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Project Management: A Foundation for Leadership Transition

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Abstract

Leadership transitions present a myriad of challenges to organizations. In the Federal government, Senior Executives are expected to move around their organizations and lead in multiple contexts based on agency need. The American Community Survey Office (ACSO) at the Census Bureau recently experienced a change in Chiefs. This paper describes how well-established project management practices served to smooth the transition between Senior Executives and enabled critical business decision-making to continue even early in the transition.

Beginning in 1998, the U.S. Census Bureau made it a business priority to inculcate the globally recognized Project Management Body of Knowledge (PMBOK) throughout the fabric of the organization. Over the course of time, the Census Bureau has built a cadre of managers who are skilled in applying the PMBOK to their work, fostering strides in operations, planning, budgeting, and innovating at the agency. The years of constructing, adjusting, and strengthening a solid Census Bureau project management infrastructure have paid off in impressive business outcomes and organizational stability through leadership transitions

By describing the correlation between effective project management and leadership success through a transition, this paper will provide examples of benchmarks, lessons learned, and leadership practices that may serve other public or private organizations as they endeavor to lead through change.

Background

The United States Census Bureau is a leading source of quality data about the people and economy of our nation. It administers and analyzes over 130 surveys, which provide vital statistical support to American communities, businesses, and government agencies.[1] This work is successfully executed thanks in part to precision synchronization of thousands of activities through the full complement of project management infrastructure that the Census Bureau has developed over the last 18 years. Through project management, leaders at the organization plan, monitor, and adjust a broad variety of activities needed to carry out the mission. Some of those activities include budgeting, training survey administrators, conducting research for continuous survey improvement, creating billions of estimates based on survey data, engaging over 250,000 stakeholders (each with unique concerns, needs, and interests), and teaching data users how to use census data.[2] However, what makes it unique from other agencies is that the operational pace and resource expenditures necessarily balloon cyclically to accommodate the Decennial Census,

[1] Retrieved from http://www.census.gov/programs-surveys/are-you-in-a-survey/survey-list.html.

[2] Internal Census Records.

which is the largest peacetime mobilization existing in the United States. As such, the Census Bureau is in a perpetual state of operational expansion and contraction, which requires the stability and agility afforded through project management.

In the late 1990's the U.S. Census Bureau was busily preparing for the 2000 Decennial Census, when it received a report from the National Performance Review that highlighted critical performance management failures such as missed deadlines and spending that exceeded budgets. As a result, leaders at the Census Bureau moved swiftly to partner with ESI International Inc. and George Washington University (GWU) to create a Project Management Master's certificate program. Leaders created staff cohorts to receive the training. Subsequently, the 2000 Decennial Census was completed at $2 billion under budget which is in part attributed to the project management infrastructure created by the first cohorts who received their certificates and applied their learning in the workplace.[3] Over the years, over 2,800 Census Bureau employees have earned either the ESI/GWU certificate, or the citation (which was created to provide a more affordable option), and worked together to build a solid project management infrastructure that undergirds operational success at the Census Bureau. Members of the Senior Executive Service are pivotal figures in project management at the Census Bureau. As leaders in the organization, they depend on the project management system to provide them with the necessary insight to plan, lead initiatives, manage risk, and navigate transitions confidently and successfully.

Senior Executive Service: An Overview

The Civil Service Reform Act of 1978 established the Senior Executive Service for the purpose of ensuring "that the executive management of the Government of the United States is responsive to the needs, policies, and goals of the Nation and otherwise is of the highest quality."[4] The 7,000-plus members of the Senior Executive Service are highly skilled managers who often work their way up through the ranks in Federal civil service. They are expected to have mastery of core management functions that can be used in multiple environments, so that they may be rotated around their agencies, or as envisioned in 1978, even across the Federal government. However, a 2009 study co-authored by the Partnership of Public Service and Booz Allen Hamilton Inc. revealed that most Senior Executives remain in the same Federal agency throughout the course of their careers where they primarily engage in operational as opposed to strategic management.[5] This situation may be remedied by a new Executive Order, "Strengthening the Senior Executive Service", released on December 15, 2015. This order is requiring agencies to submit plans for SES rotation outside of their agencies. With this development, people who serve in the Senior Executive Service may benefit further from using project management to facilitate transition.

Because Senior Executives experience movement across their organizations, they must become adept at leadership transition. Employees and leaders alike can experience leadership transition

[3] From a July 2012 interview with the then Census Director-Robert Groves on "The Federal Drive" on Federal News Radio by Tom Termin and Emily Kopp.

[4] CSRA 1978 Title V Subchapter 2 Section 3131

[5] Retrieved from http://www.boozallen.com/content/dam/boozallen/media/file/reimagining-the-senior-executive-service-2009.pdf

as something akin to crisis, even under the best of circumstances. It's not hard to imagine how all involved in the transition may experience a sense of uncertainty, mistrust, and even feelings of grief and loss. Amidst transition, manager and employees alike look for stability as new learning displaces routine, and new relationships are forged. [6,7] It is during these times when a project management system offers a constancy that proves to be the foundation of a successful leadership transition. It provides a common framework that employees and leaders can use as a platform for clear communication. Stempowski found that the use of familiar terminology and processes foster transparency of expectations which assists in developing trust, as well as accelerating understanding of initiatives. Further, the constancy and familiarity facilitates rational decision-making on a neurological level amidst the pressures of transition as described below. [8]

A leadership transition can elicit emotions such as anxiety, fear, and even grief and loss that have the ability to impede rational thought processes. Specifically, the brain's "conflict regulator", the anterior cingulate cortex (ACC), and ventromedial prefrontal cortex (vmPFC), the brain's "balance sheet" play a large part in how leaders synthesize leadership transition.[9] The ACC, which is connected to the amygdala[10] but can be accessed by the conscious mind, impacts attention.[11] It can become overstimulated in the face of conflict, distracting thinkers from focusing on problems at hand. When it is overstimulated, the ability to focus on process can assist the thinker to stay focused. For example, pain studies have demonstrated that the amount of pain experienced by individuals are not actually related to the pain itself, but rather how much that person focuses on the pain.[12] The project management process is a pathway to solutions, and by focusing on that process, leaders can see a pathway away from the psychological pain caused by an existing unresolved problem. Without a process to maintain focus, the leader could languish by overthinking the problem; therein remaining in a cycle of pain or lack of resolution with an overstimulated ACC.

When it is functioning at its best, the vmPFC balances risk, delay, and ambiguity, which is something a project management system assists leaders to accomplish.[13] Project management processes provide a structure that disrupts the potential for emotional hijacking of the brain. Trust in and familiarity with the project management process disrupts the cycle of negative emotions, which often occur at a subconscious level and are thus difficult to control, allowing a leader to focus on the facts at hand.[14] The project management system shifts the focus of a leader's mind from "imminent threat" to a framework for understanding the tasks at hand. While

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[6] McNatt, D. B., & Judge, T. A. (2008). Self-efficacy intervention, job attitudes, and turnover: A field experiment with employees in role transition. *Human Relations, 6* (6), 783-810

[7] Nicholson, N. (1984). A Theory of Work Role Transitions. *Administrative Science Quarterly, 29* (2), 172-191

[8] Amanda L. Ingrim Olkin, Yulia R. Gel. (2016). *Leadership and Women in Statistics*. CRC Press. 175.

[9] Srinivasan S. Pillay. (2011). *Your Brain and Business: The Neuroscience of Great Leaders*. Pearson Education Inc. 197.

[10] The amygdala is part of the limbic system and regulates emotions.

[11] Ibid 196.

[12] Ibid. 197.

[13] Ibid.

[14] Ibid 198.

daily tasks present challenges to leaders, the high emotions associated with a leadership transition puts them at greater risk for thought and solution disruption where no project management system, exists.

Leadership Transition at the American Community Survey Office

In the spring of 2015 at the Census Bureau, the American Community Survey (ACS) experienced the transition of its top leader, a Senior Executive. The ACS is one of the better-known surveys that the Census Bureau manages. It is a comprehensive survey that replaced the long form of the Decennial Census. Each year, the ACS is disseminated to a sample of 3.5 million people. It was designed as an improvement over the long form both to ensure that communities of small populations and small geographies are counted, and that data is available annually as opposed to every ten years. In fact, the ACS is the most reliable source of information about the people in our communities and how our communities are changing. People in state and local regions use the wealth of information provided by the ACS for a wide variety of purposes, including comprehensive planning, economic development, emergency management, and broadening understanding about local issues and conditions. Businesses rely on ACS data to make key marketing, location, and financial decisions to serve customers and create jobs; when combining these expenditures with the more than $400 billion distributed annually by the Federal government based on ACS data, this survey impacts over $1 trillion worth of investments into our nation's communities each year.[15]

A central part of the business of the ACSO is to remain agile and cost-effective in the face of omnipresent emerging information needs. In this environment, it engages in research for continuous improvement on meeting those needs along with improving data quality and the experience of survey respondents. In order to carry out this research, ACSO assembles integrated project teams, works with subject matter experts, and tests the outcome of making changes to many activities that impact the survey. Some of those activities include employing new survey methodologies, improving field and telephone protocol, testing alternative survey packaging, and adjusting the sample. All of this research is one of many initiatives at ACSO that require fully-informed oversight to ensure that progress continues even through a change in ACSO leadership. Therefore, upon taking the helm as the new ACSO Chief, Deborah Stempowski immediately employed the project management system to quickly assess research project progress with views of schedule, milestones, staffing, budgets, and risks. Because of the level of effort ACS devotes to research, its project management system is quite mature as well as very familiar to staff. As a complement to the research processes, ACS also employs a similar structure to the management of its ongoing survey.

While the operational environment was new to Stempowski, the constants of the project management infrastructure were quite familiar to her. Because of Census' strong project management culture, both Stempowski and her staff were familiar with project management language and processes, allowing them to speak a common language to address the funding

[15] U.S. Census Bureau. (August 18, 2015). Agility in Action: A Snapshot of Enhancements to the American Community Survey. Retrieved from https://www.census.gov/programs-surveys/acs/operations-and-administration/2015-16-survey-enhancements/agility-in-action.html

issue. Indeed, the project management system served as a channel for her new staff to communicate with her about their steadily advancing research initiatives, for it gave all involved a common language to work together. The familiarity accelerated Stempowski's assimilation of the information at hand. For example, early in her term, Stempowski was faced with significant funding delays for annual research projects. Even though she was not familiar with all the details of the projects, Stempowski was able to use project management language, tools and techniques to guide her staff in conducting an assessment of the resulting impact from the funding delays. Using risk management and schedule management techniques, she and her staff were able to identify the impact from the schedule delays, and then identify mitigation plans and actions. The project management infrastructure gave her questions to ask about the work, questions which could be anticipated by staff based on their regular engagement with the project management system. She knew what to look for, and they knew what she would want to know, which understandably increased everyone's comfort level. It signaled the beginning of a relationship bound by trust, which is a pillar of efficacy in the working world. The project management system not only smoothed the transition, but shortened the transition period such that normal operations were not affected by senior leadership turnover. Additionally, project management supplied the basis for rational decision-making amidst the pressures of the transition.

Project Management at the American Community Survey Office

One benefit of the way project management is practiced at the ACSO is its simplicity and integration with the Census Bureau-wide management process. A strong governance foundation provided by the ACSO Program Management Governance Board (PMGB) reinforces the project management infrastructure at ACSO. The PMGB brings together key stakeholders from senior leadership across the Census Bureau and follows established program and project management processes through a lifecycle, similar to those in use across the Census Bureau. The lifecycle begins with new work requests and moves through decision-making, planning, execution and control, then finally closeout. The PMGB monitors each phase in the lifecycle, makes critical decisions at important milestones and makes requests for adjustments where needed. It also provides status updates to senior leadership in the Decennial Directorate as well as the Operating Committee, a senior executive oversight committee chaired by the Chief Operating Officer of the Census Bureau. Each phase of the lifecycle addresses critical oversight needs. Figure 1 below illustrates the ACSO Project Management Lifecycle. Each lifecycle component is described in the section that follows.

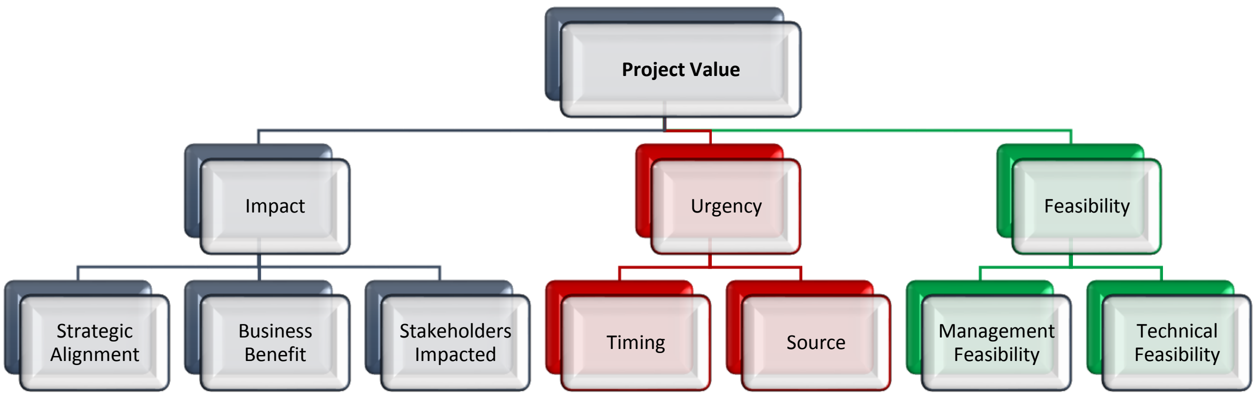
Figure 1. ACSO Project Management Lifecycle

1) New ***work requests*** begin with a short document that includes a brief description of the work, a rough estimate of the resources and a high level milestone schedule. Requestors review lessons learned from similar projects and incorporate them into the attributes of the request. Work requests are created for all work including mandatory and unfunded, that are not considered ongoing operations and maintenance for the ACS.

2) ***Decision-making*** by the PMGB is supported by a discussion of the work request as well as scoring the work request and its potential impact and risks against the ACS strategic objectives it supports. Because the PMGB has broad representation from all operational areas, including those outside of ACSO, various viewpoints are part of the process and all stakeholders are aware and informed even for projects outside of their usual scope and authority.

Even mandatory work requests are scored so the relative score can be compared to other work in the ACS portfolio. Projects are also assigned a tier level at that time so that appropriate oversight can be implemented from the project start. The PMGB assigned tiers are informed by scoring criteria which include a comprehensive consideration of the project's value as illustrated in the Figure 2 below. The PMGB also explores potential project risk, visibility, costs, and degree of complexity. It also looks at how completely the requestor defines the project and all its parameters along with how well the committee understands the work request itself.

Figure 2. Pre-Decisional Consideration of Project Value



Decision-making can have a variety of outcomes: approved, denied or deferred.

3) ***Planning*** after a project is approved requires that requestors develop a robust resource-loaded project schedule that follows ACS standards and guidelines for schedules. These standards cover baselines, task-level details such as duration, logic, order, and constraints. They also address standards for reporting, software fields, oversight, and dependency network. Project milestones must be documented. Once the schedule is in place and resources, both staff and funds, are identified and secured, the project enters the execution and control phase.

4) ***Execution and Control*** is the longest phase in the process. By following the guidelines and standards associated with the oversight tier assigned during the decision making process, project managers use consistent practices to monitor and report on the status of the work. Risk and issue identification and management are key components of this phase, with monthly project management reviews (PMRs) that provide an opportunity to address challenges with the triple constraint (budget, schedule, scope) as well as quality that is affected by all three constraints.

5) ***Project Close-out***, the final phase, provides an opportunity for the ACSO staff to reflect on work that has been completed and document lessons learned, which encompass both good practices and areas for improvement. At this time, the PMGB and ACSO acknowledge that staff who completed the work are now available for new assignments. At the close of this phase, ACSO employees take care to update the ACS portfolio to show that the work is complete. By presenting to the PMGB as part of the project close-out phase, managers are informed and can communicate with their staffs appropriately.

Conclusion

Even within an organization like the Census Bureau that has a solid project management infrastructure, there can be differing opinions about the value of project management. Some may perceive it as a futile bureaucratic process that consumes significant time and staff resources while overlooking the strategic value of consistency, continuity and delivery on strategic goals and objectives. When working within a complex system such as a Federal agency, schedules have thousands of moving parts which must be monitored, analyzed, coordinated, and updated, in order to both remain functional and achieve success. Risks need to be managed, budgets need to be monitored and scope needs to be controlled through sound project management practices. Though daily operations present multiple stresses to leaders and their staff alike, managing through a leadership transition presents special challenges associated with adapting to change. Some of our knowledge about neuroscience suggests that project management could assist all involved with leadership transition to stay focus and minimize potential distractions brought on by emotional response to change.

Not all leaders see the value in the consistent investment in project management. However, in the case of the ACSO, for Stempowski and her staff, it provided value through the seamless operation of the office during leadership transition. The bevy of complex research projects that were in play when she arrived continued without interruption, as Stempowski used the project management system to rapidly make sense of their multiple, interdependent moving parts. Indeed, project management can be credited for enabling tremendous public value to our nation's communities through the rigorous process it represents with the successful delivery of the ACS and all the ancillary activities the ACS drives. The strong governance foundation provided by the ACSO PMGB supports key stakeholders from senior leadership across the Census Bureau and reinforces established program and project management processes, similar to those in use across the Census Bureau. The project management-inspired environment provides the stability necessary to facilitate smooth transitions in leadership for continuity of operations and focus. As illustrated by the example of SES transition at the Census Bureau, other organizations may benefit from developing or strengthening an existing project management system to stay focused through the operations disruption and emotional responses caused by leadership change. For members of the Senior Executive Service who may soon be rotating across agencies, this may hold a special significance.

Leveraging on Unmanned Ariel Vehicle (UAV) for Effective Emergency Response and Disaster Management

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ABSTRACT

Over the past two decades, the impact of disasters has been devastating, affecting 4.4 billion people, resulted in 1.3 million causalities and $2 trillion in economic losses. Global climate change and worldwide instabilities have affected urban areas. In spite of all the technological advances, the impacts of natural and manmade disasters in urban areas represent an increasing challenge – therefore effective mitigation and emergency response strategies are pivotal. Concerning post-disaster reconstruction scenario, the most significant factor is accessibility to the disaster affected area and timely response based on best possible information available. Effective emergency response and sustainable post-disaster reconstruction are crucial and lie at the heart of disaster management agencies in almost every cautious country around the globe. The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years. The success of the reconstruction phases, i.e., rescue, relief, and rehabilitation, is mainly dependent on the accessibility to the site, availability of efficient project teams and timely information to make informed decision. Using UAV to access the affected areas and to monitor and capture data to make well-informed decisions, combined with the efficiency of a project team and strong coordination, project success should increase. This paper presents potential application of UAV for accessibility to affected areas, monitoring, and capturing timely and useful information for enhancing prompt and effective sustainable disaster management. The UAV with mounted imaging device will access to disaster struck areas and capture timely and useful information for making more informed decisions for effective, timely and sustainable response in post-disaster scenarios.

The potential application of UAV would be helpful for emergency response management teams to access areas that are otherwise not accessible, take timely measures by learning from captured information, making informed decisions related to effective emergency response and disaster management processes undertaken by emergency management agencies. Professionals need to have access to disaster struck areas to respond to emergency and provide urgent and critical life saving aids. Timely access and information will support a better and more efficient system for sustainable disaster management. Hence, the study is valuable for all professionals involved with research and development of emergency response and sustainable disaster management strategies.

INTRODUCTION

The recent sudden increase of natural and manmade disasters has taught many valuable lessons (Iglesias, 2007). Unfortunately, the need for preparedness is greater than ever before, given the increasing frequency and worsening intensity of weather-related storms and the escalation of technological threats (Moeini et al., 2013). No geographical area is immune or protected from the threat of emergencies and disasters. The importance of a proactive approach in responding to a disaster scenario in term of learning from past projects cannot be overstated (Arain, 2008). Pre-planning with local public safety and emergency response agencies can decrease confusion when a jobsite incident occurs (Ahmed, 2008). A quick response due to proper pre-planning and preparedness can expedite saving lives and rehabilitation process (Moeini et al., 2013).

Post-disaster reconstruction and rehabilitation is a complex issue with several dimensions (Arain, 2015). Many professionals in both fields tend to focus on planning and immediate response and have only recently begun to consider the requirements and opportunities inherent in long-term mitigation and reconstruction (Vale and Campanella, 2005). The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years (Pelling, 2003). Government, non-government, and international organizations have their own stakes in disaster recovery programs, and links must be established among them, as well as with the community. In other words, a post-disaster rehabilitation and recovery programs should be seen as an opportunity to work with communities and serve local needs. Relief and development often leads to burdens on the recipient government, and also often fails to serve the actual purpose and to reach the people in need (Shaw et al., 2003).

Environmental management professionals are now concentrating on the sustainability of environmental quality and environmental improvement; emergency managers and planners are re-focusing their efforts on the survivability of systems, organizations, and communities (Vale and Campanella, 2005). Sustainability and survivability are, in truth, two aspects of the same concept, namely: how to encourage and achieve continual improvement in ecosystems, the built environment, and human society (Pellow and Brulle, 2005). Both environmental management and emergency management have much to contribute to, and to gain from, the planning and implementation of post-disaster reconstruction.

Development is a dynamic process, and disasters provide the opportunities to vitalize and/or revitalize this process, especially to generate local economies, and to upgrade livelihood and living condition. Shaw and Sinha (2003) suggested the ideal level of involvement of different stakeholders after the disaster, as shown in Figure 2. The standard time frame of rescue, relief, and rehabilitation are defined as short term, long term, and longer term respectively.

Increasing worldwide impact of climate change, environmental degradation from human exploitation, urbanization and economic and social instabilities, unknown patterns and consequences of recent type of natural and manmade disasters, social and cultural complexity of urban residences and the aging urban infrastructures has increased the level of vulnerability to any type and different level of disaster (Pelling, 2003). Due to the increasing urbanization and population growth, the impact of any type of disaster (natural or manmade) in an urban area can be devastating with longer recovery period.

Increasing discussions and debates within disaster mitigation interest groups have raised questions regarding the practicality of adopting developmental approaches to disaster reconstruction (Ahmed, 2008). The chaos surrounding the disaster period following a disaster could easily lead to short-term and hasty decisions adversely affecting the community's ability to achieve sustainable, long term reconstruction goals (Arain, 2015). To minimize the occurrence of these unwise decisions, it is important to plan proactively for post-disaster restoration in order to provide general guidance for decision-makers and a framework for the professionals involved in reconstruction processes (Iglesias, 2007). For proactive plans and decisions, an integrated approach is required that may empower to implement the developed reconstruction strategy and monitor its results and progress.

The recent sudden increase of natural disasters has taught many valuable lessons (Iglesias, 2007). Unfortunately, the need for preparedness is greater than ever before, given the increasing frequency and worsening intensity of weather-related storms and the escalation of technological threats. No geographical area is immune or protected from the threat of emergencies and disasters. The importance of a proactive approach in responding to a disaster scenario in term of learning from past projects cannot be overstated. Pre-planning with local public safety and emergency response agencies can decrease confusion when a jobsite incident occurs (Arain, 2015). A quick response due to proper pre-planning and preparedness can expedite saving lives and rehabilitation process.

It is suggested that a timely access to relevant information and disaster site will assist in improving rescuing and reconstruction project processes, coordination and team building process because the most likely areas on which to focus to reduce unwise decision can be identified during the early stage of the post-disaster scenario (Arain and Low, 2006). Tapping on the live feed of information of post-disaster scenarios, the UAV system provides direct access to a wealth of pertinent and useful information for decision makers and eventually enhance collaborative venture. By having the access to timely information via UAV and a systematic way to make well-informed decisions, the efficiency of project team and the likelihood of strong coordination and eventually project success should increase (Arain, 2015).

The potential application of UAV would be helpful for emergency response management teams to access areas that are otherwise not accessible, take timely measures by learning from captured information, making informed decisions related to effective emergency response and disaster management processes undertaken by emergency management agencies. Professionals need to have access to disaster struck areas to respond to emergency and provide urgent and critical life saving aids. Timely access and information will support a better and more efficient system for sustainable disaster management.

UNMANNED AERIAL VEHICLE AND ITS APPLICATION

The UAV application supporting forest fire management is surely the most developed and practically demonstrated activity among all disasters (Restas, 2012). UAV can be used before fire for hot spot detection, during the intervention helping fire management with real time information and after suppression for post fire monitoring. The method of prescribed fire can be also in the focus of UAV use as a special application for fire prevention (Restas, 2015).

Detecting hot spots by aerials earlier than reporting it by civilians is obviously helps fire managers limiting the damages fires cause (Restas et al., 2014). Unfortunately the main reason why this method is not always used is the huge costs of aerials. If this procedure made by UAV is cheaper solution than the traditional one (manned aircraft) means option of drone use is the better solution. Naturally this case assumes the similar professional efficiency of different methods (Restas et al., 2014).

As pre-disaster activity, UAV following the stream of rivers can control the state of dams. In case of any unusual recognition the responsible authority can react in time for the problem. This activity is very flexible; the flight patrol can be optimized depending on time or other workload. Since affected areas are usually oversized, managing floods by aerials is always suffered from limited sources. It means drone can support disaster management at local level. This task requires tactical or operational UAV (Restas, 2015).

The stability of dams hangs on many conditions like the time it suffer from water press, how structure of dams built, what materials made of it. There is yet not enough information about it, however it can be supposed, with a procedure what is able to analyze the state of dam as airborne is help for managers. Knowing the state of dam managers can optimize the sources making the critic parts of dam stronger or in case of escalated problem can order the evacuation in time (Restas, 2015).

Since floods are a slowly developing disaster UAV can help for the management in many ways. With UAV observation can predict how flooded the area, what buildings are in risk, where from and where to evacuate the citizens, etc. The essence of this application is the gap of aerials what means the missing of manned aerials but UAV can offer as a satisfied solution (Restas, 2015).

An earthquake is a rapid escalating disaster, where, many times, there is no other way for a rapid damage assessment than aerial reconnaissance (Restas, 2015). For special rescue teams, the drone application can help much in a rapid location selection, where enough place remained to survive for victims. Floods are typical for a slow onset disaster. In contrast, managing floods is a very complex and difficult task. It requires continuous monitoring of dykes, flooded and threatened areas. UAV can help managers largely keeping an area under observation. Forest fires are disasters, where the tactical application of UAV is already well developed. UAV can be used for fire detection, intervention monitoring and also for post-fire monitoring. In case of nuclear accident or hazardous material leakage UAV is also a very effective or can be the only one tool for supporting disaster management (Restas, 2015).

Types of Unmanned Aerial Vehicles

The UAV classification is based on the military standards which have been partially adopted for civilian UAVs. Civilian UAVs are classified into two main classes: a) fixed wing, and b) multirotor or multicopter. Each UAV class has its unique design, operability and advantages and disadvantages which are briefly presented below.

Fixed Wing UAV

Fixed wing UAVs have a simple and aerodynamics structure consisting of a pair of rigid wings connected to the main fuselage. They a long flight time capacity(maximum 90 - 120 min) within both visual and beyond visual line-of-sight (VLOS & BVLOS) to cover long distances and large operational areas in a single flight.

This type of UAV is suitable for the rapid creation of aerial orthomosaic of disaster affected areas. Fixed wing UAVs offer a perfect platform for real-time accurate visual assessments of areas affected by disaster and enable the emergency responders to plan for response and recovery in large areas in a timely manner. The fixed wing UAVs are also effective platforms for immediate visual inspection of some critical infrastructure such as roads, railways, water, oil and gas pipe lines as well as power transmission lines.

Modified long range Skywalker X8

Modified long range Talon system

Modified long range Talon system

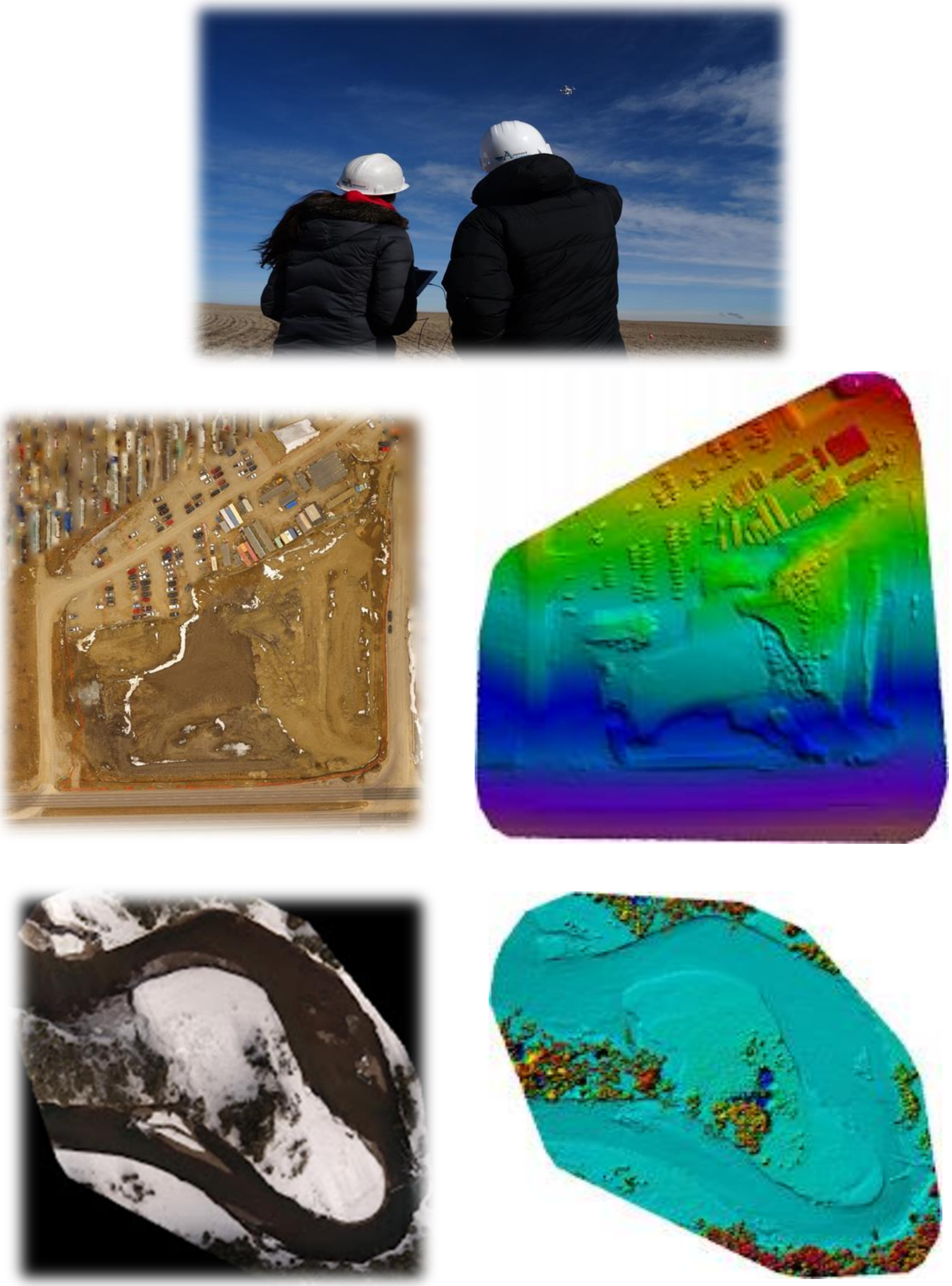
Modified Fixed Wing UAVs for aerial photogrammetry and surveying, equipped with Infrared and Sonar

Multirotor or multicopter

These types of UAVs have a more complex structure and better control systems operations compared to the fixed wing UVAs. In contrast to fixed wings UAVs multirotors have a lower speed and much shorter flight time (maximum 30- 40 minutes) due to their non-aerodynamics structure.

The main advantages, of multirotor UAVs are the Vertical Takeoff and Landing (VTOL) and capability to hover and perform agile maneuvering in small spaces. Multirotor UAVs are suitable platforms to inspect urban facilities such as bridges, power plants (fossil or nuclear fuel based), municipal buildings, hospitals and emergency centers. These types of UAVs are also able to carry different types of emergency packages such as CPR and emergency first aid kits to area with limited access. Multirotor UAVs enable the building inspectors to assess the building situation and define the possible damages with high level of accuracy and in a timely manner.

Modified Multirotor UAVs for aerial photogrammetry and surveying, equipped with Infrared and Sonar



Arial and infrared images of the flooded areas to inspect the possible equipment damage in the construction site during the flood

CONCLUSION

Concerning post-disaster reconstruction scenario, the most significant factor is accessibility to the disaster affected area and timely response based on best possible information available. Effective emergency response and sustainable post-disaster reconstruction are crucial and lie at the heart of disaster management agencies in almost every cautious country around the globe. The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years. The success of the reconstruction phases, i.e., rescue, relief, and rehabilitation, is mainly dependent on the accessibility to the site, availability of efficient project teams and timely information to make informed decision. Using UAV to access the affected areas and to monitor and capture data to make well-informed decisions, combined with the efficiency of a project team and strong coordination, project success should increase. This paper presents potential application of UAV for accessibility to affected areas, monitoring, and capturing timely and useful information for enhancing prompt and effective sustainable disaster management. The UAV with mounted imaging device will access to disaster struck areas and capture timely and useful information for making more informed decisions for effective, timely and sustainable response in post-disaster scenarios.

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The paper sets the foundation for future research into application of UAV for disaster management. UAV can help managers largely keeping an area under observation. UAV can be used for fire detection, intervention monitoring and also for post-fire monitoring. In case of nuclear accident or hazardous material leakage UAV is also a very effective or can be the only one tool for supporting disaster management. UAV can also assist in transporting medical help to disaster struck areas and also airlifting critically injured human beings to near by medical support venues. Timely access and information will support a better and more efficient system for sustainable disaster management. Hence, the study is valuable for all professionals involved with research and development of emergency response and sustainable disaster management strategies.

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The Five Stages of Grief:
(aka Setting Up an Enterprise Project Portfolio Management Organization)

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ABSTRACT

If you or someone you love has experienced a loss or a tragedy, you might be familiar with the five stages of grief. What no one may have told you is that professional organizations facing a major change also experience these phases. In this paper, the authors will share with you their experience implementation the Enterprise Project Management Office (EPMO) at the Texas Department of Public Safety (DPS). This office was created in order to manage the strategic execution cycle at the department and ensure that priorities and the most valuable initiatives were accomplished.

The authors will explain what you really need to know and what to expect when establishing an enterprise level organization that is responsible for the strategic execution cycle. They will provide valuable insight into the hurdles and roadblocks that might be encountered, along with strategies for overcoming them. They will also discuss the critical need for buy-in and what to expect when that isn't achieved at the right time, by the right people. The authors will focus on the integral role that people play in change and execution, and will provide valuable insight into techniques that might be used to minimize conflict and increase collaboration.

FIVE STAGES OF GRIEF

In 1969, Swiss psychiatrist Elisabeth Kubler–Ross studied terminally ill patients and released a book, *On Death and Dying*[i], which outlined the five stages of grief. The five stages are: Denial, Anger, Bargaining, Depression and Acceptance.

Traditionally, the five stages of grief are discussed in context of a personal loss or tragedy. However, more recently, the concepts have been applied to organizations as they undergo major change.

In December of 2011, the director of the DPS established the EPMO to ensure that all of the department's priority projects were completed efficiently and effectively, and to ensure he had visibility into the process along the way. While this directive was clear to the EPMO leadership, it was potentially less than clear to the stakeholders who would soon be impacted by this major change.

STAGE 1: DENIAL

The EPMO was created and was charged with not only standing up the organization, but also communicating the need for the organization to their stakeholders. As part of this initial communication, EPMO leadership had to explain the director intent to seek a more effective means of planning and prioritization at the enterprise level. This reality resulted in some initial denial from stakeholders.

There were two groups of thought experiencing this denial. Some business areas "wanted it all" and didn't see a need to identify dependencies or prioritize efforts. Some support areas believed they could "do it all" and wanted to provide service for every new innovative idea. However, this line of thought was the underlying cause of the problem with resource allocation that requires the need for prioritization.

Despite the communication efforts across the agency to the purpose of this new organization, several areas continued to attempt to initiate projects on their own. It was clear that a strong communication campaign would be necessary to manage stakeholder expectations and to gain buy-in on the new organization by demonstrating how it would benefit both the agency and the individual business units. Along with creating a customized communication plan based upon each stakeholder group, EPMO leadership also developed a milestone diagram as the foundation for a communication tool to have conversations with leadership.

STAGE 2: ANGER

Once the EPMO was established, they created a charter in order to codify their role for the rest of the agency.

The initial charter[ii] described that the EPMO had been created to serve the department by:

- Overseeing the management of enterprise and priority projects;
- Coordinating and overseeing enterprise and priority programs;
- Overseeing alignment of resources (financial and human) to support priority projects;
- Coordinating and overseeing the prioritization of projects;
- Providing a channel of communication for project status, financial health, and mitigation of issues, risk, and dependencies across projects, departments, and/or divisions;
- Providing a channel of communication to achieve efficiencies with project execution and Agency contracting and procurement; and
- Communicating the results and progress of the agency projects to executive management to ensure they are incorporated to future requests to the Legislature during the Legislative session.

While the language in the charter accurately codified the director's intent, it also created some discomfort for others throughout the agency who may have believed that their organizations would be negatively impacted by this change, due to additional oversight and the possibility that not all of the individual unit priorities would rise to the level of being at the top of the agency priorities.

Project portfolio management was established at DPS to help identify the priority of projects in the portfolio based on factors that demonstrated alignment to legislative requirements and strategic objectives. Many times, due to funding and the requirement to implement legislative mandates, newly mandated projects would generally take precedence over those projects that were being pursued as a way to innovate or modernize a business process. This prioritization was critical to demonstrating how resources needed to be applied (i.e., to minimize situations where agency priorities would not be completed, or not be completed on-time and on-budget. For those areas with projects that typically fell outside of the scope of funded mandates or critical infrastructure operations, this meant they would have limited access to resources required to address their requests.

Through the enterprise model, transparency into actual status and effort was achieved. The agency began tracking and reporting project resources hours and project budgets. A change control system was introduced, along with reporting on the impact of changes to resource utilization and costs. This additional visibility demonstrated that more time should be spent on effective project planning and estimating.

Project controls also identified risks or issues to projects associated with resource allocation and competing demands. These competing demands were not necessarily other projects that required the same resources. The competition also came from maintenance efforts. This level of transparency provided the leadership team with the information needed to have the right conversations and make informed decisions about where the resources were more urgently needed. This visibility was perceived by others as negatively exposing resource constraints within their operations.

Rather than understanding the new process was beneficial to their unit, and a way to receive the help and support needed to successfully reach its goals, the new system was initially seen by some as a drawback. This again highlighted the need for strong stakeholder and communication plans and additional methods to seek buy-in from those being affected by the change.

STAGE 3: BARGAINING

As the EPMO established effective relationships, they gained buy-in from the business executives. The buy-in was created due to the EPMO leadership effectively convincing the business areas why the change was important and the direct benefit they would receive from this office.

This process of bargaining included things such as explaining why filling out a business case would be ultimately beneficial to the success of a project; addressing questions about how to alternatively staff desired efforts through methods such as contracts or temporary services; and trying to include the business areas in development of the processes, templates and procedures.

EPMO leadership met with each business area's leadership team and elicited feedback into the baseline processes. Having this feedback, and making trade-offs in those areas of the processes, procedures, and templates that would not impact the overall objective of the organization, provided a method to gain both buy-in and understanding from the majority of the stakeholders.

The EPMO also requested ongoing representation from each business unit to serve on a process improvement team that would support ongoing assessment and feedback on the enterprise project processes over time and as "lessons learned" were conducted. This level of inclusion provided the various stakeholder groups with some sense of ownership in the new processes they would be following.

STAGE 4: DEPRESSION

Despite the efforts to include representation from across the organization in the development of the processes that would serve to request, analyze, and deliver projects, there were still some stakeholder areas that were remained unsure of the need. With organizational change comes some form of non-compliance that takes time to identify, assess, understand, and correct.

EPMO leadership knew that stronger partnerships with these areas would need to be established in order for the objectives of the office to be met. They began working more closely with the areas that were inadvertently duplicating efforts to determine whether certain elements of the process needed to be modified in order to accomplish what they're unit needed. Some modifications were made to the process. For example, the business case template was revised to capture additional detail to accommodate specific needs of those areas that had previously been unknown. This mitigated the problem of duplication. Sporadically, efforts continued to be identified that competed against the enterprise projects. However, by reporting the project status to leadership on a regular basis, they were able to gain insight into resource challenges that impacted project schedules and costs, and give direction to course correct as needed.

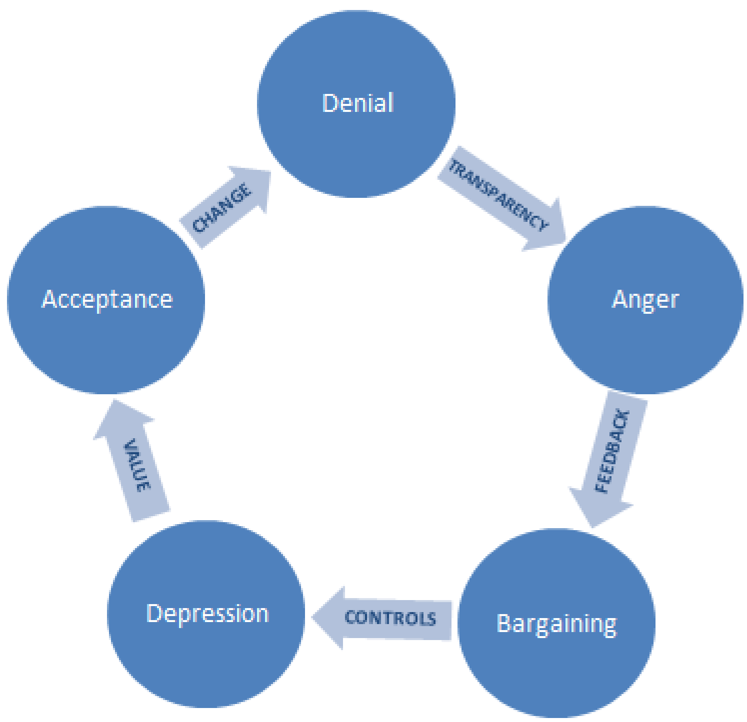
STAGE 5: ACCEPTANCE

After several months working in the new enterprise process, business divisions noticed that with transparency and prioritization, they were able to see progress in their projects, or at a minimum understand the reasons for any stalled progress. This transparency gave them the insight required to provide better direction about how to move forward and balance the needs of the agency.

Once the stakeholders adjusted and became accustomed to this change in the way of doing business, they ultimately understood the benefits the director had originally envisioned. With this acceptance came compliance from the vast majority of the department, which substantially improved project planning and delivery.

CONCLUSION

Undergoing significant organizational change can be challenging. It is critical to provide constant and thorough communication to the individuals and business areas that will be impacted by the change. Furthermore, it is imperative that the communication not only explain the changes and the benefits of those changes, but the communication must also be multi-directional. In order to gain buy-in and successful adoption of impending change, communication must also focus on asking for feedback and input as to how best to implement and address the change. Bringing stakeholder groups together for open dialogue and discussion on implementation of change will better position the organization for a successful rollout and can eliminate some challenges associated with lack of understanding and resistance to change.



Ultimately, leaders from the business divisions began to champion the DPS EPMO. By this time, the new enterprise processes had already resulted in an improved success rate of approximately 50% in the project and contract space, but that rate needed to further improve.

In late 2015, the decision was made to move all of the planning and project management resources remaining in the agency to the EPMO to help eliminate any residual competing processes. With the consolidation of these teams, further efficiencies were gained in the processes, customer expectations were more successfully managed, relationships improved, and more priorities were successfully accomplished.

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Customer Centric Project Management

Engage the Customer, but don't disengage the Project Manager

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ABSTRACT

Customer Centric Project Management (CCPM) is integrating the continuous re-examination, evolution and definition of the stakeholders' business requirements into the technology project's mandate to define deliverables based on the organizational strategy, business processes, capacity, and capability. It is producing deliverables that create value for the corporation and emphasize the value of IT professionals.

Defining business requirement that outputs of an easy to use and fit for the purpose system is based on, is a critical activity. CCPM is engaging the project customer throughout the project development lifecycle. PMs using CCPM focus less on the cost to deliver or delivering as per the established schedule and more on creating corporate strategy aligned business value. CCPM involves senior executives, system owners, business analysts and the PM and is a cultural shift from *how* we deliver to *what* we deliver.

Key Words: project development, customer centric, business requirements, requirements definition process, project management, requirements change management, project development team, outcome, methodology, value, accountability, project failure.

This paper is based on empirical observations, current literature, limited trials and project management experiences.

THE PROBLEM

In a recent article on the "10 common causes of IT project failure" [Carlson, 2013] one of the causes was: “Letting users delay projects by constantly requesting tweaks”. According to this cited cause of project failure and common belief, allowing business requirements to be changed post system design and during project development, i.e. allowing tweaks, may force the designed and partially developed project to be reworked, delaying the project and or adding costs that were not budgeted. A 1996 article [McConnell. 1996] noted that: "Studies have found that reworking defective requirements, design, and code typically consumes 40 to 50 percent of the total cost of software development [McConnell 1996].". Such significant variance between the pre-design estimated and the eventual cost of delivery or time to deliver, can in turn fail and have failed IT projects. Thus according to this school of thought changes to requirements should be limited to minimize changes to schedules and costs.

Limiting customer requested ‘tweaks’ or changes to the requirements is considering the changes to be less important than the originally stated requirements. It implies that the customer was not aware that the requested changes can be postponed. Not easily allowing changes to requirements implies that the customers who presented the original requirements and the Business Analysts (BA) who elaborated them and consequently defined the project’s output, knew the right or best business solution with which to create the expected business value or outcome, which is the original (not new) and the future definition of project success. It implies that they have expressed *all* vital customer business needs and expectations at the time the requirements were gathered and defined. It further implies that since the time the requirements were defined no one has learned or identified a better way to solve the business problem. In other words, due to an organizational flaw that prevents the organization from innovating or naivety there has not been any learning during the development of the project. By keeping the list of requirements static, the organization implicitly declares, that those who can prevent the additional effort to develop the changes or tweaks or act on opportunities to improve needed capability to be made, can decide on the eventual business results. By not making changes the mandated functionality is delivered over the significantly higher cost of an enhanced system indicating that being on-time and on-schedule is the organization’s priority.

CUSTOMER CENTRIC PROJECT MANAGEMENT

Customer Centric Project Management (CCPM) is continuous aligning the skilled re-examination and readjustment of the technology project’s mandated business based deliverables, customers’ expectations and capabilities, the project’s estimated budget, schedule, and the system’s functionality as well as the cost of not making or postponing the identified change. It is ensuring that stakeholder needs, and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved. It is setting direction through prioritization and decision making and monitoring performance to satisfy customers more than to better manage the project. It is the critical activity of engaging customers, for whom the project is being developed, as business requirements subject matter experts (SME), members of the project development team and input authority in the project’s design.

According to a World Quality Report [WQR] commissioned by HPE, Capgemini and Sogeti, quality assurance (QA) is more important than ever to 1,560 executives surveyed. Top priority of these respondents was focusing on what is of value to customers. As such CCPM aligns with International Standards (9001: 2015), Customer Focus (5.1.2.) which is the top most item in 7 Quality Management Principles (QMP). It is an enhancement of the defective and out of date requirements change definition process commonly used today. Its aim is to define the vital deliverables (functionality) or the development project’s necessary output that customers want, expect and will use, based on the latest understanding of the organizational strategy, business processes, capacity and capability. CCPM is about prioritizing customer satisfaction due to delivered system functionality that facilitate achieving organizational goals.

CCPM is not a Holy Grail that will fix all the many problems that fail projects, but it is a solution to a specific and significant project development problem that occurs too often and has too big an impact on organizations.

STAKEHOLDERS

Who is involved when the project management methodology is CCPM? The stakeholders include the organization's executives, the Project Manager (PM), the customer or system owner who funds and is to exploit the system, and the BA who is to facilitate customers to define their vital requirements. Each has a specific role and accountability.

In top performing organizations [HBR, 2002] senior executives are responsible for reengineering processes that use IT systems and for generating business value. Executives are implicitly accountable for project success, and must authorize the use of CCPM as it changes how changes to requirements are managed. If executives do not 'buy-in' to this methodology, it will not be possible to use it. However, choosing to not allow CCPM has to make them accountable for the missed opportunity cost of not having or postponing the deployment of newly discovered vital requirement(s) that would have been deployed using CCPM.

If executives do 'buy-in', they have to elaborate and communicate their support to the customer, the BAs and PM involved, and describe how the impact of continuous changes to requirements and consequently the budget and the schedule will be handled (governance).

The customer(s), sometimes referred to as business partner, must be and is held accountable for specifying the right thing that needs to be done and funds the project as well as any costs resulting from the requested changes to the requirements. This includes the return on the investment spent on making the changes to the requirements, specifying the outputs the project needs to deliver and attaining the desired outcome with or without the requested changes that is determined at the post mortem analysis of accomplishments.

The PM is the third stakeholder in CCPM. PMs generally are trained and skilled in doing things right, i.e. planning and controlling system development to deliver projects efficiently and in spite of the many organizational constraints in their way. It is why they have been chosen to lead and manage the development and system implementation (not deployment) processes and entrusted with corporate resources.

In most organizations PMs are ill-equipped to balance customers' wishes for changes to requirements and currently used on-time and on-schedule development project success criteria that is focused on efficiency. However, CCPM makes it easy and convenient for customers to ask for tweaks, for PMs to listen (hear) to customers and follow up and acknowledge their input and requests. CCPM allows the PM to manage the development process as effectively (not only efficiently) as the organizational capacity, capability, executive management and their own expertise allows.

Peter Drucker is quoted to have said: “There is nothing so useless as doing [developing] efficiently that which should not be done at all.” [Drucker], which is why the BA is the fourth and final stakeholder. BAs are the SMEs who define and translate the customers’ business needs, customers’ expectations, the mandatory business and regulatory requirements, and existing opportunities that align to the organization’s strategy into a business solution and facilitate requested changes to system requirements to be made. This not only elevates the need for qualified BAs but also the role that the BAs can and needs to play.

To underline their importance, McConnell [McConnell. 1996] states that: "As a rule of thumb, every hour you spend on defect prevention [making changes to requirements] will reduce your repair time [by] three to ten hours. In the worst case, reworking a software requirements problem once the software is in operation typically costs 50 to 200 times what it would take to rework the problem in the requirements stage.” This argues that BAs must spend more time to define requirements during design and ‘tweaks’ should be encouraged, allowed or done during project development, i.e. before not after implementation.

While today’s change management, i.e. accepting or not accepting new requirements and changing the design of the system, is often about the cost of the changes, it often does not include the calculation of what the cost of not making the changes will be. Therefore the BA must be held accountable for the professional attempt to uncover how business is done in the organization and to identify needed work processes that do not strain the corporate culture.

THE PROPOSAL

CCPM is about continuously and more directly engaging stakeholders during the System Development Life Cycle (SDLC), in evolving the list of requirements on which final project deliverables are defined. It is not constrained by the estimated time to develop, the established schedule or the estimated cost to deliver. It is often viewed by IT as involving ‘*them*’ in what ‘*we*’ do. CCPM is not a favored methodology of insecure PMs or risk averse organizational cultures. Nor is it acceptable to executives, who prioritize delivering projects within the estimated budget, in an estimated amount of time, as per the planned schedule and with the original scope, to replace standard requirements change management processes with CCPM. For many, the customer-centric iterative requirements definition process is too great a shift of the culture. CCPM is for organizations where executives prioritize the value chain and defining ‘what’ value the system’s users will be able to create, not ‘how’ work is to be done.

CCPM is centered on the concept that projects are not developed to be on-time, on schedule or to deliver defined functionality. They are developed so that internal customers can more easily change business results (outcomes), the original, not new, re-discovered and the future definition of success. As such, customers must be more directly and continuously engaged and held accountable for specifying all vital requirements as well as for requested requirements' costs and impact on the organization. Assuming that these requirements are written by BAs, implies that the BAs must be held accountable for elaborating and evolving business needs that can be embed into the socio-organizational environment as part of Organizational Change Management (OCM) needed for every large scale project deployment.

This approach conflicts with many executives' views and project management practices. In spite of the fact that CCPM is not a different way to manage our projects but an enhancement to how to change business requirements and how the development methodology integrates customers into the SDLC. As W. Edward Deming said: "It is not necessary to change. Survival is not mandatory."

The concept of facilitating making changes to requirements during the project is not new, but a cultural shift. This shift requires the organization to prioritize *what* the project delivers, i.e. the output, and the eventual outcome it enables or facilitates over *how* close the final cost and schedule are to the estimated budget and wished for schedule. CCPM is not more efficient but a more effective Requirements Change Management methodology. Its focus is on the needs of the organization and the customers, but it is also inadvertently a better way to control total cost of application ownership.

As a general rule business requirements evolve after they are defined in the Requirements Definition Document. Much as a restaurant patron needs in real time to be able to order a second bottle of wine during the meal and change his/her mind about having or skipping desert, so too internal customers need to be able to make changes to requirements when they realize a previously unforeseen possibility. Hence customers need to be continuously engaged in the evolution of project requirement. And like the restaurant patron who has to pay for the additional bottle of wine, the customers' 'right to change' is tied to his/her accountability for the extra effort (corporate resources and capacity) expanded to make the change(s).

A second and more controversial reason for CCPM comes from the CHAOS Manifesto [CHAOS Manifesto 2013]. It suggests that: "20% of features [of an application] are used often and 50% of features are hardly ever or never used. …The task of requirements gathering, selecting, and implementing is the most difficult in developing custom applications. … 20% of the features that give you 80% of the value … Therefore, reducing scope and not doing 100% of the features and functions is not only a valid strategy, but a prudent one." It does not specify who should make the decision or how it is to be decided which part of the scope (features and functions) not to deliver. However, as the PM is focused on IT project delivery and IT has no domain knowledge (business expertise), the PM cannot make this currently practiced error and mistake. Arguably, only customers who know or should know how to create value for the organization, who are accountable for the costs incurred and who have proper incentives, can decide to pay for the benefits that requested changes to requirements promises to provide. Thus customers need to be engaged in the requirements definition, design and output definition process.

CCPM balances the imperatives of what the business needs, accountability for resources expended and what the technology and the project team can deliver. It integrates the goals of the corporation, the needs and expectations of the corporate customers with the capabilities of the project development team. At the same time CCPM allocates explicit accountability for project success to the four stakeholder groups. This idea of separating accountabilities is supported by Gartner [gartner.com] which claims that: "*Organizations that separate the 'doing the right thing' from 'doing things right' tend to be more successful in the long term*."

Is CCPM important? Some indicators say it is. IT spending is in the neighborhood of $270 billion / year in Canada based on $2.68 trillion posted by NY Times [NY Times, 2013]. The annual cost of IT project failures is $1.2 trillion in the US and $6.2 globally [Sessions, 2009] and according to Gartner, 80-85% of IT spending is to keep the lights on. As a generalization, the lifetime cost of an applications end up being about 6.7 times [Outsystems] its initial cost of development and some or most of this cost is due to what many in the profession term "The PHASE II", meaning moving all the requirements that are needed but are not delivered to a subsequent phase. While it is sad that more money is wasted on maintenance than is needed, it is sadder that 80% of the money spent on maintenance allows little development of new systems or resource capabilities. Thus we need to learn how to develop the right requirements.

CONCLUSIONS

Organizations need to do a better job of evolving system requirements, as this weakness is costing corporations dearly and negatively impacts the relevance of IT. CCPM aims to make the customer as successful as possible, by engaging the customers who are accountable for the additional costs and delays or changes to the approved ROI caused by the changes to requirements. However, if CCPM is not to be a career changer (end-er) for the PM, then its use has to be approved by corporate executives prior to the start of the project. If executives have not approved it explicitly, then they must accept accountability for the opportunity lost.

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A New Research Agenda for
Project Management Communication Theory

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ABSTRACT

Based on an analysis of 272 peer-reviewed articles on project management communication, the authors found that only four percent of the articles advanced project management communication toward a better contemporary understanding of the complexity of communication. The authors posit that project management communication research needs a new research agenda based on complex responsive processes of relating. The new research agenda proposal is to use the emerging field of complexity leadership to explain better how project managers, team members, and stakeholders communicate during a project. Adopting the new project management communication research agenda will help establish more effective project management communication tools and methods. The new project management communication research agenda will also provide new research opportunities for communication scholars.

COMMUNICATION IS VITAL TO EFFECTIVE PROJECT MANAGEMENT

It is important to note the importance of communication in project management before discussing the need for a new project management communication research agenda. Estimates from the Project Management Institute and project management researchers indicate that 80–90% of a project manager’s work is communication (see Kliem, 2008, 2012; Crawford, 2002). Barkley and Saylor (2001) argue “[c]ommunication is the most important tool in customer-driven project management” (p. 274).

However, even though project management communication is considered the key to effective project management, the concept of project management communication is limited. Many definitions of project communication focus on the functional aspects such information exchange or coordinating people’s actions (see Ensworth, 2001; Longman & Mullins, 2005; Burford, 2013; Kliem, 2008). Even the emerging field of agile project management still treats communication in a purely functional manner (Augustine, 2005, pp. 26–29). As Cleland & Ireland (2002) observe: “Project managers and professionals often fail to recognize that communication on a project takes many forms: verbal in-group and individual exchanges of information, and documentation such as design drawings, reports, contracts, work orders, and the like" (p. 482).

THE CURRENT STATE OF PROJECT MANAGEMENT COMMUNICATION RESEARCH

The Functional Model of Communication. It is almost universal among recognized project management experts that there is only one model for project management communication: the functional model which is also referred to as the Source–Message–Channel–Receiver (SMCR) model. The SMCR model is based on the Shannon-Weaver Communication Model first developed in the 1950s. "Communication involves both receiving and sending messages" (McManus, 2006, p. 107; see also Cleland & Ireland, 2002; Kliem, 2008; Andriole, 2012; and Burford, 2013). Even nonverbal communication is limited to the SMCR model (Kendrick, 2012, p. 189). The leading project management professional association, the Project Management Institute (PMI), advocates the SMCR model as a best practice for project management communication in PMI's certification exams.

The author collected project management articles from the three major project management research journals (*International Journal of Project Management*, *Project Management Journal*, and *International Journal of Managing Projects in Business*); general business management journals; and communication and mass media journals. Three-hundred and thirty-three articles were initially retrieved which was then reduced to 272 articles after removing duplicates, non-peer-reviewed articles, and three non-English language articles.

The articles were carefully read and placed into one of four categories:

- **Category Zero –** No or little relevance to the research question. These are articles that mention communication once or twice at most.
- **Category One –** Firmly grounded in the functional communication model. No research in project management communication other than referencing the functional communication model.
- **Category Two –** Applied a contemporary research technique, method, or perspective to the functional communication model but the purpose was confined to exploring some aspect of the functional communication model.
- **Category Three –** Introduced a novel project management communication model or critical perspective on project management communication not based in the functional communication model.

Table 1. Count of Project Management Communication Articles by Category.

Category	Number of Articles	Percentage of Total Articles
Zero	117	43%
One	112	41%
Two	33	12%
Three	10	4%

The author then divided the articles up into articles that appeared in one of the three project management journals and articles that appeared in general management or communication journals.

Chart 1. Number of Project Management Communication Articles by Category and Type of Journal

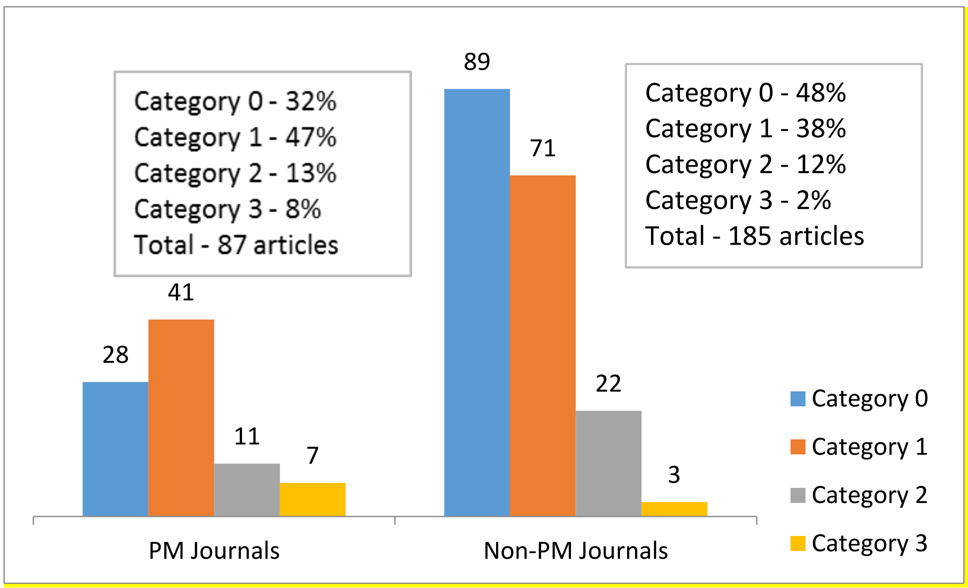

Table 2 indicates that, even though the underlying communication model used in the analysis is the functional model, the researchers were possibly attempting to extend the analysis beyond the functional model of project management communication. As Cicmil and Hodgson (2006) might observe, the researchers in the Category Two articles are attempting to "open up new trajectories within the research agenda in the field of studies relevant to projects, project performance and project management" (112).

Table 2. Research Technique, Method, or Perspective Applied in Category 2 Articles

Research Technique, Method, or Perspective	Number of Articles the Technique, Method, or Perspective was Utilized
Actor-Network Theory	2
Complexity Theory	4
Dialogue	6
Diversity	2
Ethnographic Observation	1
Intermediate Objects of Design	1
Knowledge transfer, knowledge management	3
Mental Models	2
New Product Development	1
Project Manager Influence Methods	1
Real options reasoning	1
Social Network Analysis	6
Stakeholder Focus	1
Storytelling	1
Visual Communication	1

Continuing in the vein of opening up new trajectories in project management research, the ten articles in Category Three, offer new ways of studying project management communication beyond the functional model of communication. For example, Johannessen and Olsen (2011) introduce a five system communication model that is designed to replace the functional model. Johannessen and Olsen argue that their model better captures the coordinating functions of project management communication. Koskinen (2013) and Piperca and Floricel (2012) advocate the use of social autopoietic systems communication theory to refute the functional model's assumption that meaning is transmitted in whole from the sender to the receiver. Rather, the researchers advance the theory that meaning emerges from the interactions within the project team and interactions with stakeholders. All of the Category Three articles point toward a new and critical research direction in project management communication research. In the next section, the authors detail why staying with the functional communication model perpetuates ineffective project management and hinder the field of project management communication research.

FUNCTIONAL COMMUNICATION IS NOT SUFFICIENT FOR EFFECTIVE PROJECT MANAGEMENT

In reviewing examples of how to improve project management communication, the emphasis is on functional methods. The Project Management Institute and project management experts advise the creation of a communication management plan that details whom to communicate to and how. There is some discussion about content, but that is also focused on just informational or transactional processes (Kliem, 2008, p. 75).

A prime example of the purely informational method for project management communication is the *One Page Project Management* tool. This tool was created to communicate vital project information in the most informative and digestible way. The tool is organized around tasks, deadlines, and status updates (Campbell & Collins, 2010). This tool essentially reduces communicating to reporting. That is also the concept behind the use of project management information systems that are also referred to as project management communication (Kliem, 2008, p. 25; see also Kendrick, 2012, pp. 223–228).

Cleland and Ireland (2002) hint at more than purely informational and transactional methods of communication in their list of channels of information: "plans; policies; procedures; objectives; goals; strategies; organizational structure; linear responsibility charts; leader and follower styles; meetings; letters; telephone calls; small group interactions; and example set by the project manager" (p. 483). Even so, the authors do not explain the communication aspects of the "leader and follower styles," "small group interactions," and "example set by the project manager," thus missing the opportunity to expand beyond purely functional communication.

Ignoring the relational aspects of project management communication is detrimental to project management because the success of projects and project managers is directly related to how well project managers communicate with stakeholders and the project team in fulfilling the project vision and building a high-performing project team. "[P]oor communications can have a costly impact on projects. When communications fail at the beginning, such as when assumptions and goals are being defined, correcting the situation later becomes more difficult and costly. Projects gain momentum, and few people want to hold them up while ways are found to improve communications. Any effort to rectify poor communications can result in slowing momentum and requiring work to be over. What's worst, however, is that the damage may not surface until the product or service is in production, leading to maintenance nightmares" (Kliem, 2008, p. 3).

Other project management experts agree with Kliem. Charvat (2003) writes "[c]ommunication is the backbone on any successful project rollout. Without it, projects have conflict, delays, and failure" (p. 181). According to Flannes and Levin (2001) "[t]echnology, tools, and techniques are not the reasons projects fail; they fail because of people" (p. 3). People fail through bad communication whether it results from a lack of information transfer or lack of acceptance by the receiver (p. 92). McManus (2006) lists the following symptoms of poor project management communication: confusion or misunderstanding, duplication of effort, demand or delay, demotivation, inefficiency, and lost opportunity (p. 100).

McManus (2006) further explains the poor project management communication is in place because "[p]roject managers are not generally measured or rewarded on their communication performance" (p. 100). Project managers are encouraged to take the "Just Do It" approach to project management (Winter &

Szczepanek, 2009, p. 15). Lack of proper communication training for project managers is another example of the need to improve the gap in project management communication.

WHY PROJECT MANAGEMENT COMMUNICATION IS COMPLEX RATHER THAN PURELY FUNCTIONAL

"Communication of the right information is a complex process that includes verbal and nonverbal forms of communication such as speaking, listening, observing, writing, and reading" (Barkley & Saylor, 2001, p. 274). Even so, project management communication is not currently seen as a complex process because the widely accepted model of communication is restricted. The previous sections of this paper have established that the prevailing model of project management communication is based on the Sender–Message–Channel–Receiver model, which is purely functional. Project managers are not measured on how well they communicate but how well they deliver the project product on time, within budget, and to the project customer's specifications. The problem with this emphasis on the functional image of project management is that it is self-defeating because it does not account for the true complexity of managing projects.

Winter and Szczepanek (2009, p. 29) list seven different images of project management:

1. Social Processes
2. Political Processes
3. Intervention Processes
4. Value Creation Processes
5. Development Processes
6. Temporary Organizations
7. Change Processes

The image or images a project management uses influences the project manager's actions. What is common to all of the images is that they are based on *complex responsive processes of relating* (CRPR), which goes beyond the current functional image of project management. "CRPR grounds the practice of managing projects firmly in the sphere of interactions between humans" (Cicmil, Cooke-Davis, Crawford, & Richardson, 2009, p. 76).

The value of using CRPR in developing the new research agenda for project management communication is that it better captures the complex reality of how project managers, project teams, and stakeholders interact with each other over the lifespan of the project. CRPR is "a particular way of thinking . . . that focuses . . . on how members . . . might cope with uncertainty and the unknown while these same individuals simultaneously co-create their collective futures together on an on-going basis" (Stacey, 2009, p. 30). It is the complex interactions (nonlinearity, evolution, emergence, and radical unpredictability) between the project participants that makes project management communication more than purely functional (Cicmil et al., 2009, p. 30).

In the next section, complexity leadership is advanced as a way to encapsulate the features of CRPR in managing projects. Complexity leadership captures the complexity of interactions between the project participants and composes the new research agenda to take project management communication out of the purely functional model.

PROPOSED RESEARCH AGENDA FOR PROJECT MANAGEMENT COMMUNICATION

Complexity Leadership. Complexity leadership theory is a framework for leadership that enables the learning, creative, and adaptive capacity of complex adaptive systems (CAS) in knowledge-producing organizations or organizational units. This framework seeks to foster CAS dynamics while enabling control structures appropriate for coordinating formal organizations and producing outcomes appropriate to the mission. It seeks to integrate complexity dynamics and bureaucracy, enabling and coordinating, exploration and exploitation, CAS and hierarchy, and informal emergence and top-down control (Uhl-Bien, Marion, & McKelvey, 2008, p. 196).

The above concepts apply as much to projects as to organizations. This new reality in projects compels project managers to move beyond their traditional functional role of managing schedules, tasks, and resources to empowering the knowledge workers that make up the project team (Stacey, 2001, p. 1). Project managers must use dialogue to "encourage and persuade people to share knowledge and spread it around" (p. 2), because knowledge is more than just what is stored in artifacts and arises from conversations and relationships (pp. 4, 98). As the communication hub for the project team, stakeholders, customers, and sponsor(s), project managers must use more than functional communication to lead effectively modern projects.

As with complexity communication, there are several models of complexity leadership. Possibly the most appropriate model for project managers is Goldstein, Hazy, and Lichtenstein's (2011) work. Their model is an "*active* and *constructional* model of leadership based on a highly engaged view of mutuality, interdependence, and share accountability" (p. 4; emphasis in original). Goldstein et al. argue that the traditional view of heroic/charismatic leadership will result in a lack of innovation because leadership is a series of events rather than relations (p. 2). Leadership events pairs well with Salem's (2009) complexity communication model's episodes as leadership develops more focused involvement and ownership between project managers and team members.

In Goldstein et al.'s (2011) model, effective leaders create "innovation-friendly social networks" (p. 171) that enable *interaction resonance*. Interaction resonance is essentially enriching information as it travels through the networks (p. 10). "[T]he more technical the work, the more that careful communication is needed to clarify and deepen it. Without the common language and these disciplined communication practices, information remains undecipherable and thereby devolves into mere data" (p. 38). It is not enough for project managers to just communicate information; they must be aware of how they communicate and the effects of their communication on all of their stakeholders.

BENEFITS FOR SCHOLAR AND PRACTITIONERS

Like research areas such as organizational communication or health communication, project management communication research offers benefits to scholars and practitioners. As demonstrated above, project management has a complexity beyond the functional aspects of management. This complexity arises from the interactions among the people involved in the project as they work to achieve a shared vision. Projects occur in almost every organization, encompass a great variety of communication situations, and are often well-documented. Thus, they can provide rich data for qualitative and quantitative analysis. On a more practical note, the Project Management Institute hosts a research conference every other year, and there are numerous funding sources and a large audience of practitioners eager to hear the latest research findings.

For the practitioner, increased research in project management communication will provide evidence-based tools and methods that will help improve their ability to manage projects. There is a growing consensus among project management experts that current project communication models and techniques are not effective with today's more complex and diverse projects.

Restating the arguments that opened this paper, communication is, at least, one of the top three factors for project success. The models and tools of project management communication are purely functional and transactional, which is inadequate for complex contemporary projects, especially regarding the complex responsive processes inherent in the interactions among project managers, project team members, and stakeholders. Implementing a new research agenda that recognizes the complexity of human communication will revitalize the field of project management communication by providing practitioners with better tools and methods. Ultimately, improving project management communication will aid in improving the overall effectiveness of project management.

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Putting theory to practice or practising theory? How theories of practice can be practically useful in the management of projects

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ABSTRACT

In this paper, I question the knowledge-practice divide by drawing inspiration from contemporary interest in practice-based theories. I focus on recent renewed interest in the Aristotelian notion of phroenesis (or, to put simply, the doing of practical wisdom). Rather than to turn knowledge into practice – as the theme of this symposium suggests – I argue that knowledge is practice. I stress that practical knowledge is not just what practitioners do; practical knowledge calls for deeper, more engaged forms of practical scholarship. Such scholarship demands a move away from 'grab-and-go' methods of knowledge creation depicted by earlier scholarship that provided prescriptive guidelines and toolkits, to consider the power of engaged scholarship (e.g. action research, ethnography) in co-creating practical wisdom in project management. I offer the newly-launched Professional Doctorate in Project Management at the University of Manchester as a possible way of inviting practitioners to become co-researchers in putting practical wisdom to work.

Keywords: phronesis, practice-relevant scholarship, professional doctorate

INTRODUCTION

Project management has matured as a field from being "almost theory-free" (Morris, 2013b: 67) and "extraordinarily [silent] on the theoretical" (Koskela and Howell, 2002: 293), to current recognition that project management knowledge is pluralistic, drawing on a diverse range of theories (see Söderlund, 2011, and; Morris, 2013a). In part, this growing acknowledgement of the role of theory is due to the belief that "a theory of projects is beneficial to the development and acceptance of the field for a general audience" (Hällgren, 2012: 805). As Hällgren (2012: *ibid.*) noted, the more established top-tier academic journals tend to make higher "demands for theoretical contributions and scientific rigor […] than in journals in less established areas as project management".

The pursuit of theoretical rigour is nevertheless not without criticism. Morris (2013b), for instance, while acknowledging the need to embrace theoretical pluralism, also warned against the development of theory for theory's sake. He stressed that "[t]he problems we face in the world of projects, and the ways to address them, are often intensely practical. […] Yet, academics too rarely experience the reality of really managing projects" (Morris, 2013b: 69).

In this paper, I critically consider this bifurcation between theory and practice, along with the debate on the role of theory in project management. In so doing, the purpose is to question the rhetoric of *turning knowledge into practice*. Such a turn of phrase implies the separation between theory and practice, an assumption that knowledge is an entity that comes before its application in practice. In this paper, it is argued that such a linear view of knowledge production that emphasises the dichotomous distinction between theory and practice is outmoded. By drawing on current interest in and scholarship on practice-based theories (see e.g. de Certeau, 1984, and; Nicolini, 2012), it is argued that the problem lies not in turning knowledge into practice, but to situate knowledge production and reproduction in practice. Thus, theory is not some isolated entity that precedes and juxtaposes against practice (theory vs. practice); rather, practice and theory are both sides of the same coin, recursively intertwined and mutually constitutive of one another.

The paper is structured as follows. The next section will trace the debate on project management theory. This brief overview will outline the ongoing debate on the role of theory in project management, between those who favour a normative view of finding better or 'best' practice (e.g. Morris, 2013a; 2013b), and those who reject such normative accounts and prefer to study the multiple ways in which practices actually happen (e.g. Cicmil *et al.*, 2006). Although the debate on theoretical unification/pluralism has made much progress on bringing theory to the fore, the review highlights the need to break away from the theory-practice divide. A salient review of practice-based approach to understanding project management and what project managers do is then outlined, with a view to reconnect theory and practice in project management. The paper closes with an illustration of how this can be achieved through the Manchester Professional Doctorate Programme.

PROJECT MANAGEMENT 'THEORY'? FROM UNIFICATION TO PLURALISM

Historically, project management is regarded as a practical field where knowledge about managing projects was, until the 1950s, rarely institutionalised (see e.g. Morris, 2013a, and; Garel, 2013). Garel (2013) traced the history of project management, and noted that since the late 1950s, project management knowledge began to go through intense rationalisation and institutionalisation. The creation of various bodies of knowledge by institutions such as the Project Management Institute (PMI) and the Association of Project Management (APM) marked the foundation of 'standard' models of project management (Garel, 2013; see also Hodgson and Cicmil, 2007). Koskela and Howell (2002) even gone as far as to state that there is underlying theory in project management found in the doctrine "as espoused in the [Project Management Body of Knowledge] PMBOK Guide by PMI and mostly applied in practice" (p. 293).

Early formalisation and professionalization of project management knowledge stemmed from the fields of operations management and the management of engineering projects. At its core, this early theoretical formulation was about advancing a normative set of principles for delivering best practices in project management. As Koskela and Howell (2002) asserted, “[a] theory of project management should be prescriptive: it should reveal how action contributes to the goals set to it. On the most general level, there are three possible actions: design of the systems employed in designing and making; control of those systems in order to realize the production intended; improvement of those systems” (p. 294). They added that the ultimate goal should be seen in terms of producing products as intended, by optimising costs and resource utilization, while satisfying the needs of the customer through measures such as quality, dependability and flexibility.

Söderlund (2004a) commented that such normative tradition yielded a wealth of “checklists and the optimization and critical success factors research” (p. 185), which he argued “provide very little in terms of theory” (*ibid.*). Söderlund (2004b) also called for the need to broaden the scope on researching projects, expanding what we mean by the ‘project’ to consider multi-project contexts within a firm, inter-firm coordination of projects and project ecologies. In so doing, Söderlund (2004b) and other critical scholars (e.g. Winter *et al.*, 2006, Cicmil *et al.*, 2006, and; Hodgson and Cicmil 2007) extended the narrow conceptualisation of the ‘project’, and went beyond instrumental approaches of addressing execution problems in the project life cycle found in much earlier scholarship. As Hodgson and Cicmil (2007) famously argued, the question lies not in “What is a project?”, but “What do we do when we call something “a project”?” (p. 432). In a similar vein, Cicmil *et al.* (2006) stressed that project management practice is “a *social conduct*, defined by history, context, individual values and wider structural frameworks” (p. 676; original *emphasis*).

In questioning the contours of what constitutes the ‘project’, and in shifting the focus on the lived experiences as opposed to the laws of project management, these critical scholars opened up the study of project management beyond the confines of operational research and engineering principles of planning and control. A corollary of this is the broadening of the relevance of project management scholarship to the wider fields of management and organisational studies in the academy (see e.g. Söderlund, 2004b; Kwak and Anbari, 2009, and; Jacobsson *et al.*, 2015). Indeed, Söderlund (2011) reviewed 305 articles and categorised project management scholarship into seven ‘schools of thought’ (see also Söderlund and Maylor, 2012). Marshall and Bresnen (2013), by reinterpreting the narratives of Brunel’s Thames Tunnel, offered alternative discourses that transcended the techno-rational, planning approach; apart from the planning discourse, Marshall and Bresnen viewed the Thames Tunnel from the perspectives of messy practices of muddling through; a constellation that connected people, things and ideas; a negotiation of power relations, and; a societal construction.

These alternative conceptualisations and ‘schools of thought’ characterise contemporary scholarship of project management which was, as Jacobsson *et al.* (2015) suggested, borne out of “a reaction to PMI being a dominating institution in terms of providing guidelines, […] prescriptions and tools” (p. 11). Lenfle and Loch (2010) put it strongly as they argued that focussing exclusively on engineering-execution brings damage to the project management discipline because such normative approach denies companies “a powerful weapon in innovating and evolving strategy” (p. 49). Lenfle and Loch (2010) added that “companies *do* apply trial-and-error and parallel approaches in their novel projects because they have no choice, but in doing so they go against their professional PM training rather than being supported by it” (*ibid.*; original *emphasis*).

Thus, in theorising project management, there appears to be a debate generated between two main camps of scholars. On the one hand, there are those calling for a unified, general theory of project management; on the other hand, there are those who take the view that project management can be viewed from multiple theoretical lenses. This debate is, by no means, settled. Pinto and Winch (2016), for instance, while acknowledging the tussle between those who favour the emergence of a single theory and those who see project management knowledge as pluralistic, maintained that the “[a]rticulation of the discipline as a whole requires a coherent theoretical perspective on the discipline, otherwise bodies of knowledge become mere lists of areas and sub-areas of knowledge with little insight into how the areas link to form a coherent set of competencies and how their relative importance varies contingently” (p. 241). It is this tension between the universal (objective) and the particular (subjective) that we turn to the next section, in which more recent practice-based based scholarship is reviewed.

PROJECT MANAGEMENT PRACTICE BEYOND MODERN AND POSTMODERN PERSPECTIVES

In a recent call to reconnect theory and practice in project management, Bredillet *et al.* (2015) contrasted between the modern and postmodern turns in project management. The former depicted by early formulations of project management theory focuses on answering the question of what (best) practice is, while the latter characterised by a growing body of critical scholarship considers the multiple realities of what practitioners do. Put another way, whereas the modernist turn produces objective knowledge about the rules of project management practices, the postmodernist turn places more emphasis on the subjective, situated context of what goes on when doing projects.

A practice-based approach provides a useful vantage point for breaking free from the object-subject (Cartesian) duality (e.g. Bjørkeng *et al.*, 2009; Bredillet *et al.*, 2015, and; van der Hoorn and Whitty, 2015). As Bjørkeng *et al.* (2009), drawing on the phenomenologist Alfred Schütz, noted, “no practice can be understood outside its intersubjectively created meaning and motive, which […] are socially reinforced, constructed and ascribed” (p. 146). They added that practices “reduce the scope and ordering power of a disembodied, asocial and acontextual (Cartesian) concept of reason by reconceptualising reason as a practice phenomenon […] grounded in what members find it normal to do. Thus, practice defines its own rationality” (*ibid.*).

There is a contemporary movement in project management scholarship that focusses on the lived experiences of project management practitioners. Rather than to take as given the primacy of rules and guidelines, more recent practice-based scholarship opens up the inquiry to question how practitioners do and make do (improvise upon) these rules. As de Certeau (1984) in *The Practice of Everyday Life* assert, an emphasis on everyday practices calls into doubt the common assumption that practitioners are "passive and guided by established rules" (p. xi). Nicolini (2012) also stressed that practice precedes any theory (or theorising), as he argued

> "Mundane everydayness thus becomes the received, yet necessarily indeterminate, cultural manifold within which we are all immersed, and which meaningfully discloses our world by way of our own un-theorized, everyday practical coping strategies […] Practice is therefore 'prior' to representation. Everydayness is always already a holistic affair and is experience as gestalt, i.e. as a meaningful whole." (p. 35)

Nicolini (2012) traced the origins of practice-based theories, and noted that the separation between theory and practice stemmed from classical Greek philosophy, most notably the work of Plato, which has shaped the Western tradition. Within such a frame, theory rules over practice, "[e]very action would in fact be conceived as the application of general, calculable, precise, and truthful principles, while reference to universals, such as to the universal pure idea of 'good', would make it always possible to choose the best course of action" (p. 24). Nicolini (2012: 28) added that the demotion of practice in this Western tradition is signified in differentiating between thinkers and doers, for "[t]hose who carry out a life of contemplation are already in contact with the divine while the many others who live a life of practice should expect 'contemplation' as the ultimate reward in the afterlife."

A practice-based approach seeks to correct the false dichotomy between thinking (theory) and doing (practice). Much contemporary scholarship and interest into practice-based approach owes much to the writings of Marx (see Bjørkeng *et al.*, 2009, and; Nicolini, 2012), who regarded thought and world as

> "always connected through human activity and therefore cannot be separated: on the one hand, man is always an actor and a produced; on the other hand, thinking is only one of the things people do, together with running, fighting, making love, and so on." (Nicolini, 2012: 30)

Thus, a practice-based approach views practice and knowledge as cut out of the same cloth. For de Certeau (1984: 69), practical "know-how (*savoir-faire*) finds itself slowly deprived of what objectively articulated it with respect to a "how-to-do" (*un faire*). […] Thus know-how takes on the appearance of an "intuitive" or "reflex" ability, which is almost invisible and whose status remains unrecognized." A classic example used to illustrate this lies in the practice of hammering a nail; one does not need to think and articulate the objects 'hammer' or 'nail' prior to applying such thinking in the action of hammering a nail. Thus, a practice turn emphasises the emergent, unconscious and spontaneous, where thinking and doing are recursively intertwined in real time (Bredillet *et al.*, 2015). As Bjørkeng *et al.* (2009) stressed, practice signifies "how we achieve active being-in-the-world" (p. 146).

In Pierre Bourdieu's (1977) *Theory of Practice*, this active being-in the world is encapsulated in the notion of *habitus*. As Askland *et al.* (2013) explained, *habitus* helps us understand “the concept of culturally conditioned agency” (p. 120), and describes “enduring, learnt and embodied principles and dispositions for action” (*ibid.*). Räisänen and Löwstedt (2014), also drawing on Bourdieu, explained that “practice is a dynamic interplay between past and present, individual and collective, and between contexts of culture and contexts of situation” (p. 125); in this way “[t]he objective and the subjective are fluid, continuously interacting and relational” (*ibid.*). Rather than to treat practice as a result of compliance with rules and guidelines,

> “habitus is better conceived as a way of knowing inscribed in bodies, acquired mostly during upbringing […] as a by-product of participation in daily activities largely without raising it to the level of discourse. In this sense, it is clear that for Bourdieu habitus is not a way of understanding the world as much as a way of being in the world.”
> (Nicolini, 2012: 56)

Pierre Bourdieu’s *habitus* has its roots from Aristotle’s idea of *phronesis*, crudely translated as practical wisdom (Flyvbjerg, 2006). According to Flyvbjerg (2006), *phronesis* makes up one of three intellectual virtues, the other two being *episteme* (or scientific knowledge) and *techne* (pragmatic craft). As Bredillet *et al.* (2015) assert, practice or theory alone is not sufficient. What matters is deliberate action in context. Such deliberate action involves the passing of value judgements, or *phronesis* (Flyvbjerg, 2006). Thus, Bredillet *et al.* (2015) argued that, in the heat of the battle between universal theory and practices in particular contexts, it is important never to lose sight of practical wisdom that is accumulated through knowledge in and from practice. In laying the foundation of practice-relevant scholarship, Antonacopoulou (2010) was keen to move beyond the labels ‘scholar’ and ‘practitioner’, preferring to consider the proposition that “we are all practitioners” (p. 221). Rather than to co-produce knowledge between scholars (thinkers) and practitioners (doers), Antonacopoulou (2010) urged for all practitioners to become co-researchers. She suggested that practice-relevant scholarship involved the dynamic interplay between practice that generates purposeful action, *phronesis* (or practical wisdom) that is the result of reflexive critique, and the practitioner who is constantly learning to connect practice *and* theory. It is to this end that we offer the Professional Doctorate Programme in Project Management as a way of accomplishing practice-relevant scholarship.

CLOSING REMARKS: RECONNECTING THEORY AND PRACTICE THROUGH THE PROFESSIONAL DOCTORATE PROGRAMME

A brief outline has so far been presented on historical developments of project management as a field and the roles played by theory and practice. This salient review highlighted the shift away from the pursuit of normative, prescriptive theories that offer ‘how-to-do’ guides to project management, towards emphasising the lived experiences of what project management practitioners do. Despite this move from the universal to the particular, the checklists and critical success factors type research still prevail in the field. Consequently, Reich *et al.* (2013) bemoaned that “[…] much project management research is “mired in the middle”, neither sufficiently rigorous for the academy nor sufficiently insightful for practitioners” (p. 938). The research dismissed by Reich *et al.* (2013) would fit what Van de Ven (2007) termed as "unengaged or disengaged studies" (p. 273); such studies tend to raise questions without evidence of their prevalence in practice, rely on a single theoretical model without consideration of alternatives, be based on research design that took the researcher out of the practical context, and bore little impact on practice.

In moving beyond the theory (*episteme*) – practice (*techne*) divide, the preceding section highlighted a need to draw on practice-based approaches to bring to the fore how practitioners deliberate in action using what is known as practical wisdom (*phronesis*). It is in this vein that the Professional Doctorate Programme in Project Management at Manchester is designed. This programme, to be launched in 2016, builds on the success of the Project Management Professional Development Programme (PMPDP), which has been running for over 15 years with some evidence that indicate the transformative power graduates have in becoming effective change agents in the workplace as a result (see Alam *et al.*, 2008). The experience from the PMPDP has illustrated how blending academic research and on-the-job practice can benefit not only the delegate attending the programme, but also act as a powerful means of introducing effective organisational change at the workplace. While organisations have conventionally made use of consultants as a way of seeking external validation to their problem-solving approaches, there is evidence to show that such an approach often leads to failure because these consultants are normally seen as operating externally to the organisation (see Czarniawska and Mazza, 2003). Thus, the Professional Doctorate Programme provides a platform for practitioners to become 'co-researchers' (Antonacopoulou, 2010) in order to produce knowledge from and in action (Bredillet *et al.*, 2015) through the interplay of purposeful action, reflexive critique and learning to connect between theory and practice.

As far as it is known, there is currently no provision for the Professional Doctorate Programme on a blended, part-time basis. The closest model in the field is hosted in the Royal Melbourne Institute of Technology (RMIT) University, where the Doctorate Programme in Project Management requires applicants to have around 8 years' of relevant professional experience (see Bredillet *et al.*, 2013). However, the RMIT programme allows students to undertaken research on a full-time basis, thereby removing the researcher from everyday industrial practice while doing the doctoral studies. The Professional Doctorate Programme in Project Management is distinctive in that the researchers are full-time employees working in their day jobs and building their research around real-life problems in such practical contexts. This would allow them to pursue engaged scholarship (see Van de Ven, 2007) over a sustained period of time (~4-6 years), and to approach their practical project management problem in a holistic and critical way (see Packendorff, 2013).

Instead of theory before practice, delegates on the Professional Doctorate Programme in Project Management are first and foremost practitioners who engage with ongoing reflection and theorising. To enable delegates to learn to connect between theory and practice, and to reflexively critique their purpose and actions, delegates will undergo eight residential taught sessions over the course of their research. These residential sessions principally provide the space and guidance for delegates to develop their research-in-writing process, so that they can reflect and articulate continuously on the practical and academic impacts achieved through their everyday practice. It is hoped that these sessions would facilitate the practice-relevant scholarship that Antonacopoulou (2010) called for. The eight sessions are summarised below:

- *Introduction to the doctoral research process*: this session covers basic information as to what constitutes a doctoral level achievement, ongoing debates around the concept of 'doctorateness', the typical life cycle of the doctorate degree programme, managing the relationship between and expectations of the supervisor(s) and the doctoral researcher, work-life-PhD balance and wellbeing.
- *Managing research and development, and innovation in business*: this session allows delegates to critically reflect on how business organisations manage research and development, creativity and innovation. The purpose is to get delegates to think about the relevance of their doctoral research projects within the context of managing R&D and innovation in their respective firms.
- *Academic writing (1) The literature*: this session is one of a series of sessions aimed at getting delegates to critically reflect on their reading and writing. The session will cover the importance and relevance of the literature to the research process, and offer guidance as to how delegates can go about critically reviewing articles for the purpose of framing their research problem and contribution. Delegates will also explore what constitutes an academic discipline or field of study, and how the politics of academic disciplines and fields can influence the reading and reviewing of the literature.
- *Engaged scholarship*: this session introduces the concept of 'engaged scholarship', and situates the discussion on contemporary concerns with research impacts, the debate on relevance versus rigour, and the challenges of co-production research. The session will also cover a range of methodological approaches that can facilitate engaged scholarship, through e.g. action research, ethnographic research (including autoethnographies) and case study research. The purpose of this session is to introduce delegates to a range of methodological approaches that are compatible with undertaking research at the workplace.
- *Research ethics*: undertaking research at such an involved level in the workplace can be ethically problematic. The purpose is to get delegates to reflect on the ethical implications of their work and to explore how thinking about research ethics can improve the framing of questions and dissemination of results. Principles such as voluntary participation and informed consent, 'do no harm', confidentiality, and dilemmas of representation will be covered.
- *Academic writing (2) The role of theory and interesting questions*: what is theory and how might theory help in delivering practical impacts of research? This session focuses on the role of theory and why theory is important not only for the PhD but also for framing interesting research questions (e.g. Hällgren, 2012).
- *Research objects*: this session plays on the word 'object', and is intended to get delegates to reflect on the range of objects they produce as part of the doctoral research process. These objects could include the research aims and objectives, the end-of-year progression reports, the thesis, the briefing notes that they produce to demonstrate the research impacts to their line managers, research articles

presented in a conference or published in a peer-reviewed journal, PowerPoint presentations of their research delivered at the workplace or professional network, research data (e.g. interview transcripts, audio/video recordings…), and so on. The purpose is to get delegates to reflect on the range of stuff (or objects) they produce and the power of these objects in making a difference at the workplace. Delegates will also reflect on who stands to gain and lose from the research.

- *Academic writing (3) Writing retreat*: in the final session, delegates will be able to go through a two to three-day academic writing retreat. Delegates will prepare a short paper based on their preliminary findings and theoretical framing. The session is intended to help delegates appreciate the intricacies of academic writing, which will help them in structuring the thesis.

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Rare Event Simulation-based Operational Safety Analysis for Complex Technological Projects: A Literature Review

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Abstract

Natural hazards such as hurricanes, floods, and earthquakes in most cases hold very small probabilities of happening during a project life. Yet, evaluating the effects of such hazards on the of complex technological systems operation such as hydropower facilities or chemical processing plants requires prohibitively large numbers of calculations and significant computational resources. In order to address these safety issues with efficient computational resource consumption, rare event simulation techniques are widely adopted. This study reviews the past research on the simulation of rare events with very small probabilities of occurrence. These techniques not only help to accelerate the computation speed, but also increase the estimation accuracy. In the study, two major rare event simulation techniques, importance sampling and splitting, are categorized and compared with their respective advantages and disadvantages. Applications of them are also summarized, especially for the safety management of such complex technological projects. Finally, detailed reviews of the dam-reservoir systems are presented, which serves as the case study demonstrating effectiveness of rare event simulation for complex project operations.

1. Introduction

Monte Carlo simulation is a computerized mathematical technique that allows people to account for risk in quantitative analysis and decision making. To be more specific, Monte Carlo methods present a broad class of computational algorithms that rely on repeated random sampling to obtain numerical results (Kalos and Whitlock 2008; Liu 2008). Monte Carlo simulation performs risk analysis by building models of possible results by substituting a range of values, a probability distribution, for any factor that has inherent uncertainty. The results are calculated repetitively each time using a different set of random values from the probability functions. Depending upon the number of uncertainties and the ranges specified for them, a Monte Carlo simulation could involve thousands or tens of thousands of recalculations before it would be complete. Based on the possible outcome values, distributions of the final results could be reached.

Monte Carlo methods are widely used because of their flexibility and robustness. The modern version of the Monte Carlo method was first invented in the late 1940s by Stanislaw Ulam on the nuclear weapons projects at the Los Alamos National Laboratory (Cooper et al. 1989). Immediately after Ulam's breakthrough, John von Neumann understood its importance and programmed the Electronic Numerical Integrator And Computer to carry out Monte Carlo calculations (Neumann 2005). In engineering, Monte Carlo methods are widely used for sensitivity analysis and quantitative probabilistic analysis in process design. The need of such application arises from the interactive, co-linear and non-linear behaviors of typical process simulations (Roebuck 2012). Analytical solutions or accurate approximations are only available for a very restricted class of simple systems. These techniques are used by professionals in such widely disparate fields as finance, project management, energy, manufacturing, engineering, research and development, insurance, oil & gas, transportation, and the environment. In most cases, engineering systems need to resort to simulation.

However, significant computational resources are usually required in the simulation to reach the satisfied results (Bucklew 2004). Otherwise, long wait times or buffer overflows might occur. For a discrete system of moderate complexity, there are a large number of possible system states combinations. As is often the case, estimation of the probability of failure and consequences of any given system state involves computationally expensive simulation. It is commonly infeasible to analyze all possible states as the resources required (Dawson and Hall 2006).

In order to address the potential project safety issues with efficient computational resources consumption, this study reviews past research on the rare event simulation methodologies, as well as their application. The remaining paper is structured as follows: in Section 2, previous rare event simulation methodologies, including importance sampling and splitting, are reviewed. Then, Section 3 presents the corresponding applications in both engineering projects and projects in other fields. In Section 4, detailed reviews on the dam-reservoir systems are presented, which serve as the case study demonstrating effectiveness of rare event simulation for complex project operations. Conclusions are presented in Section 5.

2. Methodology of Rare Event Simulation

Rare event simulation and quantification come from the need to insure that undesirable events will not occur. Typically, such an event is the failure of industrial critical systems, for which failure is regarded as a massive catastrophic situation. Usually the system is a “black box” whose output determines safety or failure domains (Walter and Defaux 2015). A great deal of attention has been focused on the development of Monte Carlo techniques. Today, the rare event simulation applications range from lightwave and optical communication systems (Smith et al. 1997), to industrial routing problems (Chepuri and Homem-de-Mello 2005), and to financial asset pricing (Chan and Wong 2015). According to Bucklew (2004) and Rubino and Tuffin (2009), a rare event means an event that occurs infrequently with a very small probability, but is important enough to justify the study. Rare event simulation is thus an umbrella term for a group of computer simulation methods intended to selectively sample ‘special’ regions of the dynamic space of systems that are unlikely to visit those special regions through brute-force simulation (Juneja and Shahabuddin 2002). Based on the hazard-rate twisting method, Huang and Shahabuddin (2004) discussed a general approach to estimate rare-event probabilities in static problems.

Importance sampling and splitting are the two primary techniques to make important rare events happen more frequently in a simulation (L’Ecuyer et al. 2006). The unbiased estimator is obtained with much smaller variance than the standard Monte Carlo estimator. Comparisons of their respective advantages and disadvantages are presented in Table 1 below.

Table 1. Comparisons of Importance Sampling and Splitting

Methodology	Description	Drawback
Importance sampling	Importance sampling increases the probability of the rare event by changing the probability laws that drive the evolution of the system. Then, it multiplies the estimator by an appropriate likelihood ratio to recover the correct expectation.	The main difficulty in general is to find a good way to change the probability laws.
Splitting	In the splitting method, the probability laws remain unchanged, but an artificial drift toward the rare event is created by terminating with some probability the trajectories that go away from it and by splitting those that are going in the right direction. In general, an unbiased estimator is recovered by multiplying the original estimator by an appropriate factor.	Fewer variables are necessary to describe the system as a Markov system, the better the splitting method will work. The dimensionality of the state space negatively influences the performance of the splitting method.

2.1 Principles of Importance Sampling

Importance sampling has been extensively investigated by the simulation community in the last decade, which serves as one of the general approaches for speeding up simulations and to accelerate the occurrence of rare events. The basic ideas behind importance sampling were outlined by Kahn and Marshall (1953). Certain values of the input random variables in a simulation have more impact on the parameter being estimated than on others. If these values are emphasized by sampling more frequently, then the estimator variance can be reduced to a better accepted level. Hence, the basic methodology in importance sampling is to choose a distribution that encourages the important values, and to estimate the probability of interest via a corresponding likelihood ratio estimator. Illustration of importance sampling-based simulation is shown in Figure 1. The simulation outputs are weighted to correct for the use of the biased distribution, and this ensures that the new importance sampling estimator is unbiased. The weight is given by the likelihood ratio, that is, the Radon–Nikodym derivative of the true underlying distribution with respect to the biased simulation distribution.

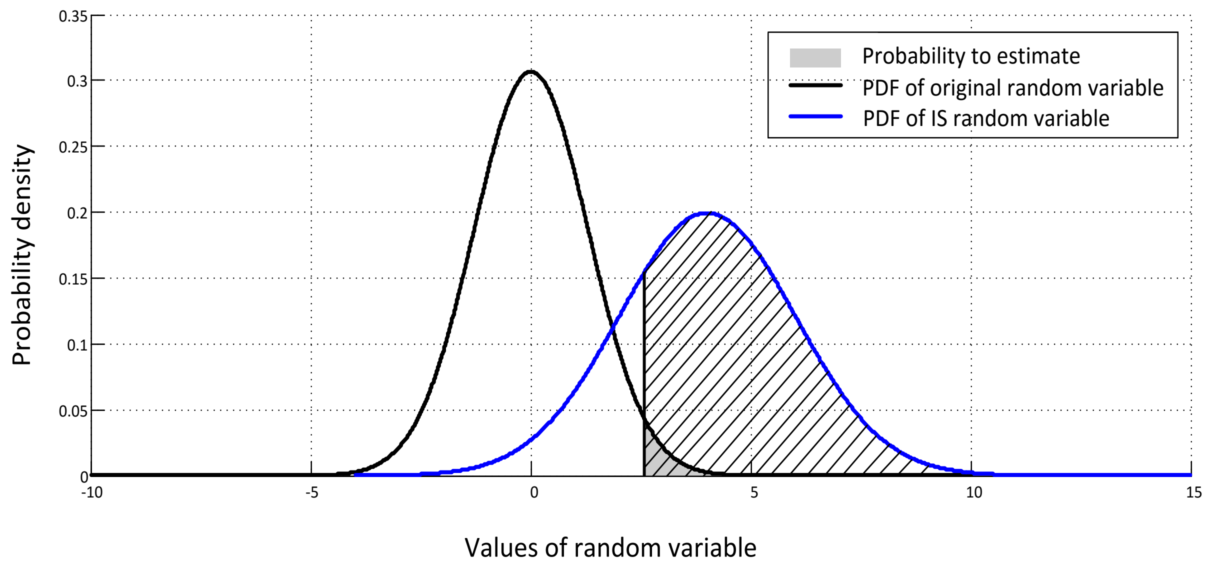

Figure 1. Graphical Illustration of Importance Sampling-Based Simulation

A considerable amount of past research has been devoted to the study of importance sampling techniques in simulation, in particular for rare-event simulation. Based on Glynn and Iglehart's (1989) research, the importance sampling idea was extended to the problems arising in the simulation of stochastic systems. Discrete-time Markov chains, continuous-time Markov chains, and generalized semi-Markov processes were covered. Shahabuddin (1995) also reviewed fast simulation techniques used for estimating probabilities of rare events and related quantities in different types of stochastic models. Based on the importance sampling technique, multiple variance reduction tools for solving rare event problems could also be found in varied areas (Ding and Chen 2013; Jacquemart and Morio 2013; Morio et al. 2010, 2013).

To be specific, Equation (1) is adopted in order to estimate the rare event probability through the importance sampling-based Monte Carlo simulation.

$$\hat{l}_{IS} = E\left(I_{\{S(X)\geq h_f\}}\right) = \frac{1}{N_{IS}}\sum_{j=1}^{N_{IS}} I_{j\{S(X)\geq h_f\}}\,, \tag{1}$$

where $\hat{l}_{IS}$ stands for the importance sampling Monte Carlo simulation estimator; $E(\cdot)$ stands for the function of expectation value; h_f stands for the cutting value of the probability estimation; $I_{(\cdot)}$ stands for the indicator function with binary values in [0, 1]; *i* stands for the index of simulation iterations; and N_{IS} stands for the iteration of simulation.

As discussed before, N_{IS} needs to be very large in order to achieve an estimation of l within the acceptable confidence intervals. Importance sampling replaces the probability density function from $f(\cdot)$ to $g(\cdot)$ as a new probability density. Detailed information is presented in Equations (2) and (3).

$$g(x) = I_{\{S(x) \geq h_f\}} f(x) = 0, \tag{2}$$

where $g(\cdot)$ stands for the probability density function of the replaced random variables; $I_{(\cdot)}$ stands for the indicator function with binary values in [0,1]; and $f(\cdot)$ stands for the probability density function of the original random variables.

$$W(x) = \frac{f(x)}{g(x)}, \tag{3}$$

where $W(\cdot)$ stands for the likelihood ratio function; $f(\cdot)$ stands for the probability density function of the original random variables; and $g(\cdot)$ is the importance sampling density, which stands for the probability density function of the replaced random variables.

As a result, the original random variable $\{X(t)\}$ with probability density function of $f(\cdot)$ is replaced by the updated random variable $\{Y(t)\}$ with a probability density function of $g(\cdot)$. Detailed information is shown in Equation (4) below.

$$\begin{aligned} l &= \int I_{\{S(X_i) \geq h_f\}} \frac{f(x)}{g(x)} g(x) dx \\ &= E_g \left[I_{\{S(Y) \geq h_f\}} \frac{f(y)}{g(y)} \right] = E_g \left[I_{\{S(Y) \geq h_f\}} W(y) \right], \end{aligned} \tag{4}$$

where l stands for probability for rare event simulation; $I_{(\cdot)}$ stands for the indicator function with binary values in [0,1]; $W(\cdot)$ stands for the likelihood ratio function; $f(\cdot)$ stands for the probability density function of the original random variables; $g(\cdot)$ stands for the probability density function of the replaced random variables; and $E_g(\cdot)$ stands for the expectation function of importance sampling Monte Carlo estimation.

Thus, an updated unbiased estimator of l is shown in Equation (5) below.

$$\hat{l}_{IS} = \frac{1}{N_{IS}} \sum_{j=1}^{N_{IS}} I_{j\{S(Y) \geq h_f\}} \frac{f(y)}{g(y)} = \frac{1}{N_{IS}} \sum_{j=1}^{N_{IS}} I_{j\{S(Y) \geq h_f\}} W(y), \quad (5)$$

where $\hat{l}_{IS}$ stands for the probability estimation based on importance sampling-based Monte Carlo simulation; N_{IS} stands for the iteration times; $I_{(\cdot)}$ stands for the indicator function with binary values in [0,1]; $W(\cdot)$ stands for the likelihood ratio function; $f(\cdot)$ stands for the probability density function of the original random variables; and $g(\cdot)$ stands for the probability density function of the replaced random variables.

2.2 Principles of Splitting

The splitting methodology was first invented to improve the efficiency of simulations of particle transport in nuclear physics. It is used to estimate the intensity of radiation that penetrates a shield of absorbing material (Booth 1985; Booth and Hendricks 1984; Booth and Pederson 1992). Then, these areas remain as the splitting method primary area of application. Splitting is also used to estimate delay time distributions and losses in ATM and TCP/IP telecommunication networks (Akin and Townsend 2001; Görg and Fuss 1999). In a recent real-life application, splitting was used to estimate the probability that two airplanes get closer than a nominal separation distance, or even hit each other, in a stochastic dynamic model of air traffic where aircrafts are responsible for self-separation with each other (Blom et al. 2005).

The splitting method is based on the idea to iteratively estimate supersets of the designed set and then to estimate the corresponding probability with conditional probabilities. Assume that we want to compute the probability $P(D)$ of an event set D. The general idea for splitting is to find a series of event sets $D = D_0 \subset D_1 \subset ... \subset D_m$. Then, the calculation of $P(D)$ is successfully transformed into $P(D) = P(D_m)P(D_{m-1} | D_m)...P(D_0 | D_1)$, where each conditional event isnot rare. Illustration of splitting based simulation is shown in Figure 2.

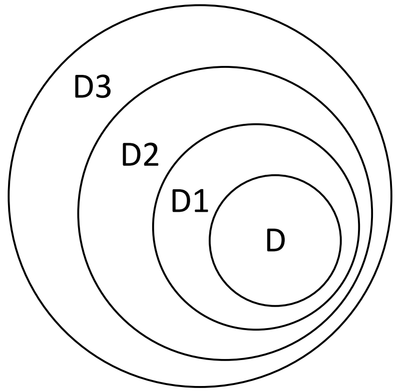

Figure 2. Graphical Illustration of Splitting Based Simulation

For $\forall D_{i-1} \subset D_i$, where $i = 1, 2, ..., m$, Equation (6) stands for the calculation relations of conditional probabilities. Here, every *j* satisfies $m \geq i > j$.

$$P\left(D_j \mid D_i\right) = \frac{P\left(D_j \cap D_i\right)}{P\left(D_i\right)} = \frac{P\left(D_j\right)}{P\left(D_i\right)} = \prod_{k=j}^{i-1} p_k \quad , \tag{6}$$

where p_k stands for the conditional probability of $P\left(D_{k-1} \mid D_k\right)$. As a result, the rare event probability is transformed to the following calculation shown in Equation (7).

$$l = \prod_{i=1}^{m} p_i \ , \tag{7}$$

where l stands for probability for rare event.

Let us define the decreasing sequence of subsets D_i where $i = 0, 1, ..., m$. Then, the corresponding rare event probability estimation is shown in Equation (8) below.

$$\hat{l}_{SP} = \prod_{i=1}^{m} \hat{p}_i = \prod_{i=1}^{m} \frac{R_i}{n_{i-1} R_{i-1}} = \frac{R_m}{\prod_{i=0}^{m-1} n_i} \quad , \tag{8}$$

where R_i stands for the simulated values. Then, the estimator for the probability of reaching the highest level shown in Equaiton (9).

$$E(\hat{l}_{SP}) = E\left(\prod_{i=1}^{m} \hat{p}_i\right) = \prod_{i=1}^{m} E(\hat{p}_i) = \prod_{i=1}^{m} p_i = l \quad , \tag{9}$$

3. Applications of Rare Event Simulation on Operational Safety Analysis

3.1 Engineering Projects

Applications of rare event simulation and importance sampling techniques could frequently be found in the reliability engineering field in past research, in order to reduce simulation expenses and increase estimation accuracy. According to Alexopoulos and Shultes (2001), importance sampling in conjunction with regenerative simulation was presented as a promising method for estimating reliability measures in highly dependable Markov systems. L'Ecuyer and Tuffin (2009) and Dai et al. (2012) also considered the Markov chain models and simulation to represent the evolution of multicomponent systems in reliability settings. This is based on dynamic importance sampling and the probability that a given set of nodes was connected in a graph where each link was failed with a given probability. According to Au and Beck (1999), an adaptive importance sampling methodology was proposed to compute the multidimensional integrals encountered in reliability analysis. In the proposed methodology, samples were simulated, as the states of a Markov chain, and then they were distributed asymptotically according to the optimal importance sampling density. Importance sampling was also adopted in structural reliability analysis (Dawson and Hall 2006; Grooteman 2008). The case studies proposed demonstrated that the risk could be a complex function of loadings, the resistance and interactions of system components and the spatially variable damage associated with different modes of system failure.

Severe blackouts due to cascading failures in the electric grid are rare but catastrophic. Consequently, the power system becomes another application focus that rare event simulation and importance sampling concentrated on. Belmudes et al. (2008) proposed an approach for identifying rare events that may endanger power system integrity. The approach was also illustrated on the IEEE 30 bus test system when instability mechanisms related to static voltage security were considered. Wang et al. (2011) also presented an effective rare-event simulation technique to estimate the blackout probability. An IEEE-bus electric network was chosen as the application case, and the most vulnerable link in the electric grid was detected, which has the highest probability of leading to a blackout event. Besides, power system security analysis is often strongly tied to contingency analysis. With variable generation sources such as wind power and due to fast changing loads, power system security analysis has to incorporate sudden changes in injected powers that are not due to generational outages. Perninge et al. (2012) used importance sampling for injected-power simulation to estimate the probability of system failure, given a power system grid state. A comparison to standard crude Monte Carlo simulation was also performed in a numerical example and it indicated a major increase in simulation efficiency.

3.2 Projects of other fields

Monte Carlo techniques and rare event simulation are also widely used in many other fields. In financial engineering, the accurate measurement of credit risk is often a rare-event simulation problem because default probabilities are low for highly rated obligors and because risk management is particularly concerned with rare but significant losses resulting from a large number of defaults. To solve these problems, Bassamboo et al. (2008) derived sharp asymptotics for portfolio credit risk that illustrated the implications of extremal dependence among obligors. Importance-sampling algorithms were then developed to efficiently compute portfolio credit risk via Monte Carlo simulation. Glasserman and Li (2005) also provided an importance sampling procedure for the widely used normal copula model of portfolio credit risk. The procedure had two parts: one that applied the importance sampling conditional on a set of common factors affecting multiple obligors, and the other that applied importance sampling to the factors themselves. The relative importance of the two parts of the procedure was determined by the strength of the dependence between obligors. Besides, in the queueing system, Blanchet and Lam (2014) developed rare-event simulation methodology for the analysis of loss events in a many-server loss system under the quality-driven regime. Heidelberger (1995) also surveyed efficient techniques via simulation for estimating the probabilities of certain rare events. In operational systems, Bee (2009) used importance sampling to estimate tail probabilities for a finite sum of lognormal distributions. And, in public health, Clemencon et al. (2013) focused, in the context of epidemic models, on rare events that might possibly correspond to crisis situations. In biochemical systems, Kuwahara and Mura (2008) proposed an efficient stochastic simulation method to analyze deviations from highly controlled normal behavior in biochemical systems.

4. Case Study on Dam-Reservoir Systems

Dam-reservoir systems are a critical component of water infrastructure, providing services such as water, power, flood control, recreation, and many economic possibilities (Vedachalam and Riha 2014). The successful performance of a dam-reservoir system depends on the aggregate satisfactory performance that prevents a failure and uncontrolled release of the reservoir. However, hundreds of dam failures have occurred throughout U.S. history that have caused immense property and environmental damage and have taken thousands of lives. Take the Lawn Lake Dam failure of 1982, for instance. The sudden release of 849,000 m^3 of water resulted in a flash flood that killed three people and caused $31 million of damage. In 1996, the Meadow Pond Dam also failed with big loss. About 350,000 m^3 of water was released, and resulted in one fatality, two injuries, and damage to multiple homes. In 2006, the Ka Loko Dam burst, resulting in a flood that caused seven fatalities and destroyed several homes. According to the Association of State Dam Safety Officials (2015), 173 dam failures and 587 incidents were reported from January 2005 through June 2013 by the state dam safety programs. Dam failures are not particularly common, but continue to occur (Baecher et al., 2011). The number of dams identified as unsafe is also increasing at a faster rate than those being repaired, as dam age and population increase. In the future, the potential for deadly dam failures will continue to grow.

Potential failure modes for dam-reservoir systems were explored by researchers. Overtopping is one of the most common failure modes for the dam-reservoir systems with significant consequences. According to national statistics, overtopping due to inadequate spillway design, debris blockage of spillways, or settlement of the dam crest account for approximately 34% of all U.S. dam failures (Association of State Dam Safety Officials 2015). Other causes include piping, seepage, internal erosion (Curt et al. 2010), and inadequate maintenance. A similar proportion has also been concluded by Kuo et al. (2008) and Zhang et al. (2009). In general, overtopping is the most common failure cause of dam-reservoir systems, particularly for the homogeneous earth-fill dams and zoned earth-fill dams. Spillways, foundations, and downstream slopes are the potential locations of the risks. Overtopping flows can erode down through an embankment dam, releasing the stored waters, potentially in a manner that can cause catastrophic flooding downstream as well as a total loss of the reservoir.

Due to the stochastic nature of a dam-reservoir system, the dynamics of system operations and corresponding overtopping risks could be modeled through Monte-Carlo simulation. According to Wang and Bowles (2006), a simulation-based model was developed on the breach process at multiple breach locations for a dam with an uneven crest under wind and wave action. Dewals et al. (2010) also applied the simulation of flows induced by several failure scenarios on a real complex of dams, involving collapse and breaching of dams in cascade. As an output, the simulation provided emergency planning and risk analysis, including the sequence of successive overtopping and failures of dams, the time evolution of the flow characteristics at all points of the reservoirs, hazard maps in the downstream valley as well as hydrographs and limnigraphs at strategic locations in the valley. Besides, Tsakiris and Spiliotis (2012) also developed an approach that combined both the simulation and semi-analytical solution, in order to address the dam breach formation caused by overtopping and the resulting outflow hydrograph. Generalized reservoir system operation models include HEC-5, which is the most widely used reservoir operation simulation model, IRIS and IRAS, the SWD SUPER Modeling System, and the WRAP Modeling System.

4.1 Research Gap

Although applications of Monte Carlo methods range widely from estimating integrals, minimizing difficult functions, to simulating complex systems, they are generally expensive and are only applied to problems that are too difficult to handle by deterministic methods. The overtopping events, in most cases, have very small occurrence probabilities. The standard Monte Carlo method is not always the most appropriate tool especially when we deal with those rare events. According to Rani and Moreira (2009), simulation without preliminary screening would be very time consuming, in view of the very large number of options of configuration, capacity and operating policy. Dawson and Hall (2006) also pointed out that the computational expense serves as one of the prohibitive reasons that the simulation technique has not been widely applied to reservoir operations. Minimizing error rates at a reasonable cost and understanding sources of errors are consequently important aspects of these practical problems. In order to save the computational expenses and increase estimation accuracy, rare event simulation has been adopted for efficient estimation, especially on small probability events. As one of the most common rare event simulation techniques, importance sampling is involved in many engineering applications in order to achieve variance reduction.

As an extension of Monte Carlo simulation, the rare event simulation techniques have been adopted in the dam-reservoir system operation. These researches mostly focus on the critical factors such as peak inflow rate, which might lead to the overtopping events (Hsu et al. 2010; Sun et al. 2012). However, overtopping is a complete process. Generally speaking, the water surface elevation in a reservoir is directly tied to the whole storage volume, with either a linear or a nonlinear relationship based on the reservoir shape. As a result, the stochastic inflow rate integrated within a certain period of time would change the reservoir storage, assuming there is no outflow releasing to the system. Overtopping would potentially occur due to the continuous high inflow volumes, even when the annual peak inflow rate is not extreme. Modeling and simulating a whole system is thus beneficial to the final overtopping estimation. Correlations between the inflow rate and the inflow volume are also proven to exist (Goodarzi et al. 2012; Klein et al. 2011; Poulin 2007).

Although overtopping results in significant consequences, in reality, such events have a very low possibility of occurrence for a specific dam-reservoir system.. Those events could be deemed as rare events. Estimation of such rare-event probabilities with crude Monte Carlo simulation requires a prohibitively large number of trials, where significant computational resources are required to reach the satisfied estimation results. Otherwise, estimation of the disturbances would not be accurate enough. Accordingly, computational expense served as one of the prohibitive reasons that the simulation technique has not been widely applied to the reservoir operation. Minimizing error rates at a reasonable cost and understanding sources of errors are consequently important aspects of these practical problems. In order to fill in the research gap, the rare-event simulation technique is thus needed and plays a critical role in evaluating the overtopping risks of dam-reservoir systems.

4.2 Future Work

Based on the current study, future efforts could be made through the following two aspects:

1) The reliable performance of dams and their appurtenant systems depends on the interactions of a large number of natural, engineering, and human systems. More information with available data resources, such as temperature, rainfall and snowfall, could be considered to be involved, as well as their inner correlations, in the future. At the same time, more failure modes would be tracked for the dam-reservoir system through both the crude and importance sampling-based simulations;

2) High performance computing generally refers to the practice of aggregating computing power in a way that delivers much higher performance than one could get out of a typical desktop

computer or workstation in order to solve large problems in science, engineering, or business. The University of Maryland has a number of high performance computing resources available for use by campus researchers requiring compute cycles for parallel codes and applications. Future work can be done in order to take use of those available computation resources and improve the simulation accuracy.

5. Conclusions

This study reviews the past research on the simulation of rare events with very small probability of occurrence. These techniques not only help to accelerate the computation speed, but also increase the estimation accuracy. In the study, two major rare event simulation techniques, importance sampling and splitting, are categorized and compared with their respective advantages and disadvantages. Applications of them are also summarized, especially for the safety management of such complex technological projects. Finally, detailed reviews on the dam-reservoir systems are presented, which serve as the case study demonstrating effectiveness of rare event simulation for complex project operations.

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Sustainable Implementation of New Technologies:

A Valuation Method for Healthcare Supply Chains

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Abstract

The external environment in which most business exists is volatile, ambiguous, and ever-evolving. In the wake of the e-commerce evolution, health care services are adapting to provide online prescription refills, in addition to sharing patient information using database software and cloud computing. Sustainability is a key component and critical measure to consider when implementing change and taking on new projects. Long term sustainability is contingent on supply chain networks (SCN) working in cooperation to produce sustainable economic, social, and environmental outputs. In order for these networks to have successful interrelationships, valuation methods must be used to select projects that produce sustainable solutions. This paper reviews the pertinence of web based technologies to the healthcare industry in order to facilitate sustainable operations, while addressing methods of evaluation for selection of new technologies. The findings conclude that measuring sustainability is relatively subjective and that sustainability might best be managed as a "risk."

Keywords: sustainability, value, healthcare, corporate social responsibility, sustainability performance management, risk management, supply chain, IT, software engineering, quality management

Glossary of Acronyms

AHP: analytical hierarchy process

GNH: gross national happiness

GRI: global reporting initative

GSA: general services administration

HIPAA: Health Insurance Portability and Accountability Act

PPP: public/private partnerships

PV: present economic value

SCN: supply chain networks

SROI: social return on investment

VfM: value for money

Introduction

Like most industries, healthcare providers rely on customers in order to continue operations. In our lifetime, we have witnessed advances in modern technology that would have at one time seemed to be the dreamed up concoctions of a science fiction novel. We have also witnessed the rise and fall of many companies, whose failure to implement change had far reaching consequences. “Eastman Kodak is a picture-perfect example. It built one of the first digital cameras in 1975.” (18) For many reasons, some perhaps well justified, the company was slow to change the once highly successful business model. “The development of smartphones that double as cameras, has battered Kodak's old film- and camera-making business almost to death.”(18)

With patients and/or caregivers who are progressively becoming more tech savvy, hospitals, pharmaceutical companies, and medical device manufacturers must tailor their services appropriately. Healthcare services such as nonprofit hospitals have seen a downward trend in terms of revenue growth over the past several years. “Total operating margins have remained negative from federal fiscal year (FFY) 2000 to midway through FFY07, according to the data, although the trend has improved slightly in recent years. That means hospitals are losing money on their core business of providing patient care.”(14) Admissions are falling due to increases in insurance rates and the availability of alternatives such as immediate care facilities, and telemedicine. For healthcare organizations, this means realignment of the firm’s fundamental strategic management plan; goals, objectives, and the strategy of the business operations, including maintaining visibility in a market where alternatives are numerous.

Healthcare facilities share a SCN with private manufacturing, distribution, and logistic firms. Meaning that healthcare supply chains house public/private partnerships (PPP). “A typical PPP example would be a hospital building financed and constructed by a private developer and then leased to the hospital authority. The private developer then acts as landlord, providing housekeeping and other non-medical services while the hospital itself provides medical services.” (2) Because of this relationship, the social/environmental outputs of long term sustainability might not necessarily align with maximizing the present economic value (PV) of the SCN. The concern is insuring that the SCN is selecting the best whole life outcome. This requires that “patient advocacy organizations, clinicians, medical clinics, health care policymakers at the Federal, State, and local levels, purchasers, payers, and both public and private insurers” (3) involved understand the importance of sustainable operations.

The Industry

There is a very real structural shift in the healthcare industry. Patients and caregivers are more technologically inclined. Convenience, ease of use and cost are highly important during the decision-making process. Paul Matsen, CMO of Cleveland Clinic is quoted as saying “about 80% of patients who are diagnosed with an illness go on the web to find information about their condition.”(12) We know that search engines play an important role in the use of the internet and identifying online resources. As researchers it is important to acknowledge trends in consumer behavior as it relates to interaction with each other, and our electronic devices. Google conducted a study using historical search data. The company used “term buckets” such as hospital brand, conditions, treatment, procedures, and symptoms in order to extrapolate their findings. The results showed that “search drives nearly 3x as many visitors to hospital sites compared to non-search visitors."(17) This same study also identified that mobility plays a role in the decision-making process. Approximately 44% of patients who research hospitals using mobile devices, schedule appointments. This statistical evidence is a good indicator of the consumer's increase in accessibility and utilization of healthcare-related digital information. With 76% of patients using hospital websites for research, not only does digital media have the largest audience base of the cumulative total market, accessibility to digital media has a significantly high conversion rate for consumer purchase. By understanding these market trends, the importance of implementing new technologies including web-based services becomes pertinent to the SCN's sustainability.

Pew Internet has examined the social media trend as it relates to the healthcare market. According to the Pew Internet survey "About one in five internet users have consulted online reviews of particular drugs or medical treatments, doctors or other providers, and hospitals or medical facilities."(5) This finding illustrates the importance of social media in relation to healthcare marketing. Firms should be monitoring social media in order to gain feedback and address consumer concerns.

A good example of successful implementation of web based technologies is the Mayo Clinic. Mayo Clinic is a nonprofit healthcare leader, with operations in several states. The company has been successful at implementing responsive website designs that enable/promote a mobile friendly experience. The clinic has an app for patients to book appointments, access information, in addition to a special pregnancy app for expecting mothers. While other healthcare providers are losing market share with operating revenues decreasing, "The Mayo Clinic in Rochester, Minn., reported operating income of $347 million for the first six months of 2014." (21) This figure represents a 131% increase from the prior year.

Behavioral Economics

Once the concern has been identified e.g., the need for innovative services and tailored marketing, the second step is understanding the psychological selection process of the end-consumer. Behavioral Economics is a methodology for reviewing human behavior relative to conventional economic models.

In making a purchase decision, consumers review the market and identify their preferences. However with the presence of multiple choices, our brains tend to simplify the process and make fast "executive decisions." Advertising as a general statement is hugely dependent on the consumer remembering and identifying with the ad. Because there is typically a time delay between the consumer's exposure to the ad and the decision-making process, the memory cues are quite critical to the advertisement's effectiveness.

In digital advertising, an alternative is to capture the sale immediately before the patient leaves the site/page. The typical end consumer values convenience, and targeted products. Whether it's creating an account, scheduling an appointment, or refilling a prescription, ease of use is a significant variable.

Consumers tend to “suffer” from several types of phenomenon when making decisions. “Present Bias” is when “decision makers tend to put too much weight on costs and benefits that are immediate and too little on those that are delayed.” (9) When we consider healthcare, there is little obvious immediate benefit from attending an annual physical or dental cleaning. What consumers perceive rather is the immediate cost in terms of time, energy, hassle, transportation, and monetary co-payments. Forgoing multiple visits over an extended period of time can be attributed to the “Peanuts effect.”(22) This is when a consumer makes repeated decisions based on present bias, and does not perceive the cumulative consequence of their actions.

Healthcare facilities can use defaults as a means of persuasion. Utilizing online accounts linked to patient emails, facilities may default to scheduling follow up appointments and send email reminders. So long as the facility is HIPAA compliant in their communication. They may guide the decision, making it harder to opt out. This plays off the aforementioned tendency to make simplified fast decisions. Since the end consumer has limited attention, the brain creates mental shortcuts. There is a greater chance an individual would accept a default versus making the cognitive decision to opt in or out.

Barriers of Entry

HIPAA was enacted in 1996 and sought to regulate the exchange of electronic information. Doctors must be careful to abide by HIPAA regulations in their marketing. Although Doctors are afforded the right to market to current patients, targeted marketing is limited as patient records and information must not be disclosed. Having patient data accessible online often requires that the data be passed along to IT personal who manage the site.

With added technology comes increased complexities. Cybersecurity is an important variable. Risks include both authorized and unauthorized transmission of data. “Hospira was the first medical device company to receive an FDA safety communication because of a cybersecurity risk.” (4) The FDA discouraged healthcare facilities from purchasing Hospira’s infusion pump medical device because it was vulnerable to cyber-attacks. The vulnerability would allow hackers the ability to administer higher or lower levels of drugs to the patient. Even malware may be transferred to medical devices if USB devices are used to transmit data from the device and general hospital computer systems. This malware has the potential to interrupt the normal operation of the infected medical device.

When considering digital marketing for the healthcare industry, it is not just a question of law but also ethics. The American Marketing Association states: “1. Do no harm, consciously avoiding harmful actions or omissions. 2. Foster trust in the marketing system, striving for good faith and fair dealing as well as avoiding deception, and 3. Embrace ethical values, building relationships and enhancing consumer confidence in the integrity of marketing.”(15)

“Perceptual barriers” are the biggest concern regarding the ability to assign value and address the importance of societal and environmental outputs among PPPs. “Insurers may resist approving an expensive new heart drug even if, over the long term, it will decrease their payments for cardiac-related hospital admissions."(6) This is a good example of "present bias", in which the insurer only perceives the present cost and not the future benefit.

Physical barriers are evident in all industries, and including variables such as monetary cost of entry/implementation.

In order for healthcare supply chains to remain sustainable, they need to be able to express the importance of their continued operation to the privately owned partners that make up the SCN. Sustainability as it relates to the example of web based technologies is twofold. First, the SCN needs to be aware of the need for new technologies in order to sustain current operations. Second, in selecting which new technologies to adapt, the SCN must evaluate the sustainability of the project, processes, and equipment. How may the healthcare supply chain evaluate a new technology, process, or project in the planning stage?

Risk

Risk is an uncertainty that may ultimately lead to a positive or negative influence on a project's objectives. Sustainability needs to be managed similar if not identical to risk. During the initial planning process, prior to the implementation of any new equipment or processes, a cross-functional project team should determine possible problems. By identifying the risk event, the probability of its occurrence, and if occurred its potential impact, the team may avoid making costly mistakes. Sustainability as a risk has the possibility of being mitigated by first understanding the drivers that could facilitate the lack of sustainability in a project, process, product, or service. In the case of web based technologies drivers may include foreseen or unpredictable changes in federal or state policy, vulnerability to threats such as malware or malicious cyber-attacks, and an inability to add-on, or change the service offerings and capacity of the new technology without removing it entirely and starting over. Using the drivers, the team may identify the likelihood or probability of the event occurring and the total loss if the event occurs. Expected loss then becomes a function of probability of event, probability of impact, and total loss. Managing sustainability from both present and future perspectives the SCN should also consider the expected useful life of the new technology. By conducting a risk reduction leverage analysis, the SCN may determine the added benefit of taking certain preventative actions in comparison to the initial exposure of the risk.

The SCN will also need to navigate endogenous risks such as market volatility and exogenous uncertainties such as economic volatility during both the implementation and ongoing control stages. If sustainability is a risk, the drivers and counter forces become risks inside of the risk and must be managed as both individual and collective.

In order to manage sustainability as a risk, evaluation of the drivers, events, impact, and loss must be quantifiable. Learning through association (classical conditioning) tells us that "if a neutral stimulus (a stimulus that at first elicits no response) is paired with a stimulus that already evokes a reflex response, then eventually the new stimulus will by itself evoke a similar response."(19) This means that the relationship between economic return and sustainability is essential to understanding its value and to relate this value to stakeholders.

Value for Money

Understanding the importance of sustainability is partially dependent on the ability to quantify its value. Value for Money (VfM) as a method of assessment may determine what projects within the supply chain are deemed most appropriate for the use of public resources and those best fit for a PPP. In a sense VfM may be used in the decision making process of whether to make or buy a product/service. Once these relationships have been established a VfM analysis may be used as a tool to periodically assess the value of the PPP. This valuation method may be applied to determine what technologies to implement, and what portion of these services should be outsourced to PPPs.

Cost Effectiveness

One method used to measure VfM is Cost Effectiveness or CE ratio. CE ratio is the cost per unit of effectiveness, which in the case of a social infrastructural institution such as a hospital, the unit of effectiveness may be the number of patients treated. A low CE ratio means a low cost per patient treated. CE ratio may also be used in order to select the most appropriate treatment method to be used in a hospital. Take for example the Alameda County Medical Center in Oakland, California. A "mismanaged urban safety-net hospital system in one of America's most violent cities."(8) Wright L. Lassiter took over as CEO in 2005, a time when ACMC was losing over a million dollars per month. Lassiter is attributed for numerous changes that eventually turned the hospital around. One example of the many changes was realizing the Cost effectiveness of an umbilical-cord blood test kit used by the hospital. The kit ACMC was using prior to Lassiter taking over cost $96.50 per unit. A similar testing tool was available on the market that would do the same job, and only cost $.29 cents per unit. This similar tool offered a lower cost to unit of effectiveness ratio. "ACMC had been choosing the premium option, at a cost of $322,000 a year. Now, the teams decided, ACMC could not afford it."(8)

Social Return

Indicators of sustainability may be broken down into three separate groups; environment, social, and corporate governance. Environmental indicators may include such business practices as non-investment expenditures for environmental protection, total emissions, consumption of renewable energy, and production of waste. Corporate governance includes indicators such as code of ethics, stakeholder impact, and collective agreements. Lastly, social sustainability focuses on indicators such as monetary support of local community, gender in the workplace, diversity, number of terminated employees, wages, and education expenditures.

Many of these indicators are critically important. For the purpose of this paper, let us focus on social sustainability for a moment. Organizational success cannot be defined by a single "financial" measure. Non-financial objectives play an intricate role in driving performance. These social drivers may influence financial performance in both positive and negative ways. Social return on investment (SROI), looks at both financial and social impact of the corporation and may be calculated as;

SROI= (Social Impact – Investment) / Investment

Supporting local community is important to the reputation of the organization. Employee morale is essential to both employee retention through a reduction of voluntary turnover, and for recruitment. Especially within the healthcare industry, as skilled labor is a limited resource and a necessary component. Making investments in non-financial objectives, may be quantified using this method, and justified based on the weighting criteria as it relates to the firms goals, objectives, and business model.

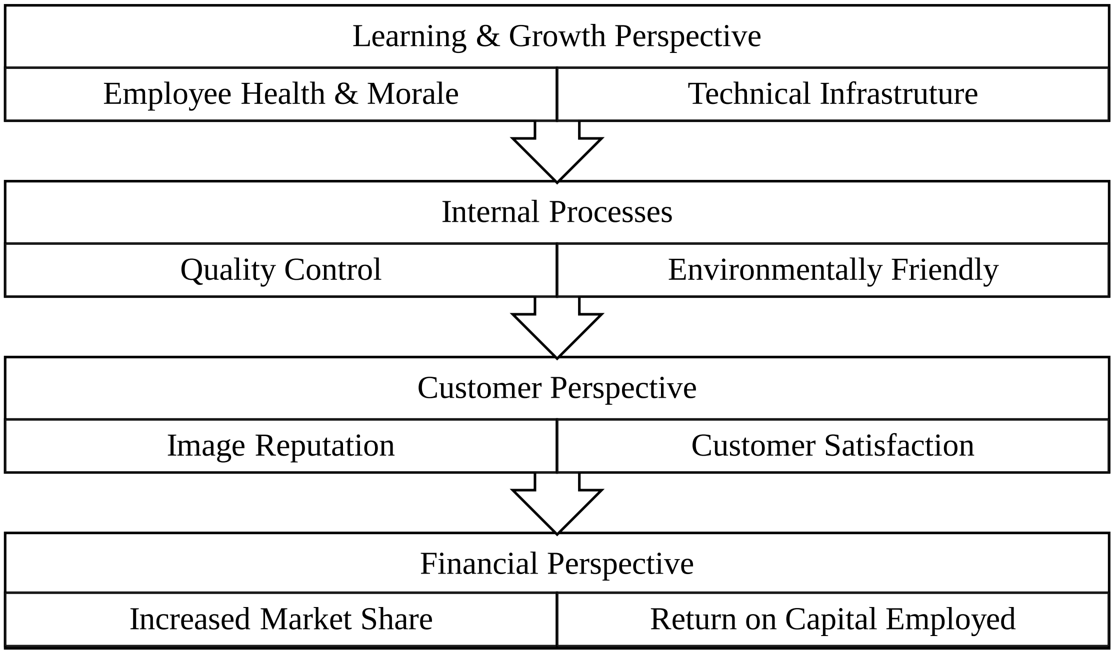
AHP

Through the use of the “Scale of Relative Importance” (13) the analytical hierarchy process (AHP) allows the user to assign value similar to that of a project selection scoring model. This ability to prioritize and assign a weighted value has proven effective in health care related selection models. Hoechst AG, is a pharmaceutical firm. The firm utilizes a scoring model based on a total of 19 questions developing five types of criteria. “The five categories include: probability of technical success, probability of commercial success, reward to the company, business strategy fit, and strategic leverage (ability of the project to employ and elevate company resources and skills).”(11)

Economic Value Added

The purpose of SCN sustainability is to successfully satisfy major stakeholders. This includes industry players such as “physicians, hospitals, and an array of powerful intermediaries, including group purchasing organizations, or GPOs, which consolidate the purchasing power of thousands of hospitals.”(6) This means that for the private firms involved, maximizing profits is a part of the SCN success. (Figure 1) is similar to a strategy map in that it illustrates the chain reaction from investment to financial outcome. A firm may estimate the future economic value as to express the importance of the investments in new technologies to maximizing the wealth of the stakeholders involved. The goal of the SCN then should be to find a relationship between the non-financial objectives and future financial value. Making changes from the ground level will also allow the firm to optimize the degree of operating leverage by taking advantage of processes that reduce costs.

Figure 1



Gross National Happiness

"The concept of well-being was first discussed by the Bhutan Gross National Happiness initiative which referred to subjective well-being as central to sustainable development."(16) GNH is a measure of sustainable infrastructure (SI). GNH measures well-being in terms of obesity, chronic illness, mental disorders, depression, and insomnia. GNH recognizes the interdependencies that exist between SCs and the SCN. Long term success of a civilization is dependent on the mental and physical health of the population. This means that healthcare supply chains must be sustainable. "An important objective for appraisal should be to foster learning of more than one type and, potentially, to modify the belief systems and behavior of individuals and organizations over time."(10) If GNH is an indication of a country's sustainability, and this is dependent on SI, then GNH is an indicator of successful healthcare supply chains. Meaning that GNH may also be used as a measure of effectiveness. A subjective, weighted system of indicators that assigns a rank or score to either an individual facility, or the SCN on a local, regional, national, and global scale.

The United States' General Services Administration (GSA) is one of the world's largest single procurement bodies. The GSA procures for all of the government's non-military related needs and spends over $600 billion annually. "The GSA and the Department of Defense are actively involved in the management of sustainability in their supply chains." There is a global push for non-financial reporting. National laws and regulations are being enacted, and the demand for transparency is increasing. The global reporting initative (GRI) has 8770 organizations who have issued reports to their database worldwide. These non-financial indicators are becoming more and more popular with investors and the GRI is slowly being "integrated into stock exchange listing guidelines, requested by large asset owners and managers and expected by large institutional customers."

Conclusion

The Baldrige framework's 11 foundational and interrelated core values for health care organizations are "visionary leadership, patient-focused excellence, valuing people, organizational learning and agility, focus on success, managing for innovation, management by fact, societal responsibility and community health, ethics and transparency, and delivering value and results."(1) In order to achieve quality in both products and services, healthcare supply chains must focus on these core values. Many of which are addressed by the need for sustainable practices, and evaluation methods.

It is not just the healthcare industry that needs to recognize the importance of sustainable technology. "Surveys of published studies show over 50% of those on sustainability in software engineering were published between 2010 and 2012, indicating the emergence of the topic in the software-development community." (7) Although ISO/9126 and ISO/IEC 25010 do not consider sustainability as a property of software quality, the Third Working Draft of ISO/IEC 42030 Systems and Software Engineering Architecture Evaluation has much to offer software practitioners. Assisting in "making trade-offs, not only among technical and economic aspects of business sustainability but also in relation to society and the environment." (7)

This paper has looked at several varying methodologies. Many of which are interrelated, and most of which have merit in this field. Further research would be necessary in order to make additional conclusions regarding sustainability as a risk, and the nature of the valuation methods that may be used. Conclusions that may be derived from the current research show that managing sustainability as a risk allows project managers, SCNs, and stakeholders to make educated decisions that allow for continued growth and operations. While evaluation methods for sustainability are primarily subjective, use of data sensitivity analysis would help assign weighted values to the various indicators, and the use of interrelated valuation methods may increase the success of risk management as it relates to sustainability, particularly in the planning, selection, implementation, and control of web-based technologies for healthcare supply chains.

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Leveraging on Unmanned Aerial Vehicle (UAV) for Effective Emergency Response and Disaster Management

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ABSTRACT

Over the past two decades, the impact of disasters has been devastating, affecting 4.4 billion people, resulted in 1.3 million causalities and $2 trillion in economic losses. Global climate change and worldwide instabilities have affected urban areas. In spite of all the technological advances, the impacts of natural and manmade disasters in urban areas represent an increasing challenge – therefore effective mitigation and emergency response strategies are pivotal. Concerning post-disaster reconstruction scenario, the most significant factor is accessibility to the disaster affected area and timely response based on best possible information available. Effective emergency response and sustainable post-disaster reconstruction are crucial and lie at the heart of disaster management agencies in almost every cautious country around the globe. The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years. The success of the reconstruction phases, i.e., rescue, relief, and rehabilitation, is mainly dependent on the accessibility to the site, availability of efficient project teams and timely information to make informed decision. Using UAV to access the affected areas and to monitor and capture data to make well-informed decisions, combined with the efficiency of a project team and strong coordination, project success should increase. This paper presents potential application of UAV for accessibility to affected areas, monitoring, and capturing timely and useful information for enhancing prompt and effective sustainable disaster management. The UAV with mounted imaging device will access to disaster struck areas and capture timely and useful information for making more informed decisions for effective, timely and sustainable response in post-disaster scenarios.

The potential application of UAV would be helpful for emergency response management teams to access areas that are otherwise not accessible, take timely measures by learning from captured information, making informed decisions related to effective emergency response and disaster management processes undertaken by emergency management agencies. Professionals need to have access to disaster struck areas to respond to emergency and provide urgent and critical life saving aids. Timely access and information will support a better and more efficient system for sustainable disaster management. Hence, the study is valuable for all professionals involved with research and development of emergency response and sustainable disaster management strategies.

INTRODUCTION

The recent sudden increase of natural and manmade disasters has taught many valuable lessons (Iglesias, 2007). Unfortunately, the need for preparedness is greater than ever before, given the increasing frequency and worsening intensity of weather-related storms and the escalation of technological threats (Moeini et al., 2013). No geographical area is immune or protected from the threat of emergencies and disasters. The importance of a proactive approach in responding to a disaster scenario in term of learning from past projects cannot be overstated (Arain, 2008). Pre-planning with local public safety and emergency response agencies can decrease confusion when a jobsite incident occurs (Ahmed, 2008). A quick response due to proper pre-planning and preparedness can expedite saving lives and rehabilitation process (Moeini et al., 2013).

Post-disaster reconstruction and rehabilitation is a complex issue with several dimensions (Arain, 2015). Many professionals in both fields tend to focus on planning and immediate response and have only recently begun to consider the requirements and opportunities inherent in long-term mitigation and reconstruction (Vale and Campanella, 2005). The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years (Pelling, 2003). Government, non-government, and international organizations have their own stakes in disaster recovery programs, and links must be established among them, as well as with the community. In other words, a post-disaster rehabilitation and recovery programs should be seen as an opportunity to work with communities and serve local needs. Relief and development often leads to burdens on the recipient government, and also often fails to serve the actual purpose and to reach the people in need (Shaw et al., 2003).

Environmental management professionals are now concentrating on the sustainability of environmental quality and environmental improvement; emergency managers and planners are re-focusing their efforts on the survivability of systems, organizations, and communities (Vale and Campanella, 2005). Sustainability and survivability are, in truth, two aspects of the same concept, namely: how to encourage and achieve continual improvement in ecosystems, the built environment, and human society (Pellow and Brulle, 2005). Both environmental management and emergency management have much to contribute to, and to gain from, the planning and implementation of post-disaster reconstruction.

Development is a dynamic process, and disasters provide the opportunities to vitalize and/or revitalize this process, especially to generate local economies, and to upgrade livelihood and living condition. Shaw and Sinha (2003) suggested the ideal level of involvement of different stakeholders after the disaster, as shown in Figure 2. The standard time frame of rescue, relief, and rehabilitation are defined as short term, long term, and longer term respectively.

Increasing worldwide impact of climate change, environmental degradation from human exploitation, urbanization and economic and social instabilities, unknown patterns and consequences of recent type of natural and manmade disasters, social and cultural complexity of urban residences and the aging urban infrastructures has increased the level of vulnerability to any type and different level of disaster (Pelling, 2003). Due to the increasing urbanization and population growth, the impact of any type of disaster (natural or manmade) in an urban area can be devastating with longer recovery period.

Increasing discussions and debates within disaster mitigation interest groups have raised questions regarding the practicality of adopting developmental approaches to disaster reconstruction (Ahmed, 2008). The chaos surrounding the disaster period following a disaster could easily lead to short-term and hasty decisions adversely affecting the community's ability to achieve sustainable, long term reconstruction goals (Arain, 2015). To minimize the occurrence of these unwise decisions, it is important to plan proactively for post-disaster restoration in order to provide general guidance for decision-makers and a framework for the professionals involved in reconstruction processes (Iglesias, 2007). For proactive plans and decisions, an integrated approach is required that may empower to implement the developed reconstruction strategy and monitor its results and progress.

The recent sudden increase of natural disasters has taught many valuable lessons (Iglesias, 2007). Unfortunately, the need for preparedness is greater than ever before, given the increasing frequency and worsening intensity of weather-related storms and the escalation of technological threats. No geographical area is immune or protected from the threat of emergencies and disasters. The importance of a proactive approach in responding to a disaster scenario in term of learning from past projects cannot be overstated. Pre-planning with local public safety and emergency response agencies can decrease confusion when a jobsite incident occurs (Arain, 2015). A quick response due to proper pre-planning and preparedness can expedite saving lives and rehabilitation process.

It is suggested that a timely access to relevant information and disaster site will assist in improving rescuing and reconstruction project processes, coordination and team building process because the most likely areas on which to focus to reduce unwise decision can be identified during the early stage of the post-disaster scenario (Arain and Low, 2006). Tapping on the live feed of information of post-disaster scenarios, the UAV system provides direct access to a wealth of pertinent and useful information for decision makers and eventually enhance collaborative venture. By having the access to timely information via UAV and a systematic way to make well-informed decisions, the efficiency of project team and the likelihood of strong coordination and eventually project success should increase (Arain, 2015).

The potential application of UAV would be helpful for emergency response management teams to access areas that are otherwise not accessible, take timely measures by learning from captured information, making informed decisions related to effective emergency response and disaster management processes undertaken by emergency management agencies. Professionals need to have access to disaster struck areas to respond to emergency and provide urgent and critical life saving aids. Timely access and information will support a better and more efficient system for sustainable disaster management.

UNMANNED AERIAL VEHICLE AND ITS APPLICATION

The UAV application supporting forest fire management is surely the most developed and practically demonstrated activity among all disasters (Restas, 2012). UAV can be used before fire for hot spot detection, during the intervention helping fire management with real time information and after suppression for post fire monitoring. The method of prescribed fire can be also in the focus of UAV use as a special application for fire prevention (Restas, 2015).

Detecting hot spots by aerials earlier than reporting it by civilians is obviously helps fire managers limiting the damages fires cause (Restas et al., 2014). Unfortunately the main reason why this method is not always used is the huge costs of aerials. If this procedure made by UAV is cheaper solution than the traditional one (manned aircraft) means option of drone use is the better solution. Naturally this case assumes the similar professional efficiency of different methods (Restas et al., 2014).

As pre-disaster activity, UAV following the stream of rivers can control the state of dams. In case of any unusual recognition the responsible authority can react in time for the problem. This activity is very flexible; the flight patrol can be optimized depending on time or other workload. Since affected areas are usually oversized, managing floods by aerials is always suffered from limited sources. It means drone can support disaster management at local level. This task requires tactical or operational UAV (Restas, 2015).

The stability of dams hangs on many conditions like the time it suffer from water press, how structure of dams built, what materials made of it. There is yet not enough information about it, however it can be supposed, with a procedure what is able to analyze the state of dam as airborne is help for managers. Knowing the state of dam managers can optimize the sources making the critic parts of dam stronger or in case of escalated problem can order the evacuation in time (Restas, 2015).

Since floods are a slowly developing disaster UAV can help for the management in many ways. With UAV observation can predict how flooded the area, what buildings are in risk, where from and where to evacuate the citizens, etc. The essence of this application is the gap of aerials what means the missing of manned aerials but UAV can offer as a satisfied solution (Restas, 2015).

An earthquake is a rapid escalating disaster, where, many times, there is no other way for a rapid damage assessment than aerial reconnaissance (Restas, 2015). For special rescue teams, the drone application can help much in a rapid location selection, where enough place remained to survive for victims. Floods are typical for a slow onset disaster. In contrast, managing floods is a very complex and difficult task. It requires continuous monitoring of dykes, flooded and threatened areas. UAV can help managers largely keeping an area under observation. Forest fires are disasters, where the tactical application of UAV is already well developed. UAV can be used for fire detection, intervention monitoring and also for post-fire monitoring. In case of nuclear accident or hazardous material leakage UAV is also a very effective or can be the only one tool for supporting disaster management (Restas, 2015).

Types of Unmanned Aerial Vehicles

The UAV classification is based on the military standards which have been partially adopted for civilian UAVs. Civilian UAVs are classified into two main classes: a) fixed wing, and b) multirotor or multicopter. Each UAV class has its unique design, operability and advantages and disadvantages which are briefly presented below.

Fixed Wing UAV

Fixed wing UAVs have a simple and aerodynamics structure consisting of a pair of rigid wings connected to the main fuselage. They a long flight time capacity(maximum 90 - 120 min) within both visual and beyond visual line-of-sight (VLOS & BVLOS) to cover long distances and large operational areas in a single flight.

This type of UAV is suitable for the rapid creation of aerial orthomosaic of disaster affected areas. Fixed wing UAVs offer a perfect platform for real-time accurate visual assessments of areas affected by disaster and enable the emergency responders to plan for response and recovery in large areas in a timely manner. The fixed wing UAVs are also effective platforms for immediate visual inspection of some critical infrastructure such as roads, railways, water, oil and gas pipe lines as well as power transmission lines.

Modified long range Skywalker X8

Modified long range Talon system

Modified long range Talon system

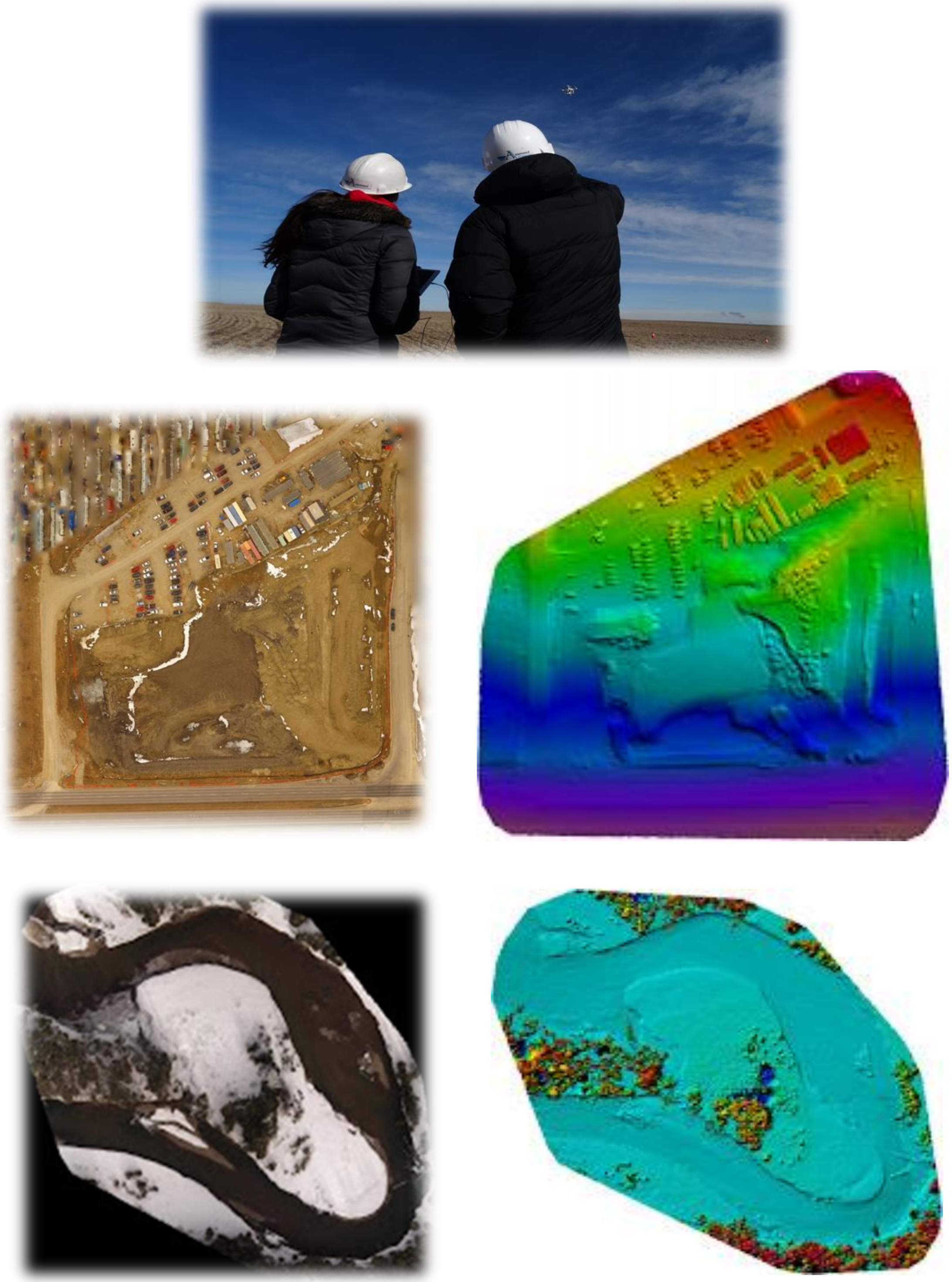
Modified Fixed Wing UAVs for aerial photogrammetry and surveying, equipped with Infrared and Sonar

Multirotor or multicopter

These types of UAVs have a more complex structure and better control systems operations compared to the fixed wing UVAs. In contrast to fixed wings UAVs multirotors have a lower speed and much shorter flight time (maximum 30- 40 minutes) due to their non-aerodynamics structure.

The main advantages, of multirotor UAVs are the Vertical Takeoff and Landing (VTOL) and capability to hover and perform agile maneuvering in small spaces. Multirotor UAVs are suitable platforms to inspect urban facilities such as bridges, power plants (fossil or nuclear fuel based), municipal buildings, hospitals and emergency centers. These types of UAVs are also able to carry different types of emergency packages such as CPR and emergency first aid kits to area with limited access. Multirotor UAVs enable the building inspectors to assess the building situation and define the possible damages with high level of accuracy and in a timely manner.

Modified Multirotor UAVs for aerial photogrammetry and surveying, equipped with Infrared and Sonar



Arial and infrared images of the flooded areas to inspect the possible equipment damage in the construction site during the flood

CONCLUSION

Concerning post-disaster reconstruction scenario, the most significant factor is accessibility to the disaster affected area and timely response based on best possible information available. Effective emergency response and sustainable post-disaster reconstruction are crucial and lie at the heart of disaster management agencies in almost every cautious country around the globe. The complex and multi-faceted processes of post-disaster recovery and reconstruction extend well beyond the immediate period of restoring basic services and life support infrastructure. While immediate restoration of services can be a matter of weeks, full recovery can stretch out 10-15 years. The success of the reconstruction phases, i.e., rescue, relief, and rehabilitation, is mainly dependent on the accessibility to the site, availability of efficient project teams and timely information to make informed decision. Using UAV to access the affected areas and to monitor and capture data to make well-informed decisions, combined with the efficiency of a project team and strong coordination, project success should increase. This paper presents potential application of UAV for accessibility to affected areas, monitoring, and capturing timely and useful information for enhancing prompt and effective sustainable disaster management. The UAV with mounted imaging device will access to disaster struck areas and capture timely and useful information for making more informed decisions for effective, timely and sustainable response in post-disaster scenarios.

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The paper sets the foundation for future research into application of UAV for disaster management. UAV can help managers largely keeping an area under observation. UAV can be used for fire detection, intervention monitoring and also for post-fire monitoring. In case of nuclear accident or hazardous material leakage UAV is also a very effective or can be the only one tool for supporting disaster management. UAV can also assist in transporting medical help to disaster struck areas and also airlifting critically injured human beings to near by medical support venues. Timely access and information will support a better and more efficient system for sustainable disaster management. Hence, the study is valuable for all professionals involved with research and development of emergency response and sustainable disaster management strategies.

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Creative Collaboration for the Agile Process

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ABSTRACT

The Agile Capability Mashup Environment (ACME) methodology is an innovative tool developed to encourage team engagement and consensus building. ACME is based on design thinking and utilizes horizontal collaboration to create an environment where diverse stakeholders, many with deep technical expertise, can engage on a level playing field. ACME combines simple low cost tools (e.g., whiteboards, cut outs, toy figurines, webcams, etc.) that assist teams to develop and communicate their ideas in multi-dimensional ways. This creates a collaborative space where teams can freely explore and critique ideas, with the goal of turning individual knowledge into a useful project team outcome.

In the Agile development process, teams work to create software and products rapidly and efficiently across different domains. In order for Agile to be executed successfully, individuals and teams with various skills sets (e.g., project management, research, design, engineering, etc.) need to communicate ideas, plan schedules, and collaborate solutions to potential problems. The criticality of communication and coordination in the Agile process necessitates the need for a tool that can appropriately facilitate these activities. When the ACME methodology is applied to Agile development, it encourages and facilitates innovative thinking and collaboration in the early stages of the engineering process as well as throughout product development. This process allows Agile teams to efficiently collaborate within and across areas of expertise to develop innovative products that provide valuable solutions to customers and stakeholders.

WHAT IS ACME?

The Agile Capability Mashup Environment (ACME) methodology is an incubator that drives innovative thinking through team engagement and consensus building. The ACME framework (Figure 1) combines team challenges and expertise with ACME assets and facilitation to arrive at solutions. Challenges and problems that teams need to address can vary widely from brainstorming the future vision for a project to defining requirements for products. Teams that are tasked with addressing these challenges are typically made up of individuals with diverse backgrounds and varying technical expertise. To foster innovative thinking, ACME provides an environment where these diverse teams are encouraged to engage on a level playing field, taking advantage of the deep technical expertise and the diversity of thought in a democratic way. Leveraging the diverse skillsets of all team members will encourage different approaches to solving the problem, which ultimately leads to more innovative solutions.

Figure 1. ACME Framework.

ACME utilizes various assets and facilitation methods to encourage collaboration and problem solving within teams. These methods are non-linear, allowing trams to continually examine the problem and the given context in order to reach the best possible outcomes. One unique asset used for sharing ideas is the Collaborative Story Development Kit (CSDK). This kit helps team members communicate complex ideas via a webcam positioned over a whiteboard. Team members are encouraged to work around the whiteboard, expressing their ideas using markers, sticky notes, and physical objects (e.g., blocks, toy figurines, etc.). The activities occurring on the whiteboard can be projected in the room so all participants can see the process as it unfolds. The CSDK is an effective tool because it provides the ability to capture the whiteboard throughout the collaborative process. The iterative process that leads to the final product is often as valuable as the end result itself.

ACME IN AGILE

The Agile development process brings teams composed of individuals with various skills sets (e.g., project management, research, design, engineering, etc.) together to rapidly and efficiently create software and products. Collaboration has been identified as a key factor to success in the Agile development process (Fowler & Highsmith, 2001; Misra, Kumar, & Kumar, 2009). Research by Hoda, Noble, and Marshall (2011) found that inadequate collaboration in Agile teams can lead to severe consequences including unclear requirements, lack of feedback, and loss of productivity. Agile teams need to communicate and coordinate frequently to be successful, thus, creating the need for a tool that can appropriately facilitate these activities. The ACME framework can be leveraged both early and throughout the stages of the Agile model (Figure 2). While the ACME process can be applied at any point in the Agile lifecycle, it has been found to be most useful in the brainstorming and design phases. The activities in these phases include requirements shaping and prototyping, respectively. ACME can also be leveraged at any other stage in the process where team collaboration is necessary in order to arrive at the best possible solution.

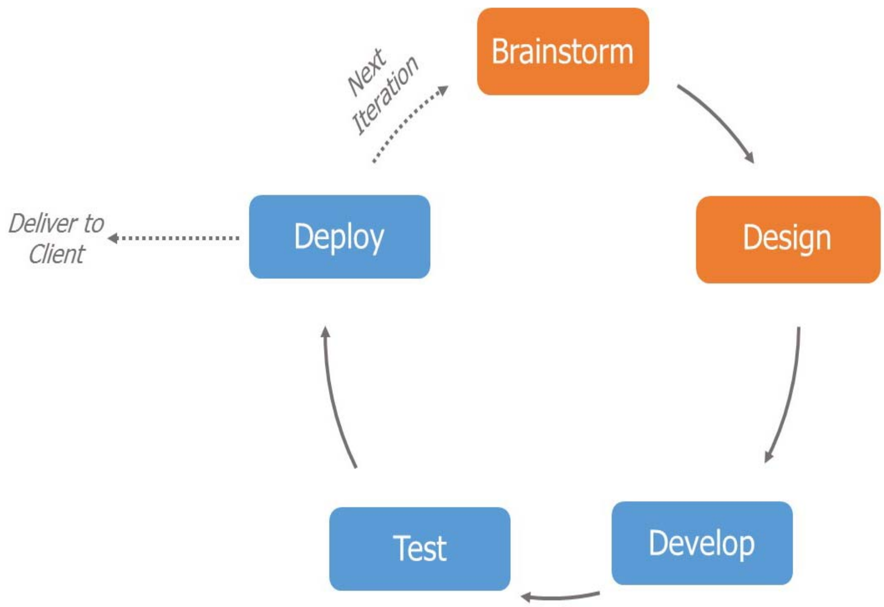

Figure 2. ACME in Agile.

The brainstorming phase is a critical stage where stakeholders need to come together to identify and agree on the requirements for the product. Stakeholders can come from many different technical backgrounds, which can all be leveraged to address requirements from multiple perspectives. The ACME methodology encourages all of the stakeholders to have a voice in the requirement generation process, by putting everyone on a level playing field and encouraging all team members to participate. This collaboration leads to better requirements because all viewpoints are considered, which results in a more robust end product.

During the design phase, the team will work with the stakeholders to define workflows, create initial designs, and test design concepts. ACME allows designers and stakeholders to work together to rapidly ideate designs on the whiteboards. Team members are encouraged to all work around the board, resulting in designs that meet stakeholder needs and work within technical constraints. With all team members involved in the process, everyone is empowered to make decisions. This allows teams to buy into the design concepts early so development can quickly move forward without the back and forth of a traditional process.

ACME is also useful for providing solutions to problems that occur throughout the Agile process. For example, sometimes blockers are identified during daily scrums that require collaboration with the stakeholders. With ACME, blockers can be resolved quickly through a brainstorming session using the ACME CSDK and facilitation methods, as needed. Overall, ACME can facilitate and enhance the Agile process by encouraging efficient collaboration across areas of expertise during all stages of Agile, but is especially useful in the early stages. See Figure 3 for examples of ACME in action in Agile projects.

Figure 3. Examples of ACME use in brainstorming, design, and problem solving with Agile teams.

WHY

IT WORKS

ACME is a very simple concept, but yet it is so effective for Agile teams. There are several factors that contribute to ACME's effectiveness including the breaking of norms, the horizontal nature of the collaborative space, and the ability to accommodate rapid decision making and consensus building.

Breaking Norms. In a typical meeting room, people encounter numerous distractions that can cause them to lose focus on their work. For example, during a team meeting people can often be checking email on their mobile device or putting the finishing touches on an important deliverable. Conducting ACME sessions requires team members to break these typical meeting norms, detach from their daily routine and take a deep dive into brainstorming and problem solving with a specific outcome in mind. Team members are encouraged to put away their technology during the discussion so they can give their full attention to the problem.

Horizontal Collaboration. ACME promotes collaboration by placing the whiteboard horizontally on a table and having team members gather around it to work. Traditionally, whiteboards are hung vertically on a wall, making it awkward for multiple people to work on the board. When a whiteboard is hung vertically it is typical for one person to take control of the marker and essentially control what is written on the board. When two team members take to the whiteboard it can quickly become a two-person conversation with the remainder of the team reduced to bystanders. Because other team members are not empowered to write on the board, their ideas may not be captured and considered. When the whiteboard is positioned on the table, it levels the playing field allowing everyone to participate on equal footing, resulting in everyone contributing their ideas during the discussion.

Rapid Decision Making and Consensus Building. The ACME assets support rapid decision making. A positive outcome of the democratic process created by horizontal collaboration is the ability to achieve shared understanding, agreement and consensus. Once a problem is identified, teams can quickly to work together to come to a shared understanding of the problem and work toward the best solution. The ability for teams to make decisions quickly and efficiently compliments the iterative nature of Agile.

These factors combine to create the ACME process which facilitates collaboration between team members. The result is team decisions that promote mutual understanding and solution buy in. ACME is a valuable tool in any setting requiring collaboration, including Agile.

OTHER APPLICATIONS

The ACME process is used at MITRE for agile projects but has also been valuable in other areas. ACME has been utilized for organizational change management framework development. During these sessions, project teams come together to create plans for their path forward. Another area where ACME has been used is in the facilitation of tabletop war gaming scenarios. During these sessions, teams work on the board to carry out war game plans and scenarios. When the exercise is complete, teams can review the documented pictures from the session to refine their approach.

CONCLUSIONS

The ACME methodology provides a valuable tool that Agile projects can leverage to promote collaboration in Agile teams. ACME combines team challenges, team member expertise, and ACME assets in order to deliver desired outcomes and solutions. ACME is especially valuable in the early brainstorming and design phases of the Agile process because it promotes collaboration and empowers team members with deep domain knowledge to share their ideas with the group. ACME can also be useful for problem solving throughout an Agile project. ACME works because it removes distractions, promotes horizontal collaboration, and it accommodates rapid decision making. Project managers need to promote a highlighly collaborative environment for success on any Agile project (Coram & Bohner, 2005). ACME has been a successful collaboration solution for MITRE project teams and their sponsors. This simple methodology can be leveraged by any project team, all that is needed is a whiteboard on a table and the desire to collaborate.

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Tangible Strategies for Aligning Your Processes with Agile

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ABSTRACT

This paper describes a victory: how a highly functioning project team adapted a traditional software development methodology while staying true to the Manifesto for Agile Software Development, converging the two to meet both process maturity requirements and the project's needs. The project has been an overwhelming success. The resulting software has aided customers in not only meeting but exceeding their mission goals, and the project team has remained cohesive, happy, and productive.

Introduction

In the software development world, “process” is a dirty word. Process implies stale unnecessary rigor that bogs down creativity and the swiftness with which products can be delivered, potentially impairing momentum. Mention process to a software development team and watch the resulting eye rolling. Using an Agile approach seems so much better – the antithesis of following a cumbersome process.

Here’s something you may already know. “The Agile Manifesto” includes 12 principles, one of which is *At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly* (Agile Alliance, 2001). The trick, in terms of processes, is determining how the secret synergy of processes can work best; how a project team can employ necessary rigor while letting team members stay in the flow.

G2

Victory over the process conundrum came by way of a project funded by the US Department of Energy’s (DOE) National Nuclear Security Administration (NNSA). Its name is a mouthful: the NNSA Program Management Information System Generation 2, called simply, “G2.”

In February 2007, G2 was the brain child of a meeting wherein the G2 system’s initial functions, design assumptions, budget, and schedule were agreed upon by a federal NNSA sponsor in Washington, DC, and an IT project manager based at Oak Ridge National Laboratory (ORNL) in Tennessee. The goal was to have a functioning G2 system by September 2007. At the time, G2 was a program information and performance management system that integrated DOE headquarters and national laboratory scope, schedule, and budget information at the project level, creating a single repository of data. It also integrated financial data for budgeting and cost reporting in addition to providing geographic information systems (GIS) visualization to monitor work progress worldwide. One of the fundamental requirements of the system was to provide DOE with a “common truth” for reporting at a time when the program office was experiencing budget increases at a 70–80% rate. The visibility and expectation of the program to achieve its mission, “to reduce and protect vulnerable nuclear and radiological materials located at civilian sites worldwide,” (National Nuclear Security Administration) was increasing, and the G2 system was integral to the process, both for planning and progress reporting. To have data integrity issues was unthinkable. To miss the September deadline was also unthinkable. Imagine the pressure.

The G2 project was then, and still is today, a project that moves at breakneck speed. Don’t be fooled though. G2 is also all about excellence. The expectation for every member of the project from the executive sponsor through the ranks of team leads and down through the entire project team can be put into one word: Excellence. A desire for excellence drives the team. Retaining that excellence and staying on deadline is tough.

Rooted in Agile

So G2, conceptualized and rooted in excellence, was kicked off using the Agile development methodology. A team of developers sunk everything they had into daily scrum meetings, working religiously with the customer to hone in on what was to become the G2 system. Many, many, many hours of concentrated effort later (including one particularly long and frenetic July 3^{rd} evening prior to a July 4^{th} deadline), G2 v1.0 was deployed. On time. And was excellent.

The executive sponsor was happy, which meant so was the project team. Because of the constant desire to do more and improve, the G2 project kept rolling, the focus now turning to how to enhance G2. Make it better. Improve upon its excellence.

Nurtured by Process

As time passed and the project team had a chance to try and catch its collective breath, little pockets of concern arose. How do you sustain momentum on a project with back-to-back intense sprints? How do you remember what you did or why? Someone suggests an improvement. Who? Why? When? Where is that information kept? Does the sponsor concur? What about all those findings from testing that might be really great enhancements? When and how would those be addressed? The G2 project team used effective but rudimentary tools for tracking: a spreadsheet for the backlog; a project portal for defect tracking and resolution; a development tool for decomposed requirements and sprint definition. And a lot of past history resided in people's heads.

Three years later, in 2010, the project team had grown, and G2's IT project manager decided to investigate incorporating some additional process rigor, with the caveat that anything considered for inclusion had to be meaningful and relevant. By virtue of being a government agency, DOE had a documented software development lifecycle guide (DOE G 200.1-1A) known as the *DOE Systems Engineering Methodology (SEM)*. Since G2 is DOE-sponsored, a choice was made to adhere to SEM and make it work. But, SEM has a reputation of being old and clumsy. It's built for waterfall development. Its level of rigor is high. A business analyst was brought onto the G2 project to determine a workable approach for incorporating SEM-based practices into the project's Agile-based processes, bearing in mind that G2 had a highly functioning project team. The "if it ain't broke, don't fix it" axiom applied. The pressure was on to see how a seemingly outdated methodology could be used to improve upon something working pretty well. But remember, one of Agile Manifesto's 12 principles is *At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly* (Agile Alliance, 2001). It was time. Let the challenge begin.

Instituting Change

There's a trick to determining how the synergy of processes can work best; how a project team can employ necessary rigor while letting team members stay in the flow and it comes in the form of a question. The most important question that can be asked when making decisions about a project's process is, "Does this make sense for us?"

SEM, like any methodology, is prescriptive and attempts to serve multiple masters. It requires 43 separate artifacts plus in-stage assessments and defined stage exits (or gates) to move on to the next phase of development. What was the goal? Exhaustive plans that cover everything from make/buy decisions to training? No. One overarching project plan that has staffing, budget, risks, technical approach, and contingency planning? Yes. Comprehensive detailed procedures? No. Key procedures for development and deployment? Yes. The easy way out would have been to create 43 artifacts and call it done; the proverbial boxes would have been checked. But, that wasn't the challenge. The challenge was to find that optimal juxtaposition between SEM and Agile.

Making It Worth It

To get the most value out of the effort, everyone had to know what was being done and have a chance to participate. The team learned that what was critical to successful change was ensuring team members' concerns were not only heard but considered. Over the course of about a year, a series of meetings were held so that the way the project already worked could be understood and documented. What followed was a natural upshot of each of those discussions, the keen awareness that there was room for improvement. As the team became more self-aware that improvements were coming from within and weren't for the sake of "instituting a process," so came the affinity and solidarity for invoking change.

Defining a Process

Ironically, defining the team's process became a process. By implementing the six steps shown in in Figure 1, the team instituted necessary change.

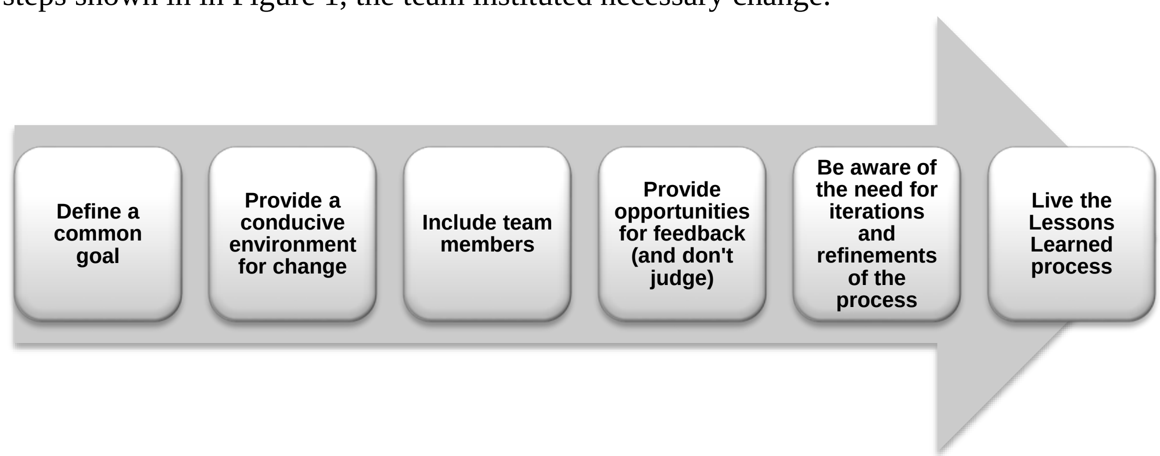

Figure 1 – Defining a Change Process

Table 1 lists, in practical terms, how each step was implemented on the G2 project.

Table 1 – The Cultural Change Process for G2

Step	As put into practice on G2
Define a common goal	Sensible adherence to SEM while maintaining Agile roots
Provide a conducive environment for change	Ensure the leadership team is not only onboard but advocating change
Include team members	Engage the full team
Provide opportunities for feedback	Provide every opportunity for feedback
Be aware of the need for iterations and refinements of the process	Refine the process as needed
Live the lessons learned process	Hold retrospectives while still listening at all times

So what ultimately happened? You can safely assume the requisite SEM artifacts were not created. Instead, a significant amount of time was spent understanding the intent of all those documents and working to create a set of artifacts that would ring true to the G2 team as well as live up to "the spirit of the law." Seven documents were authored that undergo an annual review, and nine others were instituted that are maintained on an ongoing basis (see Figure 2).

Annual Review
1. Project Plan
2. System Requirements Specification
3. Configuration Management and Software Change Control Plan
4. Software Quality Assurance Plan
5. Cyber Security Plan
6. Deployment Guide
7. Nondisclosure Agreement

Ongoing
1. Backlog
2. Coding Standards
3. Functional System Design Documents
4. As-developed Architecture
5. Organization Chart
6. Setup and Configuration Processes
7. Release-based Test Plans
8. Online Help/User's Guide
9. Release Notes

Figure 2 – G2 Artifacts

Progressing through Time

The following year, in 2010, the team embarked on what it thought was the final step of the initial process journey, this time focusing on project management, attempting to understand the connection between the PMBOK® and SEM's lifecycle stage requirements as well as Agile practices. Process mappings were created to understand compliance and address gaps. It was imperative to find a straightforward way to document what was done and why. On G2, it is called the Process Mapping Table (shown in Figure 3).

PMI Knowledge Areas	PMI Project Management Process Groups				
	Initiating	Planning	Executing	Monitoring and Controlling	Closing
Project Integration Management	• *G2 Project Charter*	• *G2 Project Plan* • Product Roadmap	• Daily Scrum • Weekly Team Meetings • G2 Project's SharePoint Site • User Training Materials • *G2 User Guide* and Online Help	• Daily Scrum • Weekly Team Meetings • Retrospectives	• Release Notes • User Acceptance Verification • User Training
Project Scope Management		• *G2 SRS* • *G2 CM and Software Change Control Plan* • Backlog (and Backlog grooming) • Release Planning Meetings	• Design Documents • RTM • Source Code and Deployed Code • Customer Demos • Deployment Guide	• Meetings with Executive Sponsor • QA Testing • UAT	
Project Time Management		• Backlog (and Backlog grooming) • Release Planning Meetings		• Backlog (and Backlog grooming)	
Project Cost Management		• EAC		• EAC Reviews • Monthly Cost Reporting	
Project Quality Management		• *G2 SQA Plan*	• Application Test Plans and Reports • QA Testing • Code Reviews • Peer Review	• Defect Reporting • Process Audits	
Project Human Resource Management		• *G2 Project Plan* • G2 Organization Chart • G2 Project, Nondisclosure Agreement	• *G2 Project Plan* • Daily Scrum • Backlog (and Backlog grooming)		
Project Communications Management		• *G2 Project Plan* • *G2 SRS*	• Daily Scrum • Weekly Team Meetings • G2 Project's SharePoint Site	• Daily Scrum • Weekly Team Meetings • G2 Project's SharePoint Site	
Project Risk Management		• *G2 Project Plan* • *G2 Failover Plan* • *ORNL Cyber Security Program Plan Supplement: Nonproliferation Systems Hosted Applications* • Product Roadmap • Backlog (and Backlog grooming) • Release Planning • Daily Scrum • Weekly Team Meetings • Retrospectives • Task Board • Interconnection Security Agreement between G2 and the National Security Alarm Training (NSAT) system		• Daily Scrum • Weekly Team Meetings	
Project Procurement Management		• *G2 Project Plan* • SOWs • Source Selection Criteria	• Subcontracting Agreements • Internal agreements with ORNL IT Services Division	• Contract Compliance • Receipt of Deliverables	• Contract Termination • De-obligation of Funds
Project Stakeholder Management	• *G2 Project Charter*	The Agile development method (used on this project) is based on routine and continuous stakeholder engagement spanning the Planning, Executing, and Monitoring and Controlling Project Management Process Groups			

Figure 3 – G2 Process Mapping Table

The G2 Process Mapping Table correlates recommended activities in the PMBOK with G2's verifiable objective evidence of compliance with them. In the black column are the PMI Knowledge Areas, and in the red header are the PMI process groups. When a cell is shaded gray, it indicates that the PMBOK contains recommended activities for the process group/knowledge area combination. The Process Mapping Table lists not only plans but Agile activities, as these interactions are as much a part of the team's overall integrated project process as the documented plans.

Good News Bad News

In early 2011, the G2 team was flying high. NNSA received notification that the G2 team won the 2010 PMI Distinguished Project Award. The entire project team flew to Washington, DC, and joyfully partook in the recognition ceremony and life was great, until a monkey wrench appeared. In 2013, two things happened that would have a significant impact on G2: (1) the G2 sponsor, the one who'd envisioned it all in 2007, got a promotion, and (2) DOE retired SEM. The team was in shock on both counts.

First, the promotion – The G2 sponsor would be leaving his post and heading to the NNSA executive offices…and taking the G2 project with him, meaning lots of new project scope. Good thing the team had documented its process as there was a lot of knowledge to impart on the newbies.

Second, SEM – DOE decided to replace SEM with DOE Order 415.1, which, as it turned out, had as part of its guidance the option to follow practices in, of all things, the PMBOK! Remember the Process Mapping Table? Thankfully the decision to understand the connection between the PMBOK® and the project's practices was a good one.

Success – By Accident or Design

Today (March 2016), the G2 team stands at roughly 50 people (including both the development team and product owners) and has had some growing pains. Staffing up has been a challenge, one that the team still struggles with in areas such as onboarding, knowledge transfer, and reinforcement of the axiom that simply adding staff does not mean more functionality will be delivered faster (aka nine women can't make a baby in a month).

It took about a year to cycle through the team's artifacts and not only remove the references to SEM but ensure, in conjunction with that effort, that the team documented and implemented current guidance in a meaningful way, still asking (and answering), "does this make sense for us?"

Finally, the one constant that the team has had through the years is great people. When working to invoke cultural change, to improve a highly functioning Agile team: Listen, gather necessary data, and proceed with intention. Typically, highly functioning Agile teams include subject matter experts who have unified to meet a common goal. And they are in a battle with time. Given that, to invoke change, listen to what the team is saying. Does it sound like "same song, different day?" How many days have you heard the song? Is it just a person or two who's voicing a concern or is there a theme? Are people going outside the process? And if so, why? Highly functioning Agile teams thrive on communication and trust. Listening, gathering data, and proceeding with intention takes out that unspoken element of mistrust. For a highly functioning Agile team to change, they have to see and accept the benefit of the change and have a level of trust in it.

The original G2 sponsor had a saying about hard work versus luck – you need a bit of both. By all accounts, the G2 project has been a success. The team's hard work (and luck) has paid off in terms of deploying and maintaining a wildly successful system and receiving not only the PMI award but other internal and industry awards as well.

Seven years after our process journey began, we claim momentary victory. Momentary because just as systems continue to improve, so do processes. Victory because our *esprit de corps* and our commitment to Agile (and each other) are as strong as ever.

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Evaluating and Building Portfolio Management Maturity

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Executive Summary

This paper focuses on implementation of portfolio management process in a Federal program. It introduces a maturity model designed to evaluate and track portfolio management capability at the U.S. Census Bureau. The authors used their collective experience implementing portfolio management in Federal Programs to inform the paper and create the model.

The model evaluates and tracks the following program maturity characteristics:

- The portfolio management process maturity levels;
- The levels of strategic planning practiced;
- The level of organizational acceptance for the portfolio management processes.

Important topics that emerged from the development of this maturity model were the definition of portfolio management characteristics, the value of strategic planning to the portfolio management process, and the importance of organizational acceptance in the success of implementing a new process.

Portfolio Management in a Federal Agency

Portfolio management is an important tool to support the fiscal accountability and transparency of government programs. The portfolio management process allows programs to select and prioritize projects that are essential to supporting important government programs. These programs and agencies work within defined budgets, with the focus being on achieving program objectives, followed by adhering to rigid standards and established protocols. Typically, agency budget authority lies with Congress and not within the organization (agency divisions and directorates). This uncertain budget environment increases the need for portfolio management. Portfolio management aids governments programs by managing limited funds and ensuring that mission critical processes remain effective and up-to-date. It also helps government programs identify projects they should cancel or re-prioritize. Portfolio management also increases stakeholder engagement, aids in decision-making and tracks project investments throughout their lifecycle. Portfolio management is essential to completing important government work.

Background

According to MITRE Corporation, a recognized expert in Portfolio Management, "Portfolio Management is a continuous and persistent process that enables decision makers to strategically and operationally manage resources to maximize accomplishment of desired outcomes (e.g. mission results, organizational improvements, enhancement of operational capabilities) within given constraints and constructs such as regulation, interdependent architectures, budgets, concept of operations, technology, and mission threads." More simply put, portfolio management is "doing the right things" to achieve organizational strategic goals. A portfolio is the complete inventory of investments required to achieve strategic priorities.

At the U.S. Census Bureau, the agency implemented portfolio management at either the directorate or the division level. Characteristic of a large government agency, there was variation in implementation of portfolio management among the different work groups and subsequently, portfolio management in some areas is more mature than in others. Previous presentations by Hostetter et al focused on only one program, the American Community Survey, which was an early adopter of portfolio management within the agency. Now we are interested in taking a broader look at the portfolio management throughout the agency and evaluating the maturity of those processes. Through our experience with the American Community Survey and other programs, we now have better idea of what would be key indicators of portfolio management maturity at the agency. As a natural step, we would like to apply that knowledge to evaluate the portfolio management capability across the different work groups at the agency, assess their maturity and classify the programs into workable levels.

Portfolio Management Maturity Model

We developed the Portfolio Management Maturity Model as a tool to evaluate the current portfolio management processes across the agency. The model assesses organizational performance in a structured repeatable format and produces an "apples to apples" evaluation of the different areas. Our intent is for the model to provide the agency the ability to evaluate the strengths and weaknesses in each portfolio management area and produce specific goals to bring each area to an optimized level of performance.

We developed the model by identifying the characteristics of a successful portfolio management process, defining the characteristics at each maturity level, and identifying relevant success criteria and questions for each characteristic and maturity level. For the levels, we used the five-step SEI Capability Maturity Model (CMM) (Stand-up, Informal, Developing, Managed, Optimized) to conform to established maturity levels. For the model, we developed maturity criteria in three main areas: Process, Strategic Planning and Tracking, and Organizational Acceptance. We based our criteria on the concept that portfolio management is one part of a successful strategic management process and that all the pieces interact and contribute to inform each individual process. Figure 1 shows how portfolio management interacts with the other strategic management processes. We provide details on the five levels of maturity and their criteria on the following pages.

Figure 1. Strategic Management Cycle

Maturity Level 1 – Stand-Up

We use the stand-up level to determine if the program area has started implementation of the characteristic criterion we are evaluating. Figure 2 to the right lists the indicators we have specified for each of the three criteria areas. Below, we list the questions we developed to assess the indicators. We designed the questions specifically to find the presence of key process, strategic planning and tracking and acceptance indicators. In this level, we focus on discovering if the program area has begun implementation of the indicators that support a successful portfolio management process and fully expect to find that some programs may have great progress in one indicator area and very little in another.

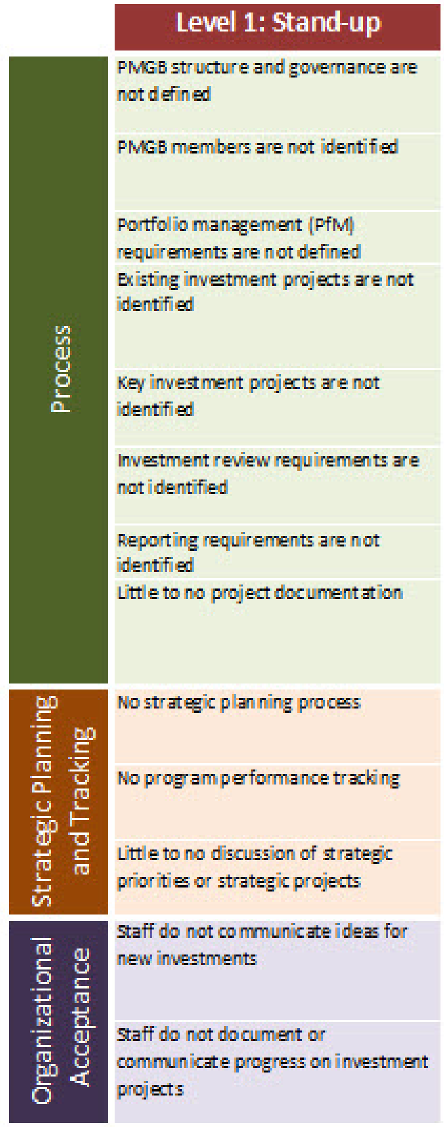

Figure 2. Maturity Level 1

Level 1 Process Questions

Has the program defined the role of the PMGB?
Has the program identified the members of its PMGB?
Has the program defined its portfolio management process?
Has the program identified all ongoing investment projects?
Has the program identified its key investment projects?
Has the program specified requirements for its investment reviews?
Has the program identified reporting requirements?
Has the program specified project documentation standards?
Does the program have templates for project documentation?

Level 1 Strategic Planning and Tracking Questions

Does the program have a Strategic Planning and Tracking process?
Does the program have measures in place to track key program performance indicators?
Does the program discuss strategic priorities?
Has the program identified its strategic priorities?

Level 1 Organizational Acceptance Questions

Does staff communicate ideas for new projects to leadership?
Does staff complete documentation for investment projects?
Does staff report progress on investment projects?

Maturity Level 2 – Informal

At the Informal level, we start assessing how mature the program is on our Portfolio Management indicators. We expect to see some activity on the major indicators but do not expect any maturity or regularity of effort. Figure 3 to the right lists the indicators we have specified for each of the three criteria areas. Below, we list the questions we developed to assess the indicators.

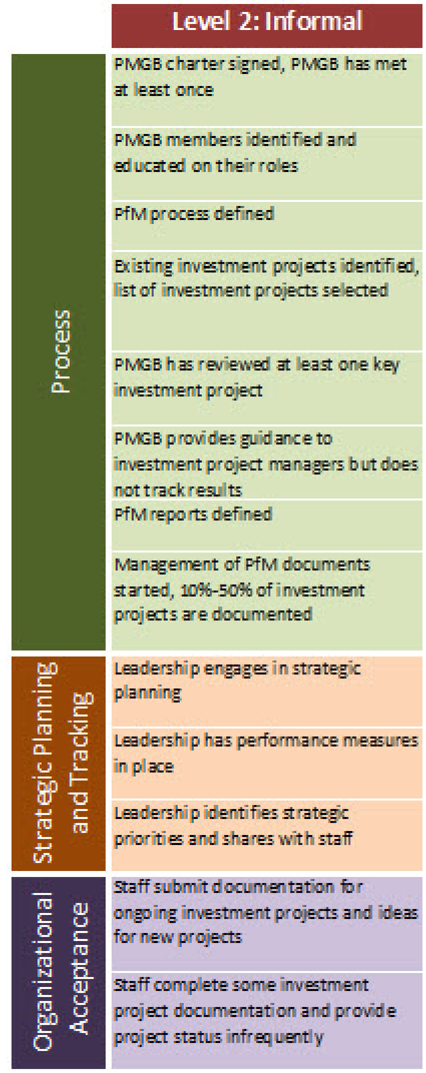

Figure 3. Maturity Level 2

Level 2 Process Questions

Has the PMGB begun to hold meetings?
Has the program educated the PMGB members on their role and the purpose of portfolio management?
Do the PMGB members get distracted with the technical/operational details of investment projects?
Has the program documented its portfolio management process?
Does the program have a formal inventory of its current investment projects?
Does the program have a list of new investment?
Does the program conduct formal reviews of key investment projects?
Do the key investment projects maintain a risk register?
Does the PMGB provide guidance to its investment project managers?
Has the program specified investment reports?
Does the program centrally manage and store project documentation?

Level 2 Strategic Planning and Tracking Questions

Has the program completed strategic planning exercises?
How long have the performance measures been in place?
Do the performance measures align to the strategic priorities? Has the program communicated its strategic priorities to staff? Has the program communicated its strategic priorities to its stakeholders?

Level 2 Organizational Acceptance Questions

Has the program educated staff on how to submit proposals for new investment projects?
Has the program provided staff templates to use for proposal submission?
Has the program provided document templates and communicated documentation expectations to staff?
Has the program educated staff on how to complete investment project documentation?

Maturity Level 3 – Developing

At the Developing level, we begin to look for formal processes, finished artifacts and cultural acceptance. We expect to see the establishment of processes and activity occurring on a more regular basis. Figure 4 to the right lists the indicators we have specified for each of the three criteria areas. Below, we list the questions we developed to assess the indicators.

Figure 4. Maturity Level 3

Level 3 Process Questions

What is the frequency of the PMGB meetings?
Do the PMGB members attend the meetings?
Do the PMGB members prepare for the meetings?
Do PMGB members participate in the meetings?
How often does the program review and update its portfolio management process?
Has the program evaluated the strategic alignment of its current projects?
How often does the program review its key investment projects?
Do the key investment projects track budget expenditures?
Does the PMGB assign and track action items to its investment project managers?
Has the program developed investment reports?
Does the program have a platform for storing investment project documentation?

Level 3 Strategic Planning and Tracking Questions

Does the program have an up-to-date strategic plan?
Has the program shared the strategic plan with stakeholders?
Has the program shared its strategic plan with stakeholders?
Does leadership have a good understanding of the data going into the performance measures?
Are the measures updated appropriately (monthly, quarterly, annually)?
Has the program aligned it investment projects to its strategic priorities?

Level 3 Organizational Acceptance Questions

Does staff submit new investment project proposals to the PMGB before work on a project begins?
Has the program educated the staff on how to report progress on investment projects?
What percent of the investment projects have completed documentation (appropriate to level of progress)?
What percent of the program's investment projects have current status reported?

Maturity Level 4 – Managed

At the Managed level, we look for formal processes, finished artifacts and cultural acceptance. At this level, we begin to look for engagement and innovation of the processes. Figure 5 to the right lists the indicators we have specified for each of the three criteria areas. Below, we list the questions we developed to assess the indicators.

Figure 5. Maturity Level 4

Level 4 Process Questions

Does the PMGB meet frequently enough to keep up with workload?
Do the PMGB members ask probing questions about the strategic value of investment projects?
Do PMGB members focus on investment project's scope/budget and schedule?
Is the program's portfolio management documentation up-to-date?
How often does the program review strategic alignment of its investment projects?
Does the program have slide templates for investment project managers to complete for the reviews?
Does the PMGB follow up on action items with its investment project managers?
Does the program update the investment reports on a regular basis?
What percent of investment projects meet project documentation standards?

Level 4 Strategic Planning and Tracking Questions

Does the program actively use the strategic plan in its planning activities?
Does the program use measures to baseline performance and track strategic investment efforts?
Does the program rank its investment proposals against its strategic priorities?

Level 4 Organizational Acceptance Questions

Do staff submit proposals for projects to begin the current year?
Do staff submit proposals for projects to begin the next year?
How frequently are the project status updated?

Maturity Level 5 – Optimized

Finally, at the Optimized level we define what we think would be a highly performing portfolio management process. We expect formal processes, finished artifacts and cultural acceptance in addition to continuous improvement of the processes and full engagement of leadership, the PMGB members and program staff. Figure 6 to the right lists the indicators we have specified for each of the three criteria areas. Below, we list the questions we developed to assess the indicators.

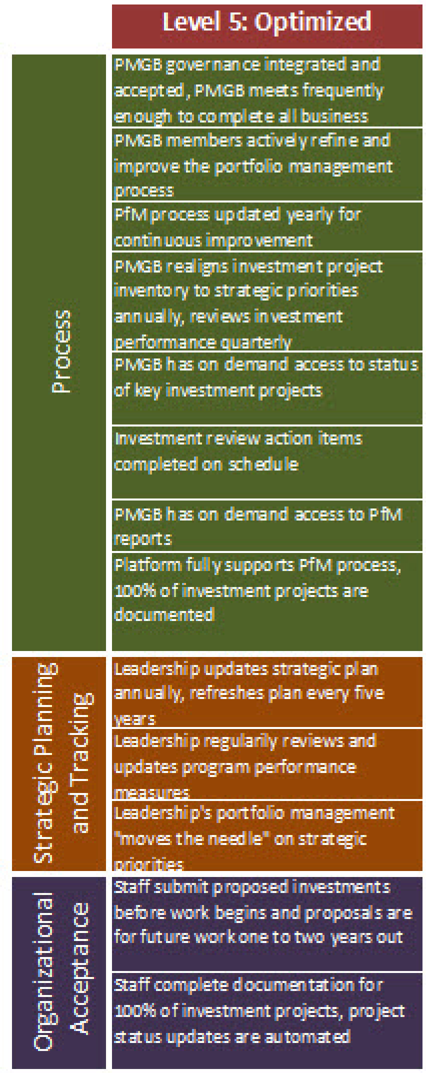

Figure 6. Maturity Model Level 5

Level 5 Process Questions

Does the PMGB review proposals and status reports in a timely manner?
Do the PMGB members evaluate and refine the portfolio management process?
Does the program continuously improve its portfolio management process?
How often does the program review the strategic performance of its investments?
Is key investment project information easily available to PMGB members?
Are the investment review actions items completed?
Are the investment reports automated?
Is project documentation easily available to the PMGB members?

Level 5 Strategic Planning and Tracking Questions

Does the program regularly refresh its strategic plan?
Does the program refresh its performance measures to support new strategic initiatives and program direction?
Have the program's efforts realized movement on its strategic priorities?
Does the program have measures to track and measure progress on strategic priorities?

Level 5 Organizational Acceptance Questions

Do staff submit proposals for projects that are to begin two years out?
Are the project status updates automated?

Next Steps

We are at the beginning of our assessment of portfolio management and will continue our work with the model, explore additional criteria for the model, and refine the questions. Our next steps will include:

1. Analyze current practices of selected programs using current model. Understanding that each directorate and division may have different needs and organizational cultures, we would analyze the current portfolio management practices of the selected program using the portfolio maturity model.
2. Develop an Implementation Scorecard. We will use the scorecard to document portfolio management maturity scores for programs. Results from the scorecards will help the programs improve their performance and identify areas needing improvement or reassessment.
3. Grade selected agency programs. We will approach programs throughout the agency to request completion of the Implementation Scorecard.
4. Interpret model results. We will conduct an evaluation of the models results after the Implementation Scorecards and grade them to assess how well the identified criteria accurately assess the programs.
5. Revise the model. After we evaluate current criteria, we will revise the model based on analysis results. The current model is a good starting point but as we better understand how the agency programs conduct portfolio management, our vision is to refine the model by adding additional criteria. Areas to consider for the future criteria include:
    - Project schedules
    - Project Server—(A recently implemented enterprise portfolio management tool to track project resources and costs).
    - Risk assessment
    - Schedule management
6. Continue to seek out portfolio management training opportunities and share them at the enterprise level with appropriate staff.
7. Continue to monitor portfolio management corporate culture at the agency. Portfolio management requires commitment by senior leadership. Senior management shared 10 Guiding Change Principles for success in achieving the goals in the agency Strategic Plan which included a statement that work will be managed through the portfolio management governance process.
8. Review the portfolio management roles of the program management offices developed recently under reorganization to understand how they are they supporting portfolio management at the agency.
9. Continue discussions of strategic management, including portfolio management with the appropriate agency stakeholders.
10. Support the principles of continuous process improvement and identification of best practices to mature and refine agency portfolio management practices.

Appendix: Project Portfolio Management Maturity Model

	Level 1: Stand-up	Level 2: Informal	Level 3: Developing	Level 4: Managed	Level 5: Optimized
Process maturity	PMGB structure and governance are not defined	PMGB charter signed, PMGB has met at least once	PMGB meets infrequently, PMGB governance established	PMGB governance integrated, PMGB meets on a regular basis	PMGB governance integrated and accepted, PMGB meets frequently enough to complete all business
	PMGB members are not identified	PMGB members identified and educated on their roles	PMGB members are actively practicing their role	PMGB members take the lead on portfolio management	PMGB members actively refine and improve the portfolio management process
	Portfolio management (PfM) requirements are not defined	PfM process defined	PfM process developed and documented	PfM process functioning and documentation is up to date	PfM process updated yearly for continuous improvement
	Existing investment projects are not identified	Existing investment projects identified, list of investment projects selected	PMGB conducts review of investment project inventory	PMGB realigns investment project inventory to strategic priorities once a year	PMGB realigns investment project inventory to strategic priorities annually, reviews investment performance quarterly
	Key investment projects are not identified	PMGB has reviewed at least one key investment project	PMGB reviews every key investment project at least once per year	PMGB reviews key investment projects (as needed)	PMGB has on demand access to status of key investment projects
	Investment review requirements are not identified	PMGB provides guidance to investment project managers but does not track results	PMGB assigns action items to investment project managers during investment review	PMGB tracks progress on action items from investment reviews	Investment review action items completed on schedule
	Reporting requirements are not identified	PfM reports defined	PfM reports developed	PfM reports updated on regular basis	PMGB has on demand access to PfM reports
	Little to no project documentation	Management of PfM documents started, 10%-50% of investment projects are documented	Platform for PfM process developed, 50%-90% of investment projects are documented	Functional platform for PfM process, 90%-100% of investment projects are documented	Platform fully supports PfM process, 100% of investment projects are documented
Strategic Planning and Tracking	No strategic planning process	Leadership engages in strategic planning	Leadership completes strategic plan and shares with staff and stakeholders	Leadership uses strategic plan for program planning	Leadership updates strategic plan annually, refreshes plan every five years
	No program performance tracking	Leadership has performance measures in place	Leadership tracks and understands program baseline performance	Leadership uses performance measures to understand affect of strategic investments	Leadership regularly reviews and updates program performance measures
	Little to no discussion of strategic priorities or strategic projects	Leadership identifies strategic priorities and shares with staff	Leadership aligns investment selection process with strategic priorities	Leadership uses strategic prioirites to guide investment project selection	Leadership's portfolio management "moves the needle" on strategic priorities
Organizational Acceptance	Staff do not communicate ideas for new investments	Staff submit documentation for ongoing investment projects and ideas for new projects	Staff submit investment proposals as they begin project, begin to submit investment proposals before work begins	Staff submit investment proposals before work begins, staff begin to submit proposals for future work	Staff submit proposed investments before work begins and proposals are for future work one to two years out
	Staff do not document or communicate progress on investment projects	Staff complete some investment project documentation and provide project status infrequently	Staff complete documentation for 50-90% of investment projects, project status is updated more frequently	Staff complete documentation for 90-100% of investment projects, project status is updated frequently	Staff complete documentation for 100% of investment projects, project status updates are automated

Transitioning Software Development and Operations Laboratory to Agile

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ABSTRACT

Over the last five years, the CATT Lab at the University of Maryland expanded its cutting-edge software development operation from five full-time developers and 10 students to nearly 30 full-time staff and 90 students. With this growth came many organizational and software development process challenges. In response to these challenges, the CATT Lab implemented staffing and work-flow solutions, as well as a tailored agile development process loosely based on Scrum. As a result of implementation of this process, the CATT Lab is able to handle rapidly changing priorities, maintain positive work environment, and deliver high quality software. The key to success are ability to adopt and tailor processes, empowering individuals, establishing clear hierarchy, measuring performance and setting targets, and introspection and continuous self-improvement.

BACKGROUND

The CATT Lab. The Center for Advanced Transportation Technology Laboratory (CATT Lab) is an applied research and development lab within the Civil and Environmental Engineering Department at the University of Maryland, College Park. The CATT Lab's mission is to develop cutting-edge software products that aid first responders, state and local Departments of Transportation, and researchers in managing and analyzing both real-time and archived data.

The CATT Lab has expanded significantly within the past five years from fewer than five full-time software developers and 10 undergraduate students to nearly 30 full-time staff and over 90 part-time students. As the Lab grew, most of the full time developers were sourced from the large pool of graduating student employees who were performing at a higher level than their peers.

Today, the CATT Lab supports a large number of software development and basic research contracts with state, local, and federal agencies across the entire country. This rapid growth exposed many deficiencies in organization, work-flow, and project management that threatened the long-term viability of the CATT Lab. The remainder of this paper discusses these growth challenges, the significant changes that were implemented, and lessons learned.

CATT LAB STRUCTURE AND PROCESS CHALLENGES

Early days of the CATT Lab. The first products to emerge from the CATT Lab consisted of web-based tools to aid Maryland transportation operations staff in visualizing, exploring, and computing basic stats on their own data—which consisted of crash data, speed and volume sensor measurements, and other related data. As these products gained interest with additional state and local agencies, the CATT Lab was commissioned to build significantly larger software products including the Regional Integrated Transportation Information System (RITIS) – a data fusion system allowing many transportation agencies and first-responders to collaborate in real time during regional incidents. With this system, the CATT Lab went beyond the development of prototype applications to the development and support of 24/7 operational systems with thousands of users in multiple time zones. Additional large work contracts were initiated at the same time – further adding complexity, staffing needs, and expectations to the CATT Lab developers and management.

Functional development challenge. As the CATT Lab staff expanded to meet the demands of new contracts, developers organized themselves in a functional manner – creating a number of development teams focused on individual technologies and products. ***Table 1*** shows the team structure and responsibilities for each of the teams.

Table 1 - CATT Lab Development Team Structure and Responsibilities

Team	Responsibility
DBA Team	Design, implementation, and maintenance of numerous relational databases.
Java Team	Extract, transform, load (ETL) tasks required to integrate new data sources into various CATT Lab databases.
Web Team	Development of front-end components showing real-time transportation data.
Analytics Team	Development of visual analytics using archived data sets using the Flex application framework.
IT Team	Hardware infrastructure to support development and operations.
GIS Team	Geographic Information Systems (GIS) related support services.

All teams were required to work closely together to achieve the common goal of delivering software products. However, in practice this proved to be difficult for the following reasons:

- **Diversity of process.** Development processes grew organically within each team with little coordination between other teams.
- **Ad-hoc leadership.** The CATT Lab organizational structure was relatively flat without a clear chain of command. The teams were either led by the strongest developer, the strongest personality, or in some instances had no leadership at all.
- **Work-flow management.** To complete a deliverable, all teams were simultaneously required develop their individual components, perform their own

testing, and finally produce a deliverable for system testing. However, if two teams were working on one project, while a third team was working on a different project based on some other external or internal priority, the individual team components would be available at different times, which introduced delays. When the components would finally be completed, there was no clear understanding of who owned the integration process and testing, nor who was responsible for fixing issues discovered during integration. This resulted in further delays and less than desirable quality.

- **Staffing distribution.** Depending on focus of the management or incoming contracts, certain teams could grow to have seven or eight full time developers plus student developers, while other teams might shrink to only one or two developers. This created issues related to teams' ability to deliver their pieces of work in a timely manner. For example, the team with eight developers would complete their piece of the project and move on to another project, while the team with only one member would struggle to keep up.
- **Management focus-shift.** Managing a functional organization where each team behaves as an independent development group proved to be extremely challenging. The Lab Management frequently targeted individual teams to perform critical or time-sensitive work based on those teams' capabilities. When a new priority arose, these teams would be redirected, which inadvertently impacted other teams waiting on them for a deliverable.
- **Unified direction.** Frequently, project managers did not share information effectively with each other, which resulted in inconsistent directions to individual teams. As an outcome, teams were frequently attempting to satisfy different, and sometimes incompatible expectations.

As developers and management grew frustrated by the above issues, morale began to decline. The dynamics within each team and even across teams also shifted and sometimes became toxic. Despite these challenges, the Lab continued to be successful and deliver high quality software. However, the stress that accompanied forced the CATT Lab to evaluate alternative organization and management.

STAFFING SOLUTIONS

To remain effective, allow for growth, and to protect its employees from burn-out and frustration, the CATT Lab needed to reorganize and become more efficient. A small group of leaders and key developers in the CATT Lab were assembled to evaluate and recommend solutions. The first set of recommendations included the following:

Introduction of hierarchy and structure. In order to combat inefficiencies created by the existing flat functional CATT Lab organizational structure the Management Team introduced a new hierarchy as shown in ***Figure 1***. The purpose of the hierarchy was to establish a clear chain of command for decision making. This new org chart decreased the number of communication channels by funneling priorities and expectations as well as development progress through designated team leads and program managers.

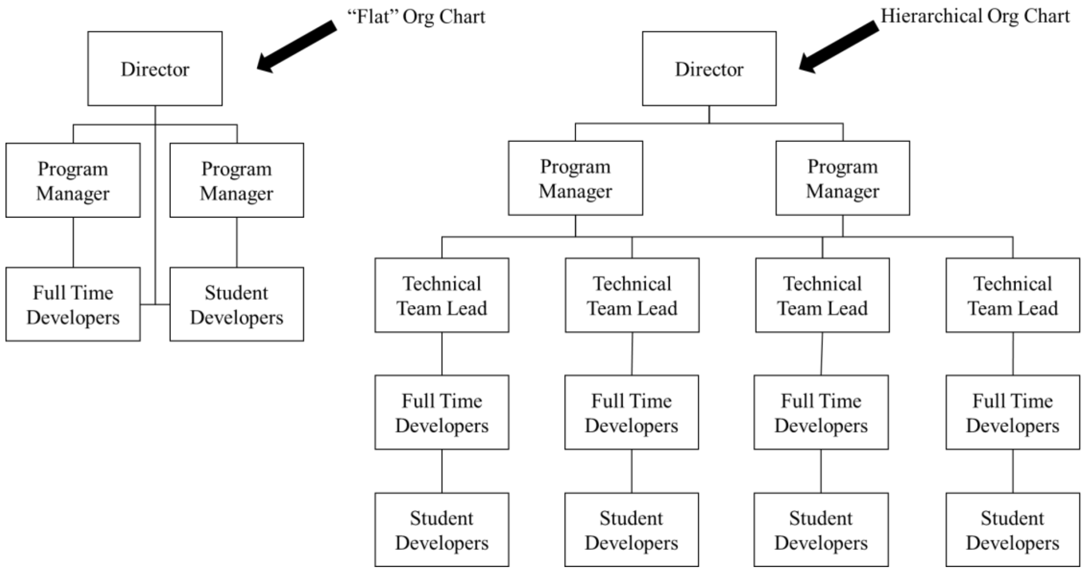

Figure 1 - CATT Lab "Flat" and Hierarchical Organizational Charts

Initially, some developers were uncomfortable with their perception of communication restrictiveness within this model. However, as they developed a habit of utilizing technical team leads, the communication became more efficient and enabled developers to focus on tasks at hand and avoid excessive meetings. The Management Team also encouraged transparency on all levels along with "skip-level" management – where each employee is free to talk and collaborate with any other employee, including the management. Ultimately, staff came to love the new organizational structure as it reduced confusion related to expectations, roles, and communication workload.

Staff diversity. As the Lab structure changed, the hiring focus shifted from hiring internal graduating student candidates, to a broader search aimed at bringing outside talent. This hiring strategy led to a more diverse staff in terms of age, gender, technical expertise, problem solving capabilities, domain knowledge, and maturity. These new, externally sourced employees were able to recognize the Lab's strengths – serving as a reality check to young employees who believed the grass was always greener on the outside. At the same time, these new employees were able to identify the Lab's weaknesses from a more critical perspective – using their own industry experience to offer suggestions for improvement.

Staff empowerment. While the new structure was introduced in a top-down manner, staff were encouraged to provide suggestions for improvement of the structure and hiring process. As active contributors, the employees became more invested and more critical of the process, which ultimately helped to incrementally improve morale and provide employees with a sense of ownership unlike what they might have had before.

WORK-FLOW SOLUTIONS

While the above changes helped resolve a good number of organizational issues with the staff, there still existed unaddressed challenges that affected the Lab's ability to meet deadlines, allocate resources efficiently, and remain flexible as an organization. These additional pain points remained:

- Constant shifts in priority that impacted schedules
- Difficulty of coordination across functional teams and leveraging resources
- Unbalanced teams
- Lack of understanding of overall CATT Lab product goals, deliverables, and schedules

Because of the newfound open communication lines, employees approached management to suggest considering adoption of the Agile software development process as a means to resolve these lingering pain points. After extensive research by management and developers, the CATT Lab formed an Agile Implementation Task Force whose focus was to provide guidance on how best to implement an Agile process that would meet the CATT Lab needs and minimize disruptions caused by the new process implementation.

One of the outcomes of this research was the realization that while the Agile process is a well-documented theoretical concept, the individual implementations of the Agile process vary wildly across industries and organization. With this understanding, the CATT Lab set out to establish a tailored version of the Agile process that would implement the relevant Agile concepts that addressed the remaining CATT Lab work-flow pain points.

CATT LAB TAILORED AGILE PROCESS IMPLEMENTATION

The Agile Process Task Force generated a proposal that addressed all major pain points and was implementable in a short period of time. The proposal was loosely based on Scrum and consisted of the following changes:

- *Cross-functional teams* – create three equally distributed cross-functional teams and three supporting teams
- *Two week sprints* – structure development in staggered two week long sprints
- *Sprint planning* – schedule work for sprints weekly and require management to be present to provide guidance and priorities
- *Physical team co-location*
- *Retrospective* – run retrospective meeting at the end of each team's sprint

Cross-functional teams. Each cross-functional team consists of subject matter experts including DBAs, back end and ETL developers, front end developers with web and analytics expertise, and quality control. The goal is to ensure that each team is capable of taking on any piece of work independently of the work being done in other teams and sprints. At the same time, exposure to multiple projects allows developers to learn other technologies and products, and to become more versatile.

Supporting teams include Information Technology (IT), User Experience (UX), and Customer Service. These teams were intended to operate outside of sprint schedule, but to be involved in sprint planning process to ensure that their priorities match the needs of development teams.

Two week sprints. All work is performed in two week chunks, called sprints, starting on Monday and ending on Friday of the following week. The goal is to ensure that work is broken down and scheduled in a manner that allows developers to remain focused and on schedule. As shown in ***Figure 2*** the start date of each sprint is staggered between each team to ensure that new priorities from management can always be scheduled quickly without disrupting the schedule and deliverables of other teams midway through their sprint. Each sprint ends on Friday, and it includes deploying completed work, running a retrospective, and breaking down and assigning the work scheduled for the following sprint. The deployments aren't always visible to the customer and could sometimes be only internal improvements. However, it is critical that each team deploys their work packages at the end of their sprint.

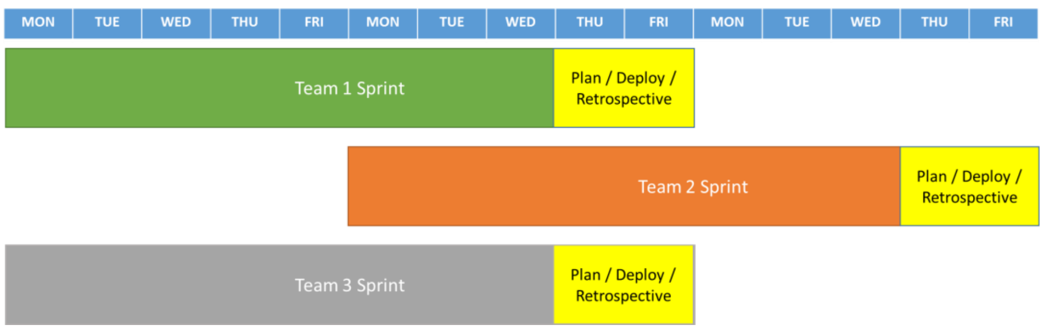

Figure 2 - Sprint Staggering

Sprint planning. Sprint planning meetings occur every Thursday morning from 8am to 10am in the designated "Scrum Room." These meetings include management, all of the technical Team Leads (who fill the role of Scrum Masters), and supporting Team Leads. These sprint planning meetings represent the core of the process and are critical to success of the CATT Lab agile process. These meetings expose all known work across the Lab, and force Management to transparently prioritize and schedule work, expose how shifts in priorities by management would affect schedules, and simultaneously provide developers insights as to why and how priorities are established.

The meeting agenda for Sprint Planning is as follows:

1. Team sprint updates – each team lead goes through the list of their current sprint tasks and provides the following information for each:
    a. Is the task on target to be completed, at risk, or will it need to be pushed to the next sprint?
    b. Percent of expected effort expended on the task
    c. Percent of task completed
2. Team flow-up – each Team Lead reports feedback from his or her team members regarding process, work progress, blockers, or any other significant events.

3. New work – anyone in the room is allowed to add new work to the board and explain where the work comes from and why it is important.
4. Update work priority – all newly identified work is then placed in one of the following bins:
    a. *Ready to be scheduled* – this is work that is well defined and ready to be scheduled. This bin is further broken down into "ASAP," "30 days," or "60 days" according to priority.
    b. *Blocked* – any work that is blocked internally or externally is placed into this bin to signify that it cannot be worked on until the block is removed.
    c. *Needs requirements* – work that is not well defined is moved to this bin to signify the need for additional information.
    d. *Needs architecture* – work that is well defined in terms of requirements, but its solution isn't readily evident.
    e. *Needs art* – work that requires user interface (UI) design by the UX team.
    f. *Needs IT* – work that requires IT team resources and/or hardware.
    g. Proposals – any potential work that requires estimation of effort and cost.
    h. *Backlog* – if work is not high in priority, it is placed in the backlog which is reviewed occasionally to reevaluate priorities.
5. Plan next sprint – work that is ready to be scheduled is taken in order of priority and assigned to each team's next sprint until each team is fully loaded with work for that sprint.
6. Plan future sprints – at least one additional future sprint is roughly outlined, but was subject to change in the following sprint planning meeting.
7. Management flow-down – the management provides any big picture changes in terms of new potential work, or anything else that may affect the development in the near future.

The development teams track all of the work in the Atlassian suite of tools including JIRA and Confluence. JIRA is an issue tracking system that allows developers to break down each task into components and assign those components to individual developers. ***Figure 3*** shows an example set of issues in a sprint tracked in JIRA.

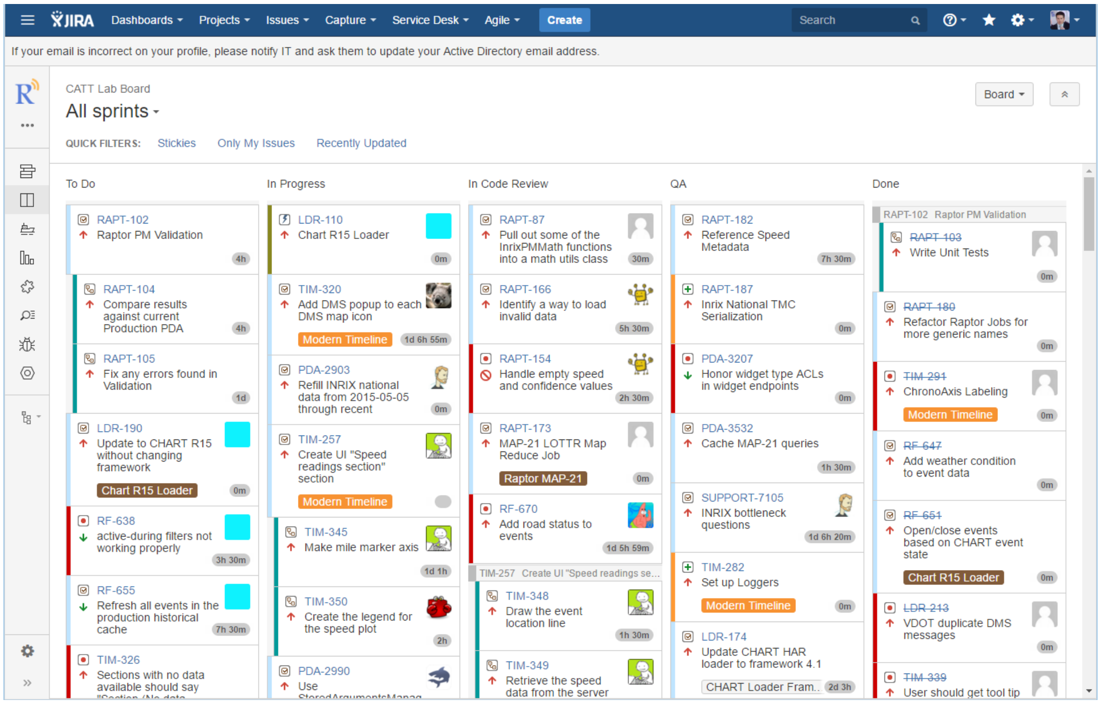

Figure 3 - JIRA Sprint Tracking

Even with the use of electronic tools like JIRA and Confluence, the CATT Lab desired to employ a more tactile and visual method for organizing and prioritizing work in their tailored agile process. The CATT Lab made use of nearly 400 square feet of wall space to their planning room to track, prioritize, and organize work using paper sticky notes. Each note represents high level work to be performed, and they are placed in appropriate locations on the wall: ready to be scheduled, backlog, blocked, under a given team's sprint, etc. Each sticky note is then moved between these sections of the wall in real-time by Management and team-members. This visual management approach allows teams to see work in progress and understand complex information like processes, task relationships and risks related to a team's ability to complete work on time. The tactile actions and the visualization help to minimize mistakes and facilitate team and management communicating during meetings.

Figure 4 shows an example of the team sprint definitions using paper sticky notes. Each column on the board represents a team, and each row represents a sprint. Each cell is the split to classify work as "on target," "at risk", or "push" depending on the current progress. Also each sticky note has a percentage of effort expended and percentage of completion.

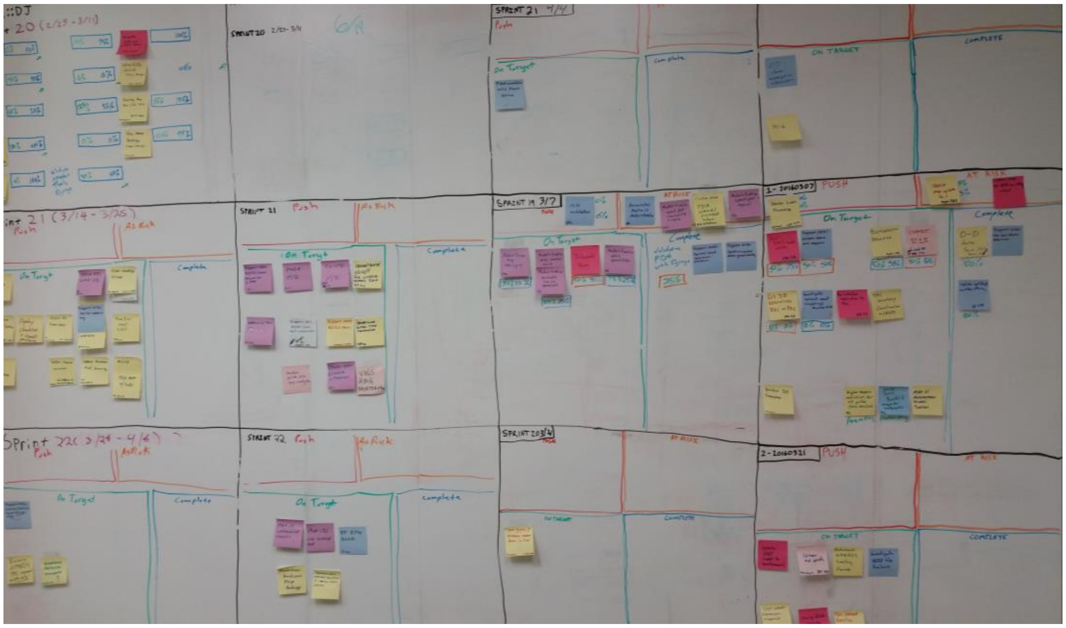

Figure 4- Defining Team Sprints

Figure 5 shows an example of the work bins and sticky notes in each bin. During the meeting the team reviews each bin and moves tickets based on changes in their priority or newly acquired information.

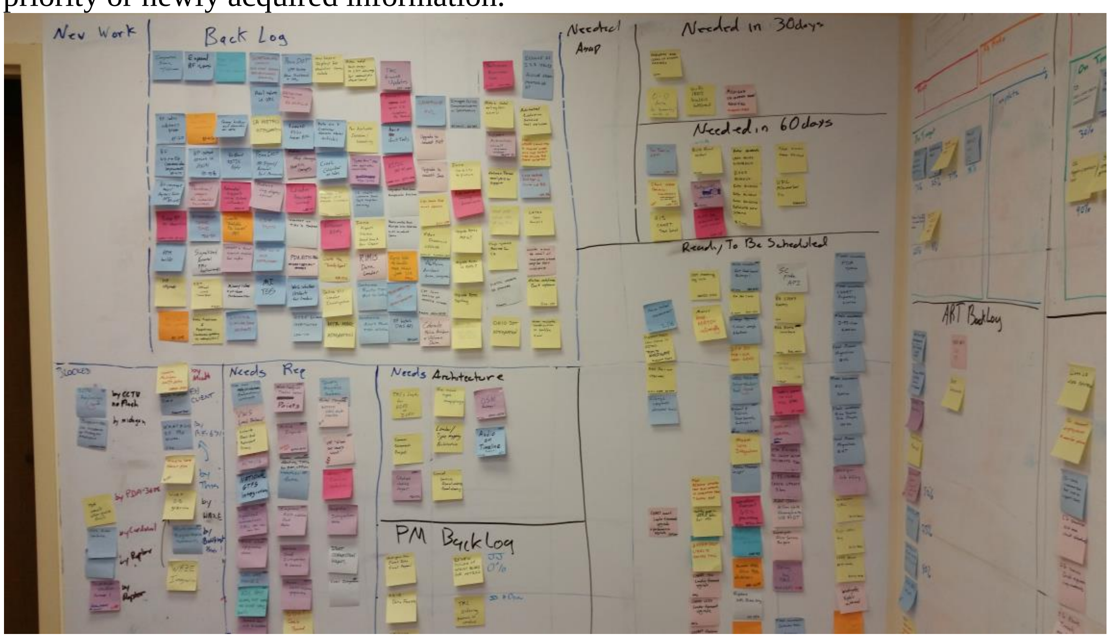

Figure 5 - Work Bins

Physical team co-location. Agile team members are collocated in a single room to ensure team members are easily visible and accessible to each other. This approach fosters tight communication and building of relationships. As team members grow accustomed to each other, they are more likely to collaborate and ask for help when needed. They also become more knowledgeable about their team’s strengths and weaknesses and can leverage that information to perform work more efficiently.

Retrospective meetings. Every Friday at the end of each sprint, teams complete their deploys and meet to discuss the previous sprint and break down and assign the work for the following sprint. This meeting is specifically for teams and management attendees are there in a passive role to answer questions and provide high level feedback. However, the focus is on the team members, students, and transparency. The agenda is as follows:

1. What did we do well this sprint?
2. What did we not do well this sprint?
3. Other feedback.
4. Next sprint planning
    a. Work breakdown
    b. Work estimation
    c. Work assignments

At the end of the retrospective meeting, the team members understand what made them successful in the previous sprint and attempt to replicate that in the future. They also outline their failures and take steps to prevent those from occurring in the future. Finally, they leave the meeting with a clear understanding of the upcoming sprint work and their role in the sprint.

LESSONS LEARNED

Living process and feedback loop. Since the agile process was implemented at the CATT Lab 12 months ago, the process has evolved. The process was developed with an understanding that continuous introspection, self-assessment, and feedback loops are needed to improve the process. Each planning meeting is better than the previous planning meeting, and each retrospective meeting makes the team more effective than it was the previous week. During this 12-month implementation period the CATT Lab team further identified new challenges, and has taken steps to address each as outlined below:

Work estimation. Accurate work estimation is critical to effective scheduling and sprint planning. The teams consistently underestimated or overestimated their work which impacted their ability to reliably schedule work. To address this issue, the CATT Lab implemented the following changes:

1. Lunch and learn presentation – the CATT Lab staff put together a lunch and learn presentation that outlines several industry standard estimation techniques that can be used to better estimate work.
2. Planning poker – during the work breakdown portion of retrospective, the team members are asked to individually evaluate effort needed for each scheduled task by assigning it a value with one of the cards with Fibonacci sequence numbers from 0 to 55. Team members with the highest and lowest estimates are asked to explain the reasoning behind their estimates to the team – starting a discussion that leads to a better understanding of the complexities of the task, approaches to solving problems, etc. This crowd wisdom approach helps the teams reach more accurate estimates.

3. Performance measures – the CATT Lab tracks a new measure to define the amount of overestimation or underestimation that occurs in each sprint and to isolate potential issues that impact those estimates.

Despite these changes, teams still struggle with estimations and require more work to improve in this area.

Aggressive demands from management. In the effort to ensure progress, the management assigned more work than was feasible, and the developers felt that they were unable to effectively push back. Early sprints frequently resulted in no deployments and majority of work being pushed to the following sprint. This had a negative impact on developer morale as they felt that the "agile process" was just a disguise for the same old stream of constantly changing priority work. To resolve this issue, the CATT Lab implemented the following changes:

1. Sprints were extended to three weeks while attempting to keep the same work load as what was scheduled in two week sprints. This helped, but it also made the organization less responsive to changing priorities, and the extended work period had the unintended effect of adding more risk and uncertainty to the sprint as more work was taken on instead of an equivalent amount of work. After several sprints, the Lab reverted back to two-week sprints.
2. The planning process was changed to ensure that only the work that Team Leads were confident would get complete, actually gets scheduled. Team Leads are then held to a high standard with the expectation that *everything* scheduled in their sprint must be completed, unless it is impacted by an external blocker or another event beyond their control. This approach has had a major impact and has resulted in significantly more productive sprints.
3. The CATT Lab developed a new performance measure to track the amount of work that gets pushed to the next sprint as a percentage of overall work assigned. While the goal is to be at 0% at the end of each sprint, the percentages could be analyzed over time to determine patterns that may expose specific issues causing work to be pushed.

Changing priorities. The implementation of an agile process cannot affect external forces that might cause Management to shift priorities, but it has helped to make priority shifts significantly less disruptive given that the development teams are fairly protected in their sprints. The impact has mainly been absorbed by the Team Leads who personally take on any incoming work to ensure that the remainder of the team continues uninterrupted. This approach works, but as Team Leads become overloaded, they may drop or forget about certain tasks, therefore introducing risk. To address this issue, the CATT Lab is implementing the following changes:

1. Proactive communication – the management is attempting to be as proactive as possible and bring up new work in early stages (even if the new work has a minimal probability of occurring) so that placeholder tasks can be created in future sprints and expectations can be managed. However, sometimes customer demands dictate immediate priority changes, which still presents a challenge.

2. Reserve Team Lead capacity – the Team Leads reserve some of their time for unplanned work and attempt to take on that work instead of disrupting the rest of the team.
3. Reduce team size – adding a fourth team has allowed the Team Leads to work with smaller teams and open up some additional personal capacity to address unplanned work.

Overly diverse sprints. Cross-functional teams are capable of performing work on many different tasks. However, scheduling too much diverse work within a sprint causes excessive context switching for individual developers, thus affecting productivity. Even going from sprint to sprint, if tasks are significantly different, additional time is spent in spin-up for each family of tasks. To address this issue, the CATT Lab implemented the following changes:

1. Assign more homogeneous work for teams for a single sprint whenever possible.
2. Designate each team as responsible for a set of logically related projects so that teams operate on familiar code bases from sprint to sprint, even if they are required to work on a different set of tasks, while still maintaining cross-functional nature of the teams.

Performance measures. There is an old saying, "what gets measured gets done" and the same holds for agile process. Without metrics, it is difficult to discern level of success or failure. The development team may think that they work hard and accomplish amazing amounts of work, while the management keeps seeing tickets getting moved to "At Risk" or "Push" sections of the scrum board. Conversely, the management may be pushing certain work, when that particular work does not lay on the critical path. The CATT Lab developed several performance measures that the team tracks and uses to guide process and skills improvement:

1. Percent of work not carried to the next sprint – at the end of each sprint, the team tracks the number of sticky notes that did not have to be pushed to the next sprint. The goal is to achieve 100% completion rate.
2. Number of deployments – this metric measures how frequently sprint ends with a successful deployment.
3. Number of pull requests posted by Team Lead – a "pull request" is a developer generated notification that code for a particular feature is completed. Other developers are invited to review this feature and merge its source code into the main source code branch. This metric is meant to measure effectiveness of reducing team sizes with an addition of the fourth team. The theoretical expectation is that as each Team Lead manages a smaller team, they are able to perform more hands-on development which will result in an increased number of pull requests.
4. Accuracy of estimates – this metric quantifies accuracy of teams' estimates in order to identify specific issues and address those in a meaningful manner.
5. Number of tickets resolved by developer and Team Leads – this metric allows tracking of individual technical performance.

CONCLUSION

Organizational change can be stressful and complex. However, when organizational change comes from within as a reaction to the success of an organization and employee concerns, the change can be more palatable and even welcome. The CATT Lab's implementation of a tailored agile process along with adapting hiring processes and organizational restructuring addressed many pain points and set the Lab up for long term viability. The keys to the CATT Lab success are:

1. Adopting and tailoring a process suited to the Lab's mission and objectives
2. Empowering individuals and allowing them to own portions of the process.
3. Establishing a clear hierarchy
4. Introspection and continuous self-improvement
5. Measuring performance and setting targets

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Near-Site Agile: Scaling Agile with Real-World Constraints

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ABSTRACT

This paper provides a description of Near Site Agile and it's advantages for scaling custom software development, especially for public sector clients. Near Site Agile splits agile teams so project managers and business analysts work onsite with the customer, and developers and testers work from nearby delivery centers where labor rates are significantly lower. This allows the developers to travel to client site as needed for agile ceremonies and client relationship building, while also providing the scalability of an outsourced delivery center for team cost, flexibility and cross-training. The trick is staying "agile" despite the lack of colocation and resulting pressures for both clients and contractors to matrix or departmentalize project teams. Lessons learned will be drawn and evaluated from IBM's project of the year winner for project management, Electronic Records Administration (ERA) 2. This project used Near-Site Agile to deliver cutting edge custom cloud-based applications to process and access petabytes of data for the National Archives (NARA) despite significant budget, facility, and schedule constraints.

ABOUT THE AUTHOR

Mr. Johnson was one of the two Agile Project Managers on the NARA ERA 2 case study project, while he was working as a Senior Agile Project Manager at IBM. During the ten month duration covered in this project, he led the scoping and contract negotiations during the transition to Near-Site Agile. He also managed multiple agile project teams on ERA 2 using Near-Site Agile to deliver a cutting edge big data search application capable of supporting discovery across hundreds of petabytes of electronic records expected at NARA by 2020.

Mr. Johnson has since left IBM to co-found One Year LLC, a software product company operating in the DMV area dedicated to bringing cutting edge information systems to life sciences research. He has been an agile project manager and practitioner for over five years working as an entrepreneur, project manager at IBM, and a management consultant with Booz Allen Hamilton, and has led multiple award winning projects for the Marine Corps, Air Force, Navy, and National Archives.

CASE STUDY OVERVIEW

Project Title: National Archives (NARA), Electronic Records Administration (ERA) 2, Digital Processing Environment and Digital Object Repository Pilot Phase II

Short Description: The purpose of the NARA ERA 2 project was to continue development of the Digital Processing Environment (DPE) and Digital Object Repository (DOR) applications for NARA's ERA 2 program. These applications are web-based cloud applications that provide scalable transfer processing of electronic records received from Federal Agencies, as well as permanent, robust preservation and access to government records. The applications are hosted in the Amazon Web Services (AWS) cloud environment and leverage the latest in free and open source software (FOSS) components. The application has approximately five hundred to one thousand potential end users once the system moves from pilot to production (as part of a future contract).

The project started using IBM's Agile With Discipline (AWD), but was then reorganized to use a new hybrid agile approach called "Near-Site Agile." IBM's Near-Site Agile approach differs from "scrum-agile" by incorporating more formal and continuous planning. It starts with a short planning period during the beginning of the project that is dedicated to architecture and initial business requirements before development begins. Teams are made up of five developers, one business analyst, one tester, and one agile project manager (half-time), as well as one client tester and product owner. This "whole team" approach ensures that all parties involved understand the requirements and testing required for the application, and the team has the authority (through the product owner) to make decisions and self-direct changes in scope for development. Teams work within four-week long sprints where one day is dedicated to planning and one day is dedicated to a team retrospective and demonstration to stakeholders. The other 18 working days (or less) are available to develop requirements, code, and test concurrently. All work is managed as stories which are tested fully in an integrated testing environment across all previous work by application teams before the story is considered "done."

Duration: 10 Months **Cost:** $15M

Project Personnel: 35 IBM Employees, 15 NARA Employees

NARA Personnel Breakdown: 3 NARA Testers, 3 NARA Product Owners, 2 NARA PMs, 2 NARA Security Officers, 2 NARA Architects, 1 NARA Program Manager, 1 NARA COTR, 1 NARA CTO

IBM Personnel Breakdown: 15 Developers, 4 Testers, 3 Business Analysts, 3 Architects, 2 System Administrators, 2 DevOps, 2 PMO staff, 2 Agile PMs, 1 Delivery Manager, 1 Program Manager

Outcomes:

- Scoped, designed, developed, and tested a cutting-edge cloud-based archiving system in 10 months
- Delivered all "must-have" functionality on-time, under budget, and in compliance with NARA standards
- Established IBM Agile Customer Delivery Center in Rocket Center, WV
- Reduced software development labor costs by over 40%
- Winner of *Project of the Year in Project Management* in 2015 global competition

HISTORY OF NEAR-SITE AGILE

Formalizing Agile Development

The origins of Agile are based in management principles popularized during the 1980s. These techniques that would come to be called “Lean” were a combination of principles including Edward Deming's Total Quality Management (TQM), Goldratt's Theory of Constraints (TOC), and Taiichi Ohno's Toyota Production System (TPS). Lean focuses on the reduction of waste in management and production processes, by limiting the seven sources of waste (transport, inventory, motion, waiting, overproduction, overprocessing, and defects), and performing continuous improvement [5]. These complementary approaches along with the development of Rapid Application Development (RAD) by IBM in the 1980s offered alternatives to the traditional “Waterfall” management model [4]. By the mid-1990s agile development methods were beginning to manifest in the form of Dynamic Systems Development method (DSDM) which offered more structure to the RAD process that had taken the IT Industry by storm [3].

The codified agile principles were established in 2001 with the Agile Manifesto. These core principles stated that agile practitioners should emphasize the following items on the left over the items on the right [2]:

1) Individuals and Interactions OVER Processes and Tools
2) Working Software OVER Comprehensive Documentation
3) Customer Collaboration OVER Contract Negotiation
4) Responding to Change OVER Following a Plan

The first and most popular approach that fully embraced these principles was “Scrum-Agile” or “scrum.” Scrum emphasizes using small teams to accomplish small batches of work beginning at project start. This builds on the lean principles that practice proves large batches result in waste from inventory and low feedback on errors in the product process, and therefore small batches are in fact more efficient (even though this is counter-intuitive). In order to enable small batches, agile uses the DSDM principles of leveraging cross-functional teams to iteratively build software by designing, building, and testing small batches of working code using timeboxes [3].

Agile teams are therefore usually made up of a customer representative or “product owner,” a project manager, a business analyst, technical team members, and testers. To decrease process in a highly dynamic environment, all interactions should be face-to-face to quickly provide feedback and the team should “own” their work with the ability to “stop production” if an error is found and quickly fix it. Standup meetings occur every morning at the beginning of the day with the entire team so everyone knows the status and what will be done that day. This means that the purist form of agile techniques did not support off-site or distributed team approaches, because the distance would not allow for responsiveness needed to correct errors in requirements or execution for agile to be effective and efficient. However, IBM pioneered new agile approaches that attempt to get a better blend of responsiveness, predictability, and scalability.

Developing Agile With Discipline

As the largest IT services and products employer in the world, IBM needed to scale it's agile processes while continuing to innovate the company delivery models. The first incarnation was the Disciplined Agile Delivery (DAD) model that advocated for the use of initial planning phases that structure the architecture and product roadmap. With the architecture and product roadmap the technical and value propositions are known well enough to structure release points and cost estimates. This enables the agile teams to then move confidently and work in small batches that validate planning assumptions and refine requirements through the use of scrum agile techniques and structured reporting. DAD provided the ability to scale across multiple teams by having better planning processes and a shared high-level architecture [1].

The second version of this model was developed specifically for the government, called Agile With Discipline (AWD). AWD emphasized the inclusion of clients as members of the team like traditional agile, but also expanded starting and ending ceremonies for iterations (i.e. "sprints" or timeboxes) so larger stakeholder groups and SMEs were systematically included. This approach worked very well for incorporating highly departmentalized customers into a projectized delivery approach like agile.

However, AWD began to run into issues. Customer product owners worked off client-site to be colocated with the agile teams. This kept the product owners away from co-workers which led to long-time product owners losing touch with the business they represented. Also, the government owners often didn't have space to house the large number of agile teams on these scaled up projects, so separate facilities were procured for the projects. This meant that government contracts needed to be large from the beginning in order to justify new facilities dedicated to agile development. NARA was scoped tightly, had issues with available client resources, and was a magnitude smaller than previous government projects that came before it using AWD, so a new approach was needed.

THE NEED FOR NEAR-SITE AGILE

When starting the NARA ERA 2 project the original intention and contract called for using IBM's AWD delivery approach. However, challenges emerged at the start that demanded changes to the plan:

- **Lack of Product Owners** – NARA had been under a hiring freeze and didn't have enough experienced and senior staff who could be spared to be full-time product owners for ERA 2
- **Lack of Space at Client Site** – NARA originally planned to have space for IBM's development teams, but AWD requires open "agile" spaces and dedicated conference rooms to enable face-to-face interaction which were not available due to a lack of space sharing and regulations on work station modifications
- **Lack of Talent Near Client Site** – IBM identified that NARA's location in College Park was not easily accessible by its available developers; most of whom didn't have the skills needed for the ERA 2 project

These challenges were critical. Each challenge hobbled the ability of the team to commit to and take advantage of the core principles of agile development: self-direction, colocation, and whole teams.

A lack of product owners meant the project would either lack proper direction by the client or the ability for teams to self-direct. Teams would either have a product owner with no leverage or insight, or the team would be severely limited so NARA could "approve" and "review." NARA's lack of available resources also impacted the ability to have NARA testers on each of the agile teams to enable continuous delivery of "accepted" code.

The lack of space meant that teams would not be able to communicate quickly and effectively through open interaction and face-to-face communication. This would significantly slow down the teams and limit their ability to iterate designs quickly and resolve potentially competing designs. Without colocation the teams would be highly limited to respond to change through fast interaction with each other.

The lack of talent near NARA threatened the ability to colocate as well as put together whole teams of people with the required skills. IBM had recruited mostly near Herndon, VA, a two hour drive in DC rush hour traffic to NARA's College Park site. At the same time, IBM had been cutting costs through very high utilitization targets across all departments, especially those in software development. This meant that many projects needed good developers and resultantly the best talent could choose to work at projects close to home. The lack of available talent was potentially crippling for IBM, since ERA 2 was scoped to include the state-of-the-art cloud-based application development. All members of the ERA 2 had to be strong programmers capable of learning new technology quickly, so either IBM was going to have to pay high prices subcontractors (and take on the associated risks) or pay for developers to stay in nearby hotels to reduce their travel burden.

Faced with nearly insurmountable odds against using agile development but requiring agile per the contract, IBM worked to devise a new strategy using what it knows best – information technology and daring project management techniques.

IMPLEMENTING NEAR-SITE AGILE

It quickly became clear that there was no solution for many of the geographic and facility space constraints at the NARA client site. At the time this became clear, there were many pressures to modify the contract and go back to a waterfall-style plan. Waterfall would enable the team to work remotely without great penalty and deliver within budget. This however could not work because NARA lacked design specifications, and there wasn't enough time in the schedule to go through NARA's governance for traditional IT projects. IBM needed to come up with a solution that could still deliver on-time and in-budget using iterative development.

The IBM project executive sponsor proposed a new concept, “Near-Site Agile” as a solution. This approach would leverage a nearby client delivery center (CDC) in Rocket Center, WV that was performing O&M support for NARA already and outsource the development. Rocket Center is a small town, but there was enough talent immediately available at the CDC since IBM was the premier and only large IT employer with access to UMD's Frostburg campus. The management team worked together with NARA and the CDC to come up with a solution that could work. The principles were as follows:

- **Colocate by Function** – Teams would split geographically between business and technical roles
    - Project managers and business analysts would locate at client-site
    - Developers and testers would locate at the client delivery center (CDC) in Rocket Center, WV
    - Teams were kept “whole” and would still maintain the power to self-direct
- **Near-Site Team Building** – teams would travel to each other's site when needed for team building
    - Teams would start off colocated to build strong relationships before splitting by function
    - Teams would travel to colocate monthly for iteration planning, midpoint checks, and retrospectives
- **Simulated Colocation** – teams heavily use video-conferencing for meetings and quick conversations
    - All team members would be equipped with high-definition cameras at workstations
    - NARA conference rooms were outfitted with HD cameras and audio equipment

“Colocation by Function” enables teams to have the delivery center benefits of training across projects and sharing of ideas between those team members that do similar types of work. Because the customer is the team’s source of requirements, the requirements leads (project manager and business analyst) must co-locate at the customer location. This enables greater responsiveness and coordination between the customer and off-site technical teams. *It's very important to emphasize that colocating by function does not take away the* *team ownership of the code, especially by the developers. Each team member remained empowered and able to self-direct their work despite being dispersed from the client.*

The “Near-Site Team Building” requirement ensures that when needed all team members can be co-located for workshops, planning sessions, and review sessions. This helps build and maintain the trust that is required with agile delivery and the speed of communication needed for highly feedback intensive meetings.

“Simulated Colocation” makes sure that teams can move fast. Stand ups, requirements meetings, and even simple discussions for feedback on testing or design options are close to in-person quality with HD video-conferencing. Software like Google Hangouts that have one-click conferencing abilities lowers the inertia so no conversation requires more than a single action to initiate face-to-face communication.

LESSONS LEARNED

Challenges with Near-Site Agile

While there are many benefits to Near-Site Agile, there are some cautions a project manager and management team needs to be aware of before employing the approach. These focus on the inherent multi-site and off-site challenges that must be addressed directly, as well as the balance of investment in the near-site client delivery center (CDC):

- **Travel and Communication Costs** - Logistical challenges with this approach are primarily rooted in maintaining cost efficiency of distributed teams despite travel on a monthly or more frequent basis by all team members. The Near-Site Agile approach also requires significant setup of collaborative technologies in both locations, which can add cost to the customer. Finally, the ability to distribute teams is limited to a reasonable travel distance, so that teams still meet within the same or nearly same time zone. This enables coordinated standup meetings in the mornings and self-forming teams as needed to support feedback loops central to agile project processes.
- **CDC Incentives and Culture** - From a teaming perspective, the travel does help to normalize cultures across locations, but only it's not a perfect remedy. Part of the benefit of a client delivery center is a low-cost labor market which is often centered around a community where the community members have deep roots. This adds significantly to the loyalty and stability of team members on the project, but adds the intricacies of small town politics. The biggest challenge is accurate and timely escalation of issues and making sure that team members are not overworking themselves to compensate for bad planning in order to bolster the CDC reputation. The PM must be actively fighting these tendencies that could lead to team burnout and inherently exploit the CDC teams.
- **Talent and Growth Rates at CDC** - Lastly, the benefits of using Near-Site Agile can be great, but there is a limit to the growth rate sustainable at a CDC in terms of available talented resources. While at first there may be large untapped talent in a small town near a major metropolitan area, eventually the growth rate of the projects at the CDC becomes greater than what the small town can support. This happened within the ten months of the NARA ERA 2 project. To address this issue, CDC members need to train each other to ramp up skills acquisitions and the PM needs to be prepared to send senior staff to to the CDC to train and grow teams.

Benefits of Near-Site Agile

The first and primary benefits of Near-Site Agile lie in its low-cost, stable resources. The incredible support that was received from the Rocket Center client delivery center (CDC) was at the core of IBM's success on the NARA ERA 2 project. However, there are also inherent advantages that a Near-Site Agile delivery offers beyond standard on-site disciplined agile models by reducing client burdens. These benefits more than make up for the challenges in employing Near-Site Agile:

- **Low-Cost Resources** – savings on software development labor can be 40-50% or more. This more than makes up for the additional logistical costs and can be an incredible competitive advantage. In agile, the labor mix is heavily technical. With five out of six and a half team members from the CDC (each time has half a PM) the net labor savings can be up to 40% compared to staffing at client-site.
- **Reliable Resources** – The CDC in Near-Site Agile is an incredible opportunity for the town where it's located. People at the CDC stay in the town because that's where they want to live. This means that resources are stable and the PM spends less time in-project training or backfilling.
- **Stable Product Owners** – client personnel, especially product owners, can now remain on-site and still be completely connected to team members using video-conferencing. This allows product owners to stay engaged at least part-time in the business they represent – increasing their effectiveness.
- **Reduced Facility Costs** -because the CDC is located in a small town with a lower cost of living, the facilities are cheaper and often flexible to be designed as true "agile spaces." The benefits of open designs and dedicated team rooms become quickly apparent as teams spend longer getting things done, rather than finding each other or bouncing between conference rooms.
- **Scalability of Delivery** – because the Near-Site Agile approach lowers the burden on the client for facilities and people there is more actual room for scaling up delivery, especially in government environments. With lower burdens on product owners more client personnel will be willing or even want to become product owners once they see success in the first releases. And the CDC can grow through resource sharing to meet that demand efficiently until human resources becomes a constraint.

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Stakeholders and Transnational Projects

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Abstract

The project stakeholder literature has evolved into a voluminous body of knowledge in recent years. However, comