compare phases.
- Major project types – Describes common structures that required project management and planning.
- Unique people – Prominent individuals that influenced the field of project management.

- PM Models/Associations – Management models and/or associations that developed during a phase.
- Education – Describes the education level, programs, and institutions that exist in a phase.
- Economy – Describes the dominant economic conditions and characteristics of a phase.
- Labor – The use of labor employed over the course of a project during a phase.
- Design – Architectural, structural, and aesthetic design of major project types during a phase.
- Materials – Describes the prevalent building materials used during a phase.

Table 1-3 shows a high level comparison of all five phases. The analysis column identifies the major trend that was identified by the researcher for each criteria.

Table 1-3

Five Phases of Project Management B

Criteria:	**Phase I**	**Phase II**	**Phase III**	**Phase IV**	**Phase V**	**Analysis**
Technology	Man-powered machinery. 1	Steam Power, Light bulb, Telegraph, Telephones, Automobiles 26	Software Programing 7	Personal Computer 11	3D Technology, Internet 4, Robotics, Nuclear Power	Advances in technology create a more connected world
Major Projects (schedule/cost) *	Florence Cathedral (200 yrs.) 1, Coliseum (8 yrs./57B) 20	Panama Canal (10 yrs./350M) 22, Hoover Dam (5yrs/700 M) 21	Apollo Project (10yrs/100B) 24	Space challenger project (10yrs/450 M) 25	Palm Islands (10+/1.5B), Beijing Stadium (5yrs/360 B) 23	Projects are completed faster. No trend in Budgets.

Major Project Types	Pyramids, Cathedrals, Castles 1,2	Dams, Canals, Railroads 26,29	Spacecraft projects, Advanced weaponry	Large public facility	Smart Buildings, Green Building	Evolved from basic structures to smart, sustainable facilities
Unique People	Machiavelli 3	Henry Gantt, Frederick Taylor 5	Bill Gates, Paul Allen	Gordon Moore, Bill Gates, Steve Jobs, Edwards Deming 12	Kent Beck, Stephen Devaux, Eliyahu Goldratt, Y.C. Chiu	Evolved from Authoritarian to Observant
PM Models/Associations	Master builder tradition (one designer, one manager) 1	Gantt chart, The American Association of Cost Engineers 6	Program Evaluation Review Technique, Product Data Management	Risk Management, Six Sigma 14	Critical Chain PM, Agile Manifesto, Best Value 31	Siloed to Best Value
Education	Skill-based (guilds, apprenticeships, workshops) 2	"Factory Model" of education - Children taught factory skills 27	Training in computer software, mass education	Emphasis on higher education 13	University utilization 28	Skill & Trade based to University utilization
Economy	Siloed kingdoms 1	Golden age of capitalism 27	Post WWII economic boom, heavy investing	Boom-Bust Cycle	Globalization 4	Siloed economies to a globalized economy
Labor	Slave labor 1	Child labor, worker exploitation, machinery 27	Industrial workers, software-skilled labor	Outsourcing of skilled labor 14	Virtual based, lack of skilled workers 32	Reduction in skilled workers over time
Design	Pyramids & Cathedrals 1,2	Industrial 29	Suburban "cookie cutter" design	Family & Socially-conscious	Sustainable, Contemporary	Primitive to Sustainable "green" facilities
Materials	Mud, Brick, Stone 1,2	Iron, steel 26,27	Continuation of iron & Steel	Copper, plastic, concrete	Steel, Reinforced Concrete	Local materials to mass production of reinforced materials

According to Table 1-3, the researcher observed the following dominant information:

- Technology has continued to progress, allowing humans to do more with less.
- The increase in technology has helped project managers deliver services faster.
- Structures have evolved from basic to smart and sustainable facilities. By observation, more maintenance is required to up keep the new technology.

- Project managers' approaches have moved from primarily authoritarian to more autonomous.
- Project managers' have improved the involvement of the entire supply chain when delivering a service.
- Education and training has increased tremendously in the past 100 years.
- Project managers are using more skilled laborers.
- The materials used by project managers are less localized and more mass produced from reinforced concrete and steel.

Project Management Phases

This next section will review each phase briefly, and identify key detailed information the researcher used to create Table 1-3.

Phase I (Ancient Mesopotamia 3100BC to Renaissance 1700AD)

The ancient world is where the researcher began the analysis of the inception of project management. The competition over land and resources by kingdoms and religions drove the people to create great structures like the Tower of Babylon and the Great Pyramids of Giza. Such accomplishments were made possible by using sun-dried mud blocks, and hoisting them into place using ramps, and thousands of slave laborers. Generally, there was one or two master-builders who designed and managed the larger project. Later, cranes were developed by the Romans, which made building faster. Important tasks became more divided, and project management gradually became more efficient. Finally, in the middle ages, education and more diverse economies lead to a

more organized approach to construction, and therefore greater success with projects. However, mass production and vast utilization of machinery had yet to be developed, and is thus what separates this phase from phase II.

Key Historical Information:

- The Tower of Babylon was a tremendous accomplishment, but seen as a failure in the bible. It took several hundred years to complete, constant rebuilding, and diverse labor force was difficult to manage.[1(p.38)]
- Master Builder Tradition – One designer, who controlled and managed the entire project.[1]
- Pyramids: Massive blocks were made of sun-dried mud from the Nile River. Thousands of slaves transported the blocks to Giza, and moved them up ramps into leveled place.[1(p.60)]
- Greeks used numerous columns to support a roof[1(p.85)]. Romans developed arch roofs and beams for support[1(p.107)]
- Coliseum: labor was divided into four sections, each headed by a master builder. This made the overall project vastly more efficient.[1(p.119)]
- "The Prince" – book on management theory by Machiavelli. Better to control people using fear than love.[3(p.27)]
- Dome of Florence Cathedral -125 year waiting period for the roof, tried to use a lot of details to minimize risk[2(p.125)]

- Notre Dame de Paris – Relatively fast construction (1163-1351). On-site planning office, active blacksmiths, foundry for casting iron, kiln for creating cement, and glassman designing patterns.[2(p.128)]
- Guilds, Apprenticeships, and Workshops were the foundation of education in Ancient times. To graduate from a guild, one had to successfully build a given project.[3]
- Feudalism – An economy of kingdoms that competed for peasants and other skilled workers.[1]

Phase II (Industrial Revolution 1760-1958)

Phase II is observed from 1760 to 1958. It was marked by the industrial revolution. Prior to this phase, goods were manufactured by hand. The transition from hand production methods to machines and manufacturing units, exhibited unprecedented sustained growth. [26] Standard of living improved noticeably, and technological development grew significantly. Numerous industries were set up amongst which textile, chemical and iron manufacturing industries were the most common. [26] The mass production of new materials like iron and then later steel lead to large-scale infrastructure development projects like the Panama Canal, Hoover dam and the Trans-Siberian Railway. [27]

Key Historical Information:

- Previously, building materials had been restricted to timber, stone and lime mortar. Metals were not available in sufficient quantity. With the mass production

of iron during this phase, challenging and diverse projects could be executed like the railroads. [26]

- Living conditions varied from the wealthy to the poor during this phase. While the factory workers lived in harsh conditions with exceedingly long work hours, the buyers lived a lavish lifestyle. [27]
- Development of railroads, canals and waterway networks, made transportation of raw materials quicker, easier, and cheaper. [26]
- Technological advancements shortened the project period. Automobiles provided effective mobility and telecommunication developments increased the speed of communication. [26]

Phase III (Application of Management Science 1958-1979)

Phase III is observed from 1958 to 1979. This phase experienced the emergence of management science in project management and business interactions. The basis of project management models in this phase was Operational Research (OR). OR is an interdisciplinary science which adopts both mathematical and statistical modeling to assist decision-making in complex real-world situations. Power of computers and software development facilitated the growth of project management skills in this phase. Critical Path Method (CPM) was adopted for scheduling purposes, and Program Evaluation and Review Technique (PERT) for calculation of probable duration of a project. The Project Management Institute (PMI) was introduced in America during this phase, to focus on project techniques. Concisely, this phase marked the beginning of modern project management.

Key Historical Information:

- Management science theories came into being in business interactions.
- Operational Research (OR) aided in management decision making.
- This phase experienced the advent of complex network diagrams Critical Path Method (CPM) and Project Evaluation Review Technique (PERT) charts.
- Precedence Diagramming Method (PDM) was initiated in this phase.
- CPM was initiated at DuPont Corporation, to handle various tasks and interactions of a project using automated algorithms.
- PERT deals with the time taken for completion of a project and monitors the same.
- The Project Management Institute was launched (1969)

  It was launched by 5 volunteers with the idea of setting up a platform to discuss project management[5]

Phase IV: (Information Management Development 1980-1994)

The time of 1980-1994 is identified as the period of information management development [12, 13]. With the advent of the personal computer and other information technologies, people began to utilize those tools to help manage larger-scale and more complicated projects [11, 14]. More low-cost project management software became popular. For the first time, project managers could be efficient on an unpresented scale, driving competition up.

Key Historical Information:

- Advent of the personal computer helps managing and controlling complex project schedules.
- Associated low costing and easy to use project management software becomes available.
- Manufacturing resource planning emerged.
- Six Sigma Methodology was initiated in 1986.
- First PMBOK (Project Management Body of Knowledge) Guide was published in 1987.
- Risk management, Agile project management was initiated during this period.
- PRINCE (Projects In Controlled Environments) was created in 1989.
  PRINCE and its successor PRINCE2 are a set of guidelines for organizing and running projects produced by UK Government standards, and later adopted by other organizations. [19]

Phase V: (Age of Technology 1995-Present)

Phase V is observed from 1995 to Present, and is marked by a digital revolution. After the advent of computers and electronics, information storage and transmission has become easier and faster. People can communicate faster and better with the use of various gadgets and high-speed internet. Automation and computerization has resulted in higher and better productivity, and a significant number of job losses, as mass production using robots requires minimum labor and maximum machinery. Scientific knowledge and technology has changed the way we live and the environment we live in.[28,17]

Interestingly, the combined theoretical testing of academia and industry, has led project management to shift from an authoritarian approach to a more autonomous approach. By observation, society has promoted the laborers to become more skilled in their craft to become experts, than just delivering services using sheer numbers alone. This has led to advancement of more education, which has led to more efficient, cheaper and better delivered services compared to the other phases.

Key Historical Information:

- The digitalization of information has reformed traditional business methods. With the easy use of communication and exchange of information, most industries can become powerful in a relatively short period. [28,17]
- Technological advancement in construction industry such as 3D printing, augmented reality, pre-fabrication, and laser scanning has produced speedier and improved methods of construction.
- Use of different materials and techniques has been successful in overcoming different adversities. For example, the Beijing National Stadium is an earthquake resistant structure, and the Palm Islands are constructed on a waterbody and can withstand high tides.[30]

Conclusion

The project management approach has evolved since its first use in ancient times. As education, technology, and people advanced, the practice of project management has helped societies to become more efficient, cheaper and faster when delivering services. In

our present day, though delivering services has not improved in the last 30 years, since ancient times, it is as good as it has ever been. As humans continue to evolve, so will project management. The trend for the evolution of project management is up.

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APPENDIX B

LITERATURE RESEARCH SOURCES

Each source is described below:

ASU Libraries

- This search engine interfaces with 650 academic databases.
- When searching, its reach stretches to over 100,000 publications.
- As a student, the researcher could fully use all its resources.

MIT Libraries

- This search engine interfaces with over 500 academic databases.
- There are over 100,000 publications available.

Google Scholar

- This search engine is a large database that contains most academic publications (hundreds of thousands).
- It uses the internet.

Google

- This search engine is the most powerful.
- Its span reaches all information available on the internet.

APPENDIX C

LITERATURE RESEARCH ON CONSTRUCTION APPROACHES

The researcher chose not to use any construction approaches or delivery methods in the analysis of project management approaches. The researcher's intent for this research was to identify the highest performing approaches with objective measurements, to identify and compare their practices with the Best Value Approach. Due to the known construction approaches and delivery methods lack of assisting project managers to deliver high performing services, they were excluded from further analysis. The researcher instead looked outside the silo of construction to identify other approaches that could assist project managers with the delivery of high performing services.

The following studies were used as justification, to remove the known construction approaches and delivery methods:

1. In 2006, the International Council for Research and Innovations in Building and Construction (CIB), one of the largest global organizations that bring international and government research institutes to collaborate on the building sector, sanctioned Task Group 61, to investigate construction performance, with an objective to stimulate global research efforts from its findings, to improve construction overall on a global scale (Egbu, 2008; Kashiwagi, 2013; Rivera, 2014).
2. In 2008, Task Group 61 [later elevated to a working commission called W117 at the end of 2008] conducted a worldwide study to identify any innovative construction methods that used performance measurements to increase project performance. The study filtered through 15 million articles, and reviewed over 4,500 articles. Out of the 4,500 articles, it found 16 articles that identified three

construction methods being used that showed how customer satisfaction and value on projects, were improved through numerous tests. Two out of the three systems and after further investigation, were found to either have performance measurements with no identification of its structure and how well it worked, or could not show exactly how it improved project performance through performance measurements. The system was the Best Value Approach (Egbu, 2008; Kashiwagi, 2013; Rivera, 2014; PBSRG, 2017).

3. In 2013, PBSRG sanctioned a follow on worldwide study to the CIB worldwide study in 2008 by Task Group 61. The study's objective was to identify the global performance in construction. The study sifted through hundreds of papers, websites, and personal industry contacts, and found that construction performance was similar around the world. According to this study, the construction industry identified poor performance in the delivery of services (Thomas, and Napolitan, 1995; Odeh, and Battaineh, 2002; Hsieh et al., 2004; Assaf, and Al-Hejji, 2006; Arain, and Pheng, 2006; Lo et al., 2006; Sambasivan, and Soon, 2007; Al-Kharashi, and Skitmore, 2009; Mahamid, et al., 2011; PBSRG, 2017).
4. In 1998, a study was published on the performance [in terms of cost, schedule and quality] of the three principle project delivery methods [construction management at risk, design build and design bid build] used in the United States. The study collected data from 251 U.S. building projects, and over 100 variables to explain project cost, schedule and quality performance. The conclusion of the 1998 study identified that the project delivery of design build produced higher cost and schedule advantages. The design build was concluded to produce equal and

sometimes higher quality that the other two systems. Interestingly, in follow-on study to include Integrated Project Delivery (IPD) presented at the 2015 CII annual conference, it was identified that there was inconclusive evidence to support any project delivery method was any worse or better than the others. This was conflicting evidence that did not support the 1998 study. What is known about the delivery methods used in construction is that they have all struggled with poor performance, despite the numerous methods used to overcome it (Konchar and Sanvido, 1998; Molenaar, et.al., 2014; Pennsylvania State University, 2015; Leicht, 2015; LePatner, 2015).

APPENDIX D

DESCRIPTION OF APPROACHES

This appendix is a detailed analysis of many of the project management approaches used in this research. The researcher chose to complete this report, to add more information to the body of knowledge. This report consists of a detailed description of the approaches, using nine criteria. They are as follows:

1. Description of model
2. Developer
3. Year developed
4. Reason for development (data reflects the category "unknown" when a specific reason was not found)
5. Industry used
6. Popularity (discovery through new data collection and client provided data)
7. Major Strength
8. Issue
9. Unique

In a separate attachment, a chart of comparison has been created. The chart of comparison is an excel table that lists all the approaches and compares their nine criteria. Lastly, the attachment includes all the references used to complete this report.

This next section will cover each of the following approaches in detail:

1. Agile [Scrum, Kanban, Extreme Programming, Adaptive Project Framework]
2. Waterfall
3. Critical Path Method

4. Critical Chain Project Management
5. PMI/PMBOK
6. Prince/Prince2
7. Event Chain Methodology
8. Extreme Project Management
9. Lean
10. Lean Six Sigma
11. Six Sigma
12. Process Based Project Management
13. Business Process Modelling
14. Deming PDCA
15. Stage Gate
16. PRiSM
17. Benefits Realization
18. Rapid Applications Development
19. Spiral

Agile - Scrum

Description of model:

Scrum is an empirical agile project management framework used to deliver increments of high value to the customer iteratively. Scrum relies on self-organizing, empowered teams to deliver the product increments. It also relies on a customer, or Product

Buyer, to provide a team with a list of desired features using business value as the priority mechanism.

In Scrum, a small team is led by a Scrum Master whose main job it is to clear away all obstacles to work getting done more efficiently. The team works in short cycles of two weeks called “sprints”. The team members meet daily to discuss what has been done and where there are any roadblocks that need clearing. This methodology allows for quick development and testing, especially within small teams.

Philosophy:

- Manage complexity, unpredictability and change through visibility, inspection and adaptation.

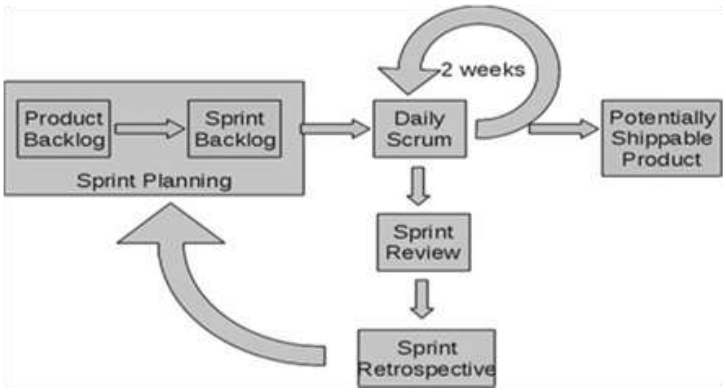
Principles:

- Empiricism – Make decisions based on observation and experimentation not theory, that is replace detailed up front planning and processes by just in time inspect and adapt cycles.
- Self-Organization – Allow the team to self-manage and be autonomous, allow them to organize themselves around clear goals, objectives and constraints.
- Collaboration – Collaborate with the team, minimize management and direction.
- Prioritization – Work on the most important thing first, that is the things that add the most value, do not waste time working on things that do not add immediate value.

- Time Boxing – Set time boxes and stick to them do not extend them. This creates the rhythm that everyone can work to.

Process:

- Model Diagram



- Year developed:1995
- Developer: Hirotaka Takeuchi and Ikujiro Nonaka introduced the word 'scrum' as a term in the context of product development in 1986 in their article on the New Product Development Game.[3] Jeff Sutherland and Ken Schwaber conceived the Scrum process in the early 90's. They codified Scrum in 1995 to present it at the Oopsla conference in Austin, Texas (US) and published the paper "SCRUM Software Development Process".
- Industry: Manufacturing, software, healthcare
- Popularity: common
- Reason for development: To overcome problems of traditional project management
- Strengths:

- Fast moving, cutting edge developments can be quickly coded and tested using this method, as a mistake can be easily rectified.
- It is a lightly controlled method which insists on frequent updating of the progress in work through regular meetings. Thus, there is clear visibility of the project development.
- Due to short sprints and constant feedback, it becomes easier to cope with the changes.
- The overhead cost in terms of process and management is minimal thus leading to a quicker, cheaper result.

- Weaknesses:
  - Teams whose members are geographically dispersed or part-time.
  - Teams whose members have very specialized skills.
  - Products with many external dependencies.
  - Products that are mature or legacy or with regulated quality control.
  - Project quality management is hard to implement and quantify unless the test team can conduct regression testing after each sprint.
  - Daily meetings sometimes frustrate team members.

Agile – Kanban

Description of model:

Kanban methodology is less structured methodology. There is no process framework in this methodology. It only has an introduced model which improves the

process through incremental improvements. This methodology can be applied to any other methodology.

Philosophy:

Emphasizes JIT principles by matching the amount of work in progress (WIP) to the team's capacity It is a method for managing knowledge work which balances demands for work with the available capacity for new work. Work items are visualized to give participants a view of progress and process, from task definition to customer delivery. Team members "pull" work as capacity permits, rather than work being "pushed" into the process when requested.

Principles:

Kanban is rooted in two sets of principles, for change management and service delivery, which emphasize evolutionary change and customer focus. The method does not prescribe a specific set of steps, but starts from existing context and stimulates continuous, incremental and evolutionary changes to the system. It aims to minimize resistance to change to facilitate it.

Process:

- The method does not prescribe a specific set of steps, but starts from existing context and stimulates continuous.
- Kanban has six general practices: visualization, limiting work in progress, flow management, making policies explicit, using feedback loops, and collaborative or

experimental evolution. They involve seeing the work and its process and improving the process, keeping and amplifying useful changes and learning from, reversing and dampening the ineffective.

- In Kanban, wok is organized on Kanban board. In Kanban process is running as:
    - Testing
    - Ready for release
    - Released Columns
- Kanban management criteria are WIP (Work in progress). By managing WIP and monitoring WIP we can optimize the flow of work items.
- Year developed: 1940
- Developer: Taichi Ohno at Toyota
- Industry: Manufacturing, software, healthcare
- Reason for development: to organize the chaos that surrounds so many delivery teams by making the need for prioritization and focus clear.
- Strengths:
    - Kanban fits best with a highly cohesive team that knows what it takes to keep the flow going.
    - Helps save resources.
    - Kanban is ideal for teams that have members with overlapping skills.
    - Kanban methodology increases the process flexibility.
    - It reduces the wastes from the process.
    - It improves the delivery flow.
    - It reduces the time cycle of the process.

- Weaknesses:
    - Sometimes Kanban team make the board overcomplicated.
    - Lack of timing is another disadvantage because there are no timeframes associated with each phase.

Agile – Extreme Programming (XP)

Description of model:

Extreme Programming (XP) is a pragmatic approach to program development that emphasizes business results first and takes an incremental, get-something-started approach to building the product, using continual testing and revision.

Philosophy:

Extreme Programming is an agile software engineering methodology. This methodology, which is shortly known as XP methodology is mainly used for creating software within a very unstable environment. It allows greater flexibility within the modeling process. The main goal of this XP model is to lower the cost of software requirements. It is quite common in the XP model that the cost of changing the requirements on later stage in the project can be very high.

Principles:

XP is defined by a set of five values that establish a foundation for all work performed as part of development process. These five values are communication, simplicity, feedback, courage, and respect.

Process:

- Model diagram

- Year developed: 1996.
- Developer: Kent Beck
- Industry: Software
- Popularity: Common
- Reason for development:
- Strengths:
    - Extreme programming methodologies emphasis on customer involvement.
    - This model helps to establish rational plans and schedules and to get the developers personally committed to their schedules which are surely a big advantage in the XP model.
    - This model is consistent with most modern development methods so; developers can produce quality software.
- Weaknesses:
    - This methodology is only as effective as the people involved, Agile does not solve this issue.
    - This kind of software development model requires meetings at frequent intervals at enormous expense to customers.

- It requires too much development changes which are really very difficult to adopt every time for the software developer.
- In this methodology, it tends to impossible to be known exact estimates of work effort needed to provide a quote, because at the starting of the project nobody aware about the entire scope and requirements of the project.

Adaptive Software Development

Description of model:

It is a structured and systematic process for continually improving decisions, management policies, and practices by learning from outcomes of previous decisions. The characteristics of an ASD life cycle are that it is mission focused, feature based, iterative, time boxed, risk driven, and change tolerant.

Philosophy:

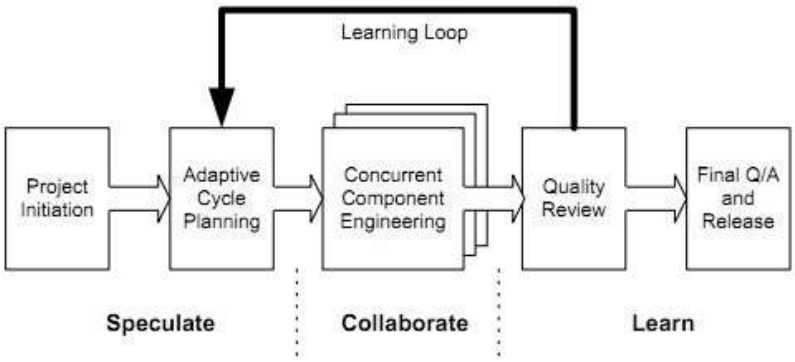
It embodies the principle that continuous adaptation of the process to the work at hand is the normal.

Principles:

Adaptive Software Development focuses on collaboration and learning as a technique to build complex systems. It is evolved from the best practices of Rapid Application Development (RAD) and Evolutionary Life Cycles.

Process:

- Model diagram



- Year developed: n/a
- Developer: Jim Highsmith and Sam Bayer.
- Industry: Software
- Popularity: Common
- Reason for development: To work on high uncertainty projects
- Strengths:
    - it is mission-driven based on the project vision
    - it is component rather than task-based (result-driven)
    - it is limited in time
    - each time-box is only one iteration in a larger set of iterations
    - it is risk-driven
    - it is change-tolerant
- Weaknesses:
    - Time consuming

Waterfall

Description of model:

The waterfall model is a sequential (non-iterative) design process, used in software development processes, in which progress is flowing steadily downwards (like a waterfall) through the phases of conception, initiation, analysis, design, construction, testing, production/implementation and maintenance.

Philosophy:

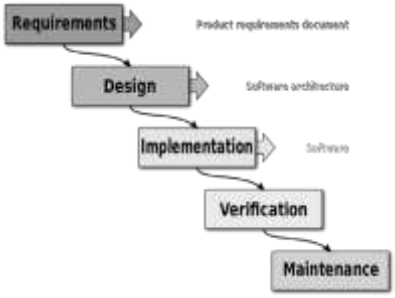
The waterfall development model originates in the manufacturing and construction industries: highly structured physical environments in which after-the-fact changes are prohibitively costly, if not impossible. Because it was created in a time when no formal software development methodologies existed, this hardware-oriented model was simply adapted for software development.

Principle:

- In Royce's original waterfall model, the following phases are followed in order:
- System and software requirements: captured in a product requirements document
- Analysis: resulting in models, schema, and business rules
- Design: resulting in the software architecture
- Coding: the development, proving, and integration of software
- Testing: the systematic discovery and debugging of defects
- Operations: the installation, migration, support, and maintenance of complete systems

Process:

- Model diagram



- Year developed: 1956
- Developer: The first known presentation describing use of similar phases in software engineering was held by Herbert D. Benington at Symposium on advanced programming methods for digital computers on 29 June 1956.
- Reason for development: The waterfall model provides a structured approach; the model itself progresses linearly through discrete, easily understandable and explainable phases and thus is easy to understand; it also provides easily identifiable milestones in the development process. It is perhaps for this reason that the waterfall model is used as a beginning example of a development model in many software engineering texts and courses.
- Strengths:
    - This model is simple and easy to understand and use.
    - It is easy to manage due to the rigidity of the model – each phase has specific deliverables and a review process.
    - In this model phases are processed and completed one at a time. Phases do not overlap.
    - Waterfall model works well for smaller projects where requirements are

very well understood.

- Weaknesses:
    - Once an application is in the testing stage, it is very difficult to go back and change something that was not well-thought out in the concept stage.
    - No working software is produced until late during the life cycle.
    - High amounts of risk and uncertainty.
    - Not a good model for complex and object-oriented projects.
    - Poor model for long and ongoing projects.
    - Not suitable for the projects where requirements are at a moderate to high risk of changing.

CPM (Critical Path Method)

Description of model:

The Critical Path Method or Critical Path Analysis, is a mathematically based algorithm for scheduling a set of project activities. It is a method for identifying, scheduling and dealing with tasks that directly affect a project's end date.

Philosophy:

It is based on the concept that there are some tasks you can't start until a previous one has been finished. When you string these dependent tasks together from start to finish, you plot out your critical path. The sequence of scheduled activities determines the duration of the project. It is the longest sequence of tasks in a project plan that must be completed

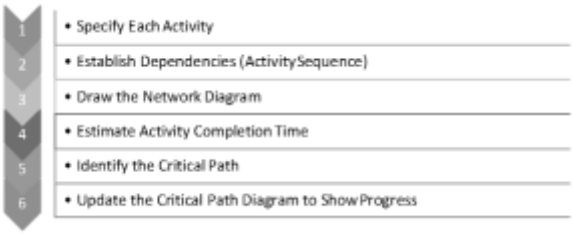
on time for the project to meet its deadline. If there is a delay in any task on the critical path, then your whole project will be delayed.

Principles:

It is an approach to project scheduling that breaks the project into several work tasks, displays them in a flow chart, and then calculates the project duration based on estimated durations for each task. It identifies tasks that are critical, time-wise, in completing the project.

Process:

- Model diagram



- Year developed: 1950
- Developer: Morgan R. Walker and James E. Kelly
- Industry: Software development, construction, aerospace & defense, Research project, product development
- Popularity:
- Reason for development: Missile defense construction project
- Strengths:
    - Identifies the Most Important Tasks

- Helps Reduce Timelines
- Compares Planned with Actual
- Makes risk assessment easy. It discovers and makes dependencies visible.
- It shows the critical path, and identifies critical activities requiring special attention.
- It helps in assigning the float to activities and flexibility to float activities.

- Weaknesses:
  - The critical path method is an optimal planning tool; it always assumes that all resources are available for the project always.
  - It does not consider resource dependencies.
  - There are chances of misusing float or slack.
  - Less attention on non-critical activities, though sometimes they may also become critical activities.
  - Projects based on the critical path often fail to be completed within the approved time duration.

CCPM (Critical Chain PM)

Description of model:

Critical chain project management (CCPM) is a method of planning and managing projects that emphasizes the resources (people, equipment, physical space) required to execute project tasks. It differs from more traditional methods that derive from critical path and PERT algorithms, which emphasize task order and rigid scheduling.

Philosophy:

Theory of Constraints, or TOC for short, is a set of concepts, principles and tools created by Dr. Eliyahu Goldratt to manage systems better. TOC is a management philosophy providing the tools and applications to systematically identify and construct simple solutions to seemingly complex problems. Critical Chain Project Management (CCPM) is one of the many solutions in the TOC framework. CCPM involves managing time buffers and task priorities to systematically work through a project plan that will define and exploit constraints.

Principles:

It assists businesses in achieving their goals by providing a mechanism to gain better control of their initiatives. According to Goldratt, the strength of any chain, either a process or a system, is only as good as its weakest link. TOC is a systemic way to identify constraints that hinder system's success and to effect the changes to remove them.

Process:

- The five focusing steps that this solution uses to accomplish this are:
    - Identify the system constraint.
    - Exploit the constraint.
    - Subordinate everything else to the constraint.
    - Elevate the system constraint to a new level of productivity (increase its throughput).
    - Go back to step 1 and find the new constraint.

- Model diagram

- Year developed: 1997
- Developer: The Critical Chain Method (CCM) or Critical Chain Project Management (CCPM) is an outgrowth of the Theory of Constraints (TOC) developed by Eliyahu Goldratt to scheduling and managing manufacturing.
- Industry: Manufacturing
- Popularity: Uncommon
- Reason for development: To improve the reliability of the delivery of project and reduce cycle time for development projects.
- Strengths:
    - Application of CCPM has been credited with achieving projects 10% to 50% faster and/or cheaper than the traditional methods (i.e., CPM, PERT, Gantt, etc.) developed from 1910 to 1950s.
    - Reduced overtime
    - Projects completing on time or ahead of schedule
    - Increased throughput
    - More focused meetings
    - A single prioritized list of jobs for production and support codes to focus

on.

    - Less multitasking.

- Weaknesses:
    - Because additional time buffers are built into each stage of the plan, Critical Path doesn't work very well for small-scale projects with a quick-turnaround.

PMI: PMBOK

Description of model:

The Project Management Body of Knowledge is a set of standard terminology and guidelines (a body of knowledge) for project management. The body of knowledge evolves over time and is presented in A Guide to the Project Management Body of Knowledge (the Guide to the PMBOK or the Guide), a book whose fifth edition came out in 2013. The Guide is a document resulting from work overseen by the Project Management Institute (PMI), which offers the CAPM and PMP certifications.

Philosophy:

The PMBOK Guide also overlaps with general management which both include planning, organizing, staffing, executing and controlling the operations of an organization. Other management disciplines which overlap include financial forecasting, organizational behavior, management science, budgeting and other planning methods.

Principle:

The PMBOK Guide is intended to be a "subset of the project management body of knowledge that is generally recognized as a good practice. 'Generally recognized' means the knowledge and practices described are applicable to most projects most of the time and there is a consensus about their value and usefulness. 'Good practice' means there is a general agreement that the application of the knowledge, skills, tools, and techniques can enhance the chance of success over many projects."

Process:

- The five process groups are:
    - Initiating: processes performed to define a new project or a new phase of an existing project by obtaining authorization to start the project or phase.
    - Planning: Those processes required to establish the scope of the project, refine the objectives, and define the course of action required to attain the objectives that the project was undertaken to achieve.
    - Executing: Those processes performed to complete the work defined in the project management plan to satisfy the project specifications
    - Monitoring and Controlling: Those processes required to track, review, and regulate the progress and performance of the project; identify any areas in which changes to the plan are required; and initiate the corresponding changes.
    - Closing: Those processes performed to finalize all activities across all Process Groups to formally close the project or phase.

- Popularity: Common
- Year developed: The evolution of the PMBOK Guide is reflected in editions of the Guide. The Guide was first published by the Project Management Institute (PMI) in 1996.
- Developer: American National Standards Institute (ANSI)
- Industry main used in: Financial forecasting, organizational behavior, management science, budgeting and other planning methods.
- Reason for development: The PMBOK Guide is intended to be a "subset of the project management body of knowledge that is generally recognized as a good practice.
- Strengths:
    - Easy breakdown of project management steps
    - Expansion of experience into other field and industries
    - Provide standardization of process
- Weaknesses:
    - The PMBOK may be more work than needed if you want to apply it in small projects (too many processes...). Another disadvantage is that although it is carefully written to be applicable in every industry, it tends to be inefficient in projects that are plagued by lots of change requests because the requirements are not clear upfront (especially software/web projects)

PRINCE2 (Projects IN Controlled Environments)

Description of model:

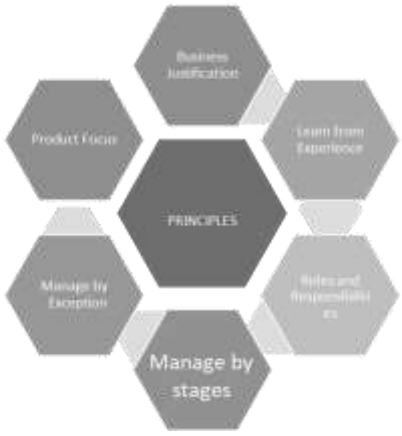
PRINCE2 is about doing the right projects, at the right time, for the right reasons.

Philosophy:

- Emphasizes on having a planning method that derives essential activities from the desired product
- Believes in controlling quality, schedule and cost of the product delivered
- Has a sequence of processes defined to start, control and conclude a project.

Principles:

- Model diagram



- Year developed: October 1996
- Developer: It was initially developed as a UK government standard for information systems

    - projects, and the current buyer, AXELOS, is a joint venture by the Cabinet Office and Capita

- Industry: Information systems, essentially applicable in all industries
- Popularity: All UK Government Projects, in process of being established in Netherlands, Belgium, Germany, Spain, South Africa, Australia, and the United States.
- Reason for development: Common reasons of project failure
- *Strengths:*
    - Better control and use of resources
    - A means for managing risks and issues
    - Flexible decision points
    - Regular reviews of progress against the project plan and business case
    - Assurance that the project continues to have a business justification
    - Early visibility of potential problems
    - Effective communication between the project team and other stakeholders
    - A mechanism for managing deviations from the project plan
    - A process for capturing lessons learned
- *Weaknesses:*
    - Laborious and stressful
    - Does not guarantee on time project delivery
    - Does not guarantee on cost project delivery
    - Considered inappropriate for small projects or where requirements are

expected to change

Event Chain Methodology

Description of model:

The underlying idea behind event chain methodology is that there are potential risks that often lie outside the project's scope. It's important to prepare for these risks and plan what to do if they occur. Why? Unexpected events will impact your project's schedule, deliverables, and potentially its success. Each stage is executed in a pre-determined, linear fashion.

Philosophy:

Event chain methodology helps to mitigate the effect of motivational and cognitive biases in estimating and scheduling.

Principles:

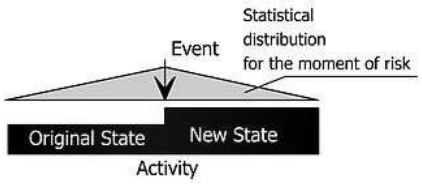
- Probabilistic Moment of Risk: An activity (task) in most real-life processes is not a continuous uniform process. Tasks are affected by external events, which can occur at some point in the middle of the task.
- Event Chains: Events can cause other events, which will create event chains. These event chains can significantly affect the course of the project. Quantitative analysis is used to determine a cumulative effect of these event chains on the project schedule.
- Critical Events or Event Chains: The single events or the event chains that have

the most potential to affect the projects are the “critical events” or “critical chains of events.” They can be determined by the analysis.

- History Matching and Relevance Analysis: Probability and outcomes of the events can be obtained from historical data based on previous similar projects. Relevance analysis can be performed to select most appropriate risks for the project based on combination manager’s belief and historical evidence.
- Project Tracking with Events: If project is practically completed and data about the project duration, cost, and events occurred is available, it is possible to refine information about future potential events and helps to forecast future project performance.
- Event Chain Visualization: Events and event chains can be visualized using event chain diagrams on a Gantt chart.
- Risk Mitigation with Event Chains: If an event or event chain occurs, it can trigger the execution of a mitigation plan. Mitigation plans will be embedded in the project schedule. However, mitigation plans can also be affected by events; therefore, the master project schedule with all possible mitigation plans will be analyzed together.

Process:

- Model diagram



- Event chain methodology helps to mitigate the negative impact of psychological heuristics and biases, as well as to allow for easy modeling of uncertainties in the project schedules:
    - Mitigate effect motivational and cognitive biases in estimating and scheduling.
    - Simplify the process of defining risks and uncertainties in project schedules, particularly improve the ability to provide reality checks and visualize multiple events.
    - Perform more accurate quantitative analysis while taking to an account such factors as relationship between different events and actual moment of the events.
- Year developed: Unknown
- Developer: It is based on existing analysis methodologies including Monte Carlo simulation, Bayesian approach and others.
- Industry: Large Scale Construction
- Popularity: Common
- Reason for development: Event chain methodology focuses on finding the chain of situations that lead to a problem or a delay. As such, many project managers will use it with other project management approaches. Any event can cause a change in the normal progression of things. Once identified, the project manager can deal with these event chains accordingly. Some consider this method a furtherance of the critical chain approach.
- Strength: Event Chain Methodology enables managers to examine the relationship

between tasks and external pressures. This creates more realistic projects.

- Weakness: Project managers can get caught up in identifying threats, they can forget that external events can be beneficial and present opportunities.

XPM (extreme Project Management)

Description of model:

Extreme project management is the art and science of facilitating and managing the flow of thoughts, emotions and interactions in a way that produces valued outcomes under turbulent conditions. Extreme Project Management is a set of tools, templates, and processes for managing projects whose goal expresses an ideal state but whose solution for reaching that goal is unknown or unlikely.

Philosophy:

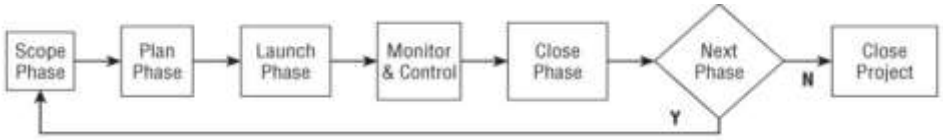
- In extreme project management methodology, there are no fixed project phases and fixed set of guidelines on how to execute the project activities.
- It adapts to the situation and executes the project activity the best way possible.

Principles:

- Requirements and project activities being chaotic is normal
- Uncertainty is the most certain characteristic of an extreme project
- This type of projects is not fully controllable
- Change is the king and you need to welcome it every possible way
- The feeling of security is increased by relaxing the project controls

Process:

- Model diagram



- Year developed: n/a
- Developer: - (Doug Decarlo)
- Industry: Any complex project, software
- Popularity: Uncommon
- Reason for development: Extreme projects are at the furthest corner of the landscape where uncertainty and complexity are at their highest levels. Because of that, the failure rates of Extreme projects are the highest among all types of projects
- Strengths:
    - Keep options open as late as possible
    - Offers an early look at number of partial solutions
- Weaknesses:
    - May be looking for solutions in the wrong place
    - No guarantee of positive outcome

Lean

Description of model:

Lean is a methodology that is focused on streamlining and cutting out waste. The first step is to create a work process breakdown to identify and eliminate bottlenecks,

delays, and all forms of waste (“muda”). The goal is to do more with less: i.e. deliver value to the customer using less manpower, less money, and less time.

There are many ways to do this, but the two most prevalent are the 6 Sigma DMAIC method or the Deming Cycle (Called the "A3" since the steps are recorded on an A3 size paper). 6 Sigma Companies use 6 Sigma Black Belts to take an improvement project through the steps of Define, Measure, Analyze, Improve, and Control. Other companies use the A3 Problem solving Process which includes the statement of the problem, the current situation, the root cause of the problem, suggest alternative solutions, suggest a recommended solution and have a cost-benefit analysis. This information would fit all on one A3 size sheet of paper. Another type of lean project management is called Kanban.

Philosophy:

One of the main goals of lean project management is creation and removal of blockages in the production process to accelerate growth and increase productivity.

Principles:

- The main principle of lean project management is delivering more value with less waste in a project context. There are 5 core principles to Lean-value identification: value stream mapping, enabling flow, developing pull, and continuously improving.
    - Specify the value desired by the customer
    - Identify the value stream for each product providing that value and

challenge all the wasted steps (generally nine out of ten) currently necessary to provide it

- Make the product flow continuously through the remaining value-added steps
- Introduce pull between all steps where continuous flow is possible
- Manage toward perfection so that the number of steps and the amount of time and information needed to serve the customer continually falls

Process:

Lean project management has many techniques that can be applied to projects and one of main methods is standardization. Key techniques are those "inherited" from Agile software development like: blame-free employee involvement, the need for a strong facilitator, pipelining, etc.

- Model diagram

- Year developed: Late 1940's
- Developer: Toyota engineer Taiichi Ohno
- Industry: Manufacturing, Information Technology, Services, Project Management

- Popularity: The number of companies using lean construction methods has been steadily increasing with increased awareness. With the increase of learning tools, books, classes and seminars that have become available to business buyers and companies, lean building has shown a substantial boom in the industry. Implantation in other countries such as the UK, Brazil, India and Germany has also been increasing.
- Reason for development: Shortcomings in the manufacturing process.
- Strengths:
    - Using fewer materials and having less waste can greatly reduce all around costs. Although the philosophy of lean construction is focused on overall reduction, not just for profit, utilizing this methodology has shown to increase the bottom line.
    - Construction time can greatly be reduced by increased planning and strategic vision.
    - Fewer accidents and a higher rate of safety through increased worker focus and understanding.
    - Increased schedule reliability and predictability.
    - Improved overall results due to increased communication and fewer workers.
    - Decreased stress for workers and management due to fewer workers.
    - Increased productivity all around due to a higher rate of planning.
    - Increased job satisfaction resulting in more performance commitment.

- Weaknesses:
    - A Lean organization manages only what needs managing, when it needs management.
    - For this method of construction to be effective, all areas of management, along with the workers, must be in accordance with the plan. If there is a break in the chain, the lean methodology cannot work.
    - Getting everyone onboard with a new production method isn't easy, and some people may be ambivalent about change.
    - For successful implementation, management officials must be able to guide employees directly and efficiently. The lean method of operation is derived by how well a management official can work with his employees more so than with the standard procedure, and personality clashes, as well as other issues may arise.
    - Training and educating employees in the lean method takes time and dedication, and as expressed earlier, some workers may not like or deal well with change.
    - Staying on course with a new system of operation can be difficult for some managers, and some may grow frustrated.
    - Cohesive teamwork is essential for lean production. Each worker must be well versed in his position or a breakdown will occur as all workers rely on one another.
    - Training employees with a new system can take some time, and this could decrease the overall time on a project or design.

- Management must be astute to all production issues as a breakdown in the system can easily occur. Staying alert to the change in operations can be hard for all employees.
- Suppliers and distributors must be notified of the change in production, and this could cause problems.
- A temporary decrease in employee morale might be noticed due to the change in policy.

Lean Six Sigma

Description of model:

Combining the minimalist approach of Lean ("no waste!") and the quality improvement of Six Sigma ("zero defects!"), Lean Six Sigma focuses on eliminating waste so that projects are more efficient, cost effective, and truly answer customers' needs. Lean six sigma then is a methodology that looks to combine the best of both the lean manufacturing and the 6 Sigma approaches. As a result, the combination provides a method to accelerate a company's decision-making processes, while both reducing production inefficiencies as well as increasing product quality.

Philosophy:

Lean Six Sigma refers to the eight types of waste it strives to eliminate as "DOWNTIME," which is an abbreviation of "defects, overproduction, waiting, non-utilized talent, transportation, inventory, motion and extra-processing." Simply put, any

use of resources that doesn't create value for the end customer is considered a waste and should be eliminated. Lean Six Sigma training uses "Belt" levels like Six Sigma.

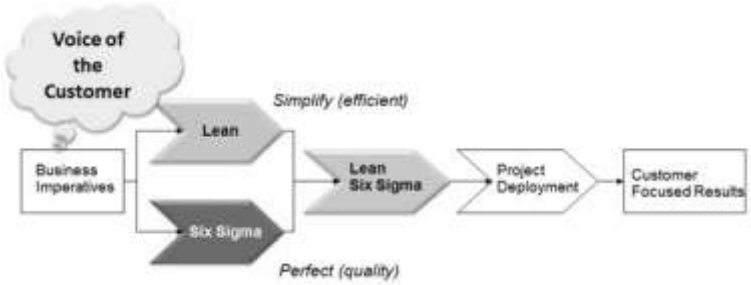
Principles:

The first of five guiding principles of Lean Six Sigma is that the customer always comes first. It’s vital to make sure that all employees understand that customers are the heart of any business. The second is to understand that flexibility is fundamental; no business procedure is ever written in stone. The third is to focus on isolating and fixing only those problems that require fixing. The fourth guiding principle refers to speed and proportion. The more steps it takes to complete a process, the longer it will take. The main question is whether extra steps add to or decrease value. The final principle is to eliminate complexity and keep business processes as simple as possible.

Process:

Lean Six Sigma uses tools such as process maps, affinity diagrams and value stream mapping to identify and eliminate inefficiencies. Process mapping is a common starting point. The goal is to depict each step in a current process using symbols and flowcharts. Value stream mapping assists in identifying waste and eliminating non-value-added activities in each step of a process. From there, affinity diagrams help a Sigma team review, organize and prioritize information about problems and potential solutions gathered during brainstorming sessions

- Model diagram



- Year developed: During the 2000s Lean Six Sigma broke off Six Sigma.
- Developer: The first concept of Lean Six Sigma was created in 2001 by a book titled Leaning into Six Sigma: The Path to integration of Lean Enterprise and Six Sigma by Barbara Wheat, Chuck Mills, Mike Carnell.
- Industry: Manufacturing, Information Technology, Services, Project Management
- The main reason to implement LSS approach in Caterpillar Inc. was to gain competitive advantage by breakthrough improvements. Because of innovative products, their revenues had grown by 80 percent.
- Popularity: Throughout the early 2000s and mid 2000s Lean Six Sigma was not a popular practice among businesses. In the late 2000s with the Great Recession, this prompted many businesses away from the Six Sigma concept and more towards a Lean Six Sigma concept
- Reason for development: Lean Six Sigma allows managers to effectively address issues of speed, quality, and cost. Rather than just eliminating steps that may appear wasteful or spending months testing a variety of innovative options, it balances the worth of each of the two methodologies from which it originates.

Lean principles emerged in the 1990s, to reduce process cycle times, improve on-time delivery and reduce costs by eliminating non-value-added waste.

- Strengths:
    - Lean Six Sigma increases your organization's profit by streamlining processes.
    - Decreases costs. Lean Six Sigma enables you to fix processes that cost your organization valuable resources.
    - Lean Six Sigma develops effective employees within your organization.
    - Lean Six Sigma improves the efficiency of your organization.
    - Lean Six Sigma encompasses many common features of Lean and Six Sigma such as an emphasis on customer satisfaction, a culture of continuous improvement, the search for root causes, and comprehensive employee involvement. In each case, a high degree of training and education takes place, from upper management to shop floor.
- Weaknesses:
    - An integration of two different approaches there is a possibility that one dominates other throughout implementation.
    - It does not support creativity and turns people into robots mainly due to increased workload.
    - Reports that is does not work well in small-to-medium-sized enterprises (SME) due to lack of critical success factors such as commitment from top management, lack of understanding of tools and techniques and lack of financial capability.

Six Sigma

Description of model:

Six Sigma is a statistics-based methodology that seeks to improve the quality of a process by measuring the defects or bugs present and getting it down as close to zero as possible. A process can therefore attain a rating of Six Sigma if 99.99966% of the final product — your project deliverable — is defect-free.

Philosophy:

Six Sigma's goals are to reduce defects and variation so that processes are more consistent and predictable. Six Sigma is essentially a set of practices used in organizations to improve the manufacturing process output and eliminate defects in the production line

Principles:

Six sigma methods integrate principles of business, statistics and engineering to achieve tangible results. In lean Six Sigma, there are five principles that are used:

- Law of the market - the customer is always to be put first.
- Law of flexibility if a process is easily maneuverable, it is easier to work with. A method of business that cannot be changed for any reason can cause problems.
- Law of focus - is meant to keep the focus on the problems within the company and not the entire company itself.
- Law of velocity - means that if a process has many, many details that must be performed, it may be slowing down the process. The work put into the

process should be proportional to the results the company sees.

- Law of complexity - keep it simple. When a process is complex and difficult, it may have elements that are not necessary.

Process:

Six Sigma methodology is usually implemented using two sub methodology: DMAIC and DMADV. The first methodology stands for Define, Measure, Analyze, Improve and Control. It is usually used as on existing processes/products that are currently not meeting the requirements. DMAIC will usually offer incremental improvements on these existing processes. On the other hand, the DMADV methodology (Define, Measure, Analyze, Design and Verify) is used to develop totally new processes/products. The end product will then bear the Six Sigma quality level. DMADV can also be used on existing products that require more than just an incremental improvement. These two Six Sigma methodologies are executed by what are called Six Sigma Green and Black belts. There is also a Six Sigma Master Black Belts that supervises the two others.

- Model diagram

- Year developed: Originated by Motorola in the 1980s.
- Developer: Motorola

- Industry: Manufacturing, Information Technology, Services, Project Management
- Popularity: Today Six Sigma is widely used in many industries
- Reason for development: Six Sigma, a registered trademark of the Motorola Corporation, came first in the 1980s to improve service quality and reliability and reduce defect levels of products and services by eliminating process inefficiencies.
- Strengths:
    - Success implementation of Six Sigma usually leads to an increase in profitability.
    - Will enhance the value of products/services from a customer point of view
    - Alleviates Team Building problems since it requires that kind of cross-functional communication to succeed.
    - Continuous Improvement.
    - Compulsory Training.
    - Low Resistance for Organizational Change - members of the organization are constantly expected to come up with recommendations and solutions to improve the current processes.
- Weaknesses:
    - Six Sigma approach is too costly and focused and the cost inherited by trying to improve efficiency is far greater that having the waste in the first place.
    - Six Sigma is that it relies heavily on data and measurement.
    - Identifying what exactly qualifies as a statistical error and what is acceptable and what are the assumptions that can be made.

- Very destructive in companies that rely highly on innovation and creativeness such as high-tech fields where 'outside the box' thinking is essential to drive the business and revenues.

Process Based Project Management

Description of model:

Process-based management is a management approach that views a business as a collection of processes, managed to achieve a desired result. The processes are managed and improved by organization in purpose of achieving their vision, mission and core value. A clear correlation between processes and the vision supports the company to plan strategies, build a business structure and use sufficient resources that are required to achieve success in the long run

Philosophy:

It's all about "mission accomplished." Every project is defined by your company mission or vision statement "Improve Global Collaboration." Before project kick-off, the plan is analyzed to see if it will live up to your mission statement; if it won't then all strategies and goals are adjusted to meet that objective.

Process:

- Documenting the process
- Analyzing process performance
- Implementing the improvements
- Year developed: -

- Developer: -
- Industry: Healthcare, Military, Product
- Popularity: Uncommon
- Reason for development: -
- Strengths:
    - This approach helps ensure that every project aligns with, and adds value to, the organization's strategic vision.
    - Documenting a process provides a clear guideline of how organization improves their processes and performances over time. [8]
    - Understanding of the correlations between business processes avoids taking wrong decisions. It reduces costs, time and resources wasting on unnecessary things. [2]
    - Analyzing the processes, an organization will be able to predict sources of hazard and choose right decisions. [3]
    - Analyzing processes and implementing new objects if required, the organization deal with fast changes in demand.
- Weaknesses:
    - Adjusting every team's projects and processes to fit the mission can be very time- consuming. And it doesn't allow for side projects, so if your company wants to take on tasks unrelated to your values you'll have to revisit your company mission statement first

Business Process Modeling

Description of model:

Business process modeling (BPM) in systems engineering is the activity of representing processes of an enterprise, so that the current process may be analyzed or improved.

Philosophy:

A business process is a collection of related, structured activities or tasks that produce a specific service or product (serve a goal) for a customer or customers.

Principle:

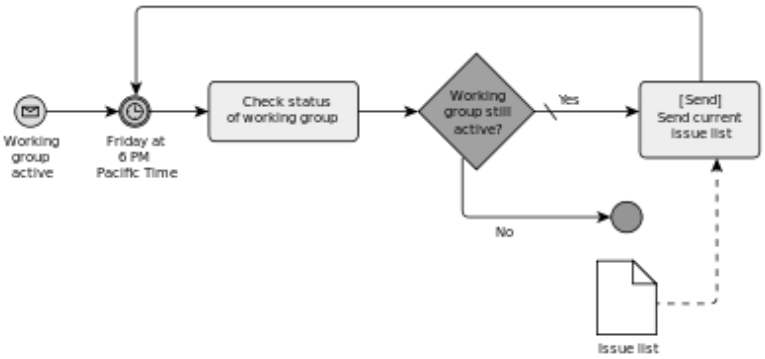
BPM is typically performed by business analysts, who provide expertise in the modeling discipline; by subject matter experts, who have specialized knowledge of the processes being modeled; or more commonly by a team comprising both. Alternatively, the process model can be derived directly from events' logs using process mining tools.

Process:

There are three main types of business processes:

- Management processes that govern the operation of a system. Typical management processes include corporate governance and strategic management.
- Operational processes that constitute the core business and create the primary value stream. Typical operational processes are purchasing, manufacturing, marketing, and sales.

- Supporting processes, that support the core processes. Examples include accounting, recruitment, and technical support.
- Model diagram



- Popularity: common
- Year developed: 20th century
- Developer: The term 'business process modeling' was coined in the 1960s in the field of systems engineering by S. Williams in his 1967 article 'Business Process Modeling Improves Administrative Control'.
- Industry main used in: In the most basic sense, a business model is the method of doing business by which a company can sustain itself. That is, generate revenue. The business model spells-out how a company makes money by specifying where it is positioned in the value chain.
- Reason for development: Sequence can have a pivotal influence on business process activities, but sequence is not always pivotal, and indeed certain situations are best analyzed from a non- sequential viewpoint.

- Strengths:
    - Align Operations with Business Strategy
    - Improve Process Communication
    - Increase Control and Consistency
    - Improve Operational Efficiencies
    - Gain Competitive Advantage
- Weaknesses:
    - Sequence can have a pivotal influence on business process activities, but sequence indeed certain situations are best analyzed from a non-sequential viewpoint.

Deming PDCA

Description of model:

The PDSA Cycle (Plan-Do-Study-Act) is a systematic series of steps for gaining valuable learning and knowledge for the continual improvement of a product or process. Also known as the Deming Wheel, or Deming Cycle, the concept and application was first introduced to Dr. Deming by his mentor, Walter Shewhart of the famous Bell Laboratories in New York.

Philosophy:

PDCA was made popular by Dr W. Edwards Deming, who is considered by many to be the father of modern quality control; however, he always referred to it as the "Shewhart cycle". Later in Deming's career, he modified PDCA to "Plan, Do, Study, Act"

(PDSA) because he felt that "check" emphasized inspection over analysis. PDSA cycle was used to create the model of know-how transfer process.

Principle:

A fundamental principle of the scientific method and PDCA is iteration—once a hypothesis is confirmed (or negated), executing the cycle again will extend the knowledge further. Repeating the PDCA cycle can bring us closer to the goal, usually a perfect operation and output

Process:

The cycle begins with the Plan step. This involves identifying a goal or purpose, formulating a theory, defining success metrics and putting a plan into action. These activities are followed by the Do step, in which the components of the plan are implemented, such as making a product. Next comes the Study step, where outcomes are monitored to test the validity of the plan for signs of progress and success, or problems and areas for improvement. The Act step closes the cycle, integrating the learning generated by the entire process, which can be used to adjust the goal, change methods or even reformulate a theory altogether. These four steps are repeated over and over as part of a never-ending cycle of continual improvement.

- Model diagram

- Popularity: common
- Year developed: 1991
- Developer: Dr W. Edwards Deming
- Industry main used in: You can use the model in all sorts of business environments, from new product development, project and change management, to product lifecycle and supply chain management.
- Reason for development: An engaged, problem-solving workforce using PDCA is better able to innovate and stay ahead of the competition through rigorous problem solving and the subsequent innovations.

Stage Gate

Description of model:

Stage-Gate is a value-creating business process and risk model designed to quickly and profitably transform an organization's best new ideas into winning new products. When embraced by organizations, it creates a culture of product innovation excellence - product leadership, accountability, high-performance teams, customer and market focus, robust solutions, alignment, discipline, speed and quality.

Philosophy:

A phase–gate model is a conceptual and operational road map for moving a new project from idea to launch – a blueprint for managing the new-product process to improve effectiveness and efficiency.

Principle:

Each phase consists of a set of prescribed, cross-functional, and parallel activities undertaken by a team of people from different functional areas. Phases have a common structure and consist of three main elements:

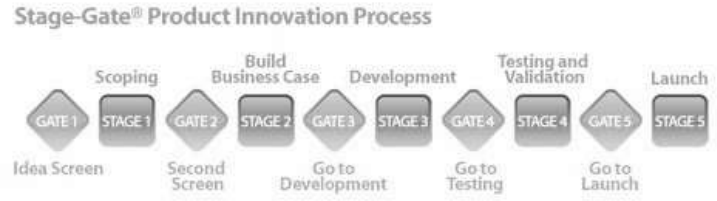
- Activities: Consist mainly in information gathering by the project team to reduce key project uncertainties and risks.
- Integrated Analysis: An integrated analysis of the results of the activities is undertaken by the project team.
- Deliverables: The results of integrated analysis that are used as input for the next Gate.

Process:

- In the typical Stage-Gate model, there are 5 stages, in addition to the Idea Discovery Stage:
    - Stage 0 – Idea Discovery: Pre-work designed to discover and uncover business opportunities and generate new ideas.
    - Stage 1 – Scoping: Quick, inexpensive preliminary investigation and scoping of the project – largely desk research.

- Stage 2 – Build the Business Case: Detailed investigation involving primary research – both market and technical – leading to a Business Case, including product and project definition, project justification, and the proposed plan for development.
- Stage 3 – Development: The actual detailed design and development of the new product and the design of the operations or production process required for eventual full-scale production
- Stage 4 – Testing and Validation: Tests or trials in the marketplace, lab, and plant to verify and validate the proposed new product, brand/marketing plan and production/operations.
- Stage 5 – Launch: Commercialization – beginning of full-scale operations or production, marketing, and selling.

- Model diagram



- Popularity: common
- Year developed: 1940s
- Developer: American Association of Cost Engineers
- Reason for development: The project leader and team provide Gatekeepers with the high-level results of the activities completed during the previous stage.
- Strengths:
  - Its ability to identify problems and assess progress before the project's

conclusion.

  - The organization can potentially be provided with quantitative information regarding the feasibility of developing potential product ideas.
  - The model is an opportunity to validate the updated business case by a project's executive sponsors.

- Weaknesses:
  - Overly structured processes may cause creativity to be reduced in importance and to hinder the largely iterative process of innovation.

PRiSM

Description of model:

PRiSM stands for Projects Integrating Sustainable Methods and is a project management methodology that is aimed at managing change while incorporating environmental sustainability into its processes. The goal with PRISM is to complete projects while reducing a company's negative environmental and social impact. It is, quite literally, green project management.

Philosophy:

PRiSM Brings modification (projects) into a more tactical focus by leveraging existing organizational systems to guarantee that advantages are recognized horizontally and vertically, with the utmost attention concentrated on business sustainability

Principles:

PRiSM is a process-based, structured methodology for managing change. The methodology highlights areas of sustainability and integrates them into the traditional core project phases to reduce negative environmental and social impacts in all project types using the GPM P5 Standard.

- Commitment & Accountability - Recognizing the essential rights of all to healthy, clean and safe environments, equal opportunity, fair remuneration, ethical procurement, and adherence to rule of law.
- Ethics & Decision Making - Supporting organizational ethics, decision making with respect for universal principles through identification, mitigation, and the prevention of adverse short and long-term impacts on society and the environment.
- Integrated & Transparent - Fostering the interdependence of economic development, social integrity, and environmental protection in all aspects of governance, practice and reporting.
- Principal & Values Based - Conserving and enhancing our natural resource base by improving the ways in which we develop and use technologies and resources.
- Social & Ecological Equity - Assessing human vulnerability in ecologically sensitive areas and centers of population through demographic dynamics.
- Economic Prosperity - Establishing fiscal strategies, objectives, and targets that balance the needs of stakeholders, including immediate needs and those of future generations.

Process:

PRISM is an enterprise project lifecycle management solution that supports the planning, execution, and completion of capital projects for dependable forecasts, cost control, and performance measurement. PRISM aligns the project budget and schedule, provides change management with workflow, and delivers predictive analytics with enterprise reports and dashboards so that you can make better informed decisions.

- Year developed: 2013
- Developer: Developed by GPM Global
- Industry: Large-scale real estate development or construction/infrastructure projects
- Popularity: Uncommon
- Reason for development: PRISM methodology is used primarily on large-scale construction projects, such as real estate developments, where adverse environmental impacts are a very real danger. PRISM requires project managers to gain accreditation, ensuring the methodology is administered properly and retains its value. It was established for companies to incorporate job procedures with sustainability efforts to attain company goals while reducing unfavorable ecological effect.
- Strengths:
    - Shows stakeholders that the company is serious about eco-ideals; reduced energy, waste management and distribution costs.
- Weaknesses:
    - PRiSM cannot work in isolation. Every level of the company needs to be

on board with sustainable principles, or the methodology will fall flat.

- PRiSM cannot operate in seclusion. Every level of the business must be on board with sustainable concepts, or the method will fail.

Benefits Realization

Description of model:

Benefits realization management (BRM) (also benefits management, benefits realization or project benefits management) is one of the many ways of managing how time and resources are invested into making desirable changes.

Philosophy:

Project benefits management is defined as "the initiating, planning, organizing, executing, controlling, transitioning and supporting of change in the organization and its consequences as incurred by project management mechanisms to realize predefined project benefits".

Principle:

BRM practices aim to ensure the alignment between project outcomes and business strategies and has been shown to increase project success across different countries and industries. The Project Management Institute (PMI) identified that only one in five organizations report high maturity in benefits realization.

Process:

- A generic BRM process is to:
    - Identify the investment outcomes; Define benefit measures for each outcome; Collect current benefit measure data to have a quantitative basis for decision making; Agree a tailored BRM approach for this investment; Plan the new or changed capabilities necessary to realize the benefits; Plan the investments needed to make the changes necessary to create or change the capabilities; Optimize the plan to reduce waste and have acceptable levels of resource, risk, cost, quality and time; Implement the plan; Review the impact of the plan implementation on the Benefit Measures and use insights to improve; On completion of the plan, ensure BRM continues to sustain the capabilities and realization of benefits
- Model diagram

- Popularity: common
- Year developed: Late 1980s and early 1990s
- Developer: Association for Project Management (APM)

- Industry mainly used in: IT industry
- Reason for development: The main roles are Business Change Managers (BCMs) who help the Benefits Buyers (i.e. the main beneficiaries) identify, plan and review the expected benefits from the change and project managers who deliver the reliable capability on time and within budget.

Rapid Applications Development

Description of model:

RAD is an approach to software and training product development based on minimal planning, as opposed to rapid prototyping and real-time development. This is a type of software development that does not spend a lot of time or resources on planning and instead uses a method of prototyping to introduce the product. RAD should be used when there is a need to create a system that can be modularized in 2-3 months of time.

Philosophy:

RAD concentrates on the delivery of the product and involves the client from the start and focuses on the client's needs, uses an incremental approach, keeps the project plan updated, applies development fundamentals, and manages risks to avoid catastrophic setbacks.

Principles:

Successful rapid development starts with understanding and defining the client's business needs, and then moves through the phases of high-level requirements to detailed

requirements, to design, to prototyping, to development, and to implementation. Testing should be involved early in the project and throughout the development effort. One of the goals of RAD is to provide an updated "look and feel" of the evolving product and to allow the client to have hands-on contact with the product as soon as possible

Process:

- The phases in the rapid application development (RAD) model are:
    - Business modeling: The information flow is identified between various business functions.
    - Data modeling: Information gathered from business modeling is used to define data objects that are needed for the business.
    - Process modeling: Data objects defined in data modeling are converted to achieve the business information flow to achieve some specific business objective. Description are identified and created for CRUD of data objects.
    - Application generation: Automated tools are used to convert process models into code and the actual system.
    - Testing and turnover: Test new components and all the interfaces.
- Model diagram

- Year developed: James Martin developed the rapid application development approach during the 1980s at IBM.
- Developer: James Martin developed the rapid application development approach during the 1980s at IBM and finally formalized it by publishing a book in 1991, Rapid Application Development. This has resulted in some confusion over the term RAD even among IT professionals. It is important to distinguish between RAD as a general alternative to the waterfall model and RAD as the specific method created by Martin. The Martin method was tailored toward knowledge intensive and UI intensive business systems.
- Industry: All Industries, users include: HR Professionals, Project Managers, Team Leaders, Social Media Managers, Data Specialists and Developers.
- Popularity: Rapid application development has become one of the most popular and powerful development methods.
- Reason for development: Rapid application development is a response to processes developed in the 1970s and 1980s, such as the Structured Systems Analysis and Design Method and other Waterfall models. One of the problems with these methods is that they were based on a traditional engineering model used to design and build things like bridges and buildings. The waterfall solution to this was to try and rigidly define the requirements and the plan to implement them and have a process that discouraged changes to either. The new RAD approaches on the other hand recognized that software development was a knowledge intensive process and sought to develop flexible processes that could take advantage of knowledge gained over the life of the project and use that

knowledge to reinvent the solution.

- Strengths:
    - Reduced development time.
    - Increases reusability of components
    - Quick initial reviews occur
    - Encourages customer feedback
    - Integration from very beginning solves a lot of integration issues.
- Weaknesses:
    - Depends on strong team and individual performances for identifying business requirements.
    - Only system that can be modularized can be built using RAD
    - Requires highly skilled developers/designers.
    - High dependency on modeling skills
    - Inapplicable to cheaper projects as cost of modeling and automated code generation is very high.

Spiral

Description of model:

The spiral model is a risk-driven process model generator for software projects. Based on the unique risk patterns of a given project, the spiral model guides a team to adopt elements of one or more process models, such as incremental, waterfall, or evolutionary prototyping.

Philosophy:

In later publications, Boehm describes the spiral model as a "process model generator", where choices based on a project's risks generate an appropriate process model for the project. Thus, the incremental, waterfall, prototyping, and other process models are special cases of the spiral model that fit the risk patterns of certain projects.

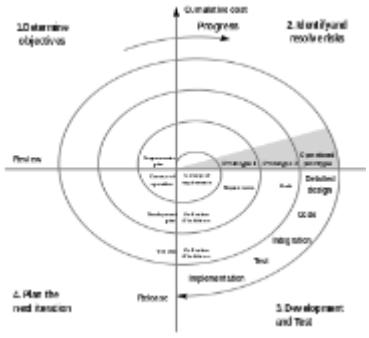
Principle:

Boehm also identifies many misconceptions arising from oversimplifications in the original spiral model diagram. He says the most dangerous of these misconceptions are:

- The spiral is simply a sequence of waterfall increments;
- All project activities follow a single spiral sequence; and
- Every activity in the diagram must be performed, and in the order shown.

Process:

- Model diagram



- Year developed: This model was first described by Barry Boehm in his 1986

paper "A Spiral

- Model of Software Development and Enhancement".
- Developer: Barry Boehm
- Industry main used in: Software development
- Reason for development: The project leader and team provide Gatekeepers with the high-level results of the activities completed during the previous stage.
- Strengths:
    - High amount of risk analysis hence, avoidance of Risk is enhanced.
    - Good for large and mission-critical projects.
    - Strong approval and documentation control.
    - Additional Functionality can be added later.
    - Software is produced early in the software life cycle.
- Weaknesses:
    - Can be a costly model to use.
    - Risk analysis requires highly specific expertise.
    - Project's success is highly dependent on the risk analysis phase.
    - Doesn't work well for smaller Projects

Conclusions and Recommendations

The construction industry, operates within a dynamic and fast changing environment with projects that have limited start and end dates, unique constraints, diversified team players, and are becoming more difficult to systematize and to develop sound methodologies and processes for; it is complex, and clients are becoming more

sophisticated and demand fast, high-quality and reliable construction with better value for money.

Many tools, techniques and standards or guides have been developed by different organizations to support the management of projects. 19 approaches were identified. Practitioners need to understand which approach works best for them, rather than follow the most popular model trending.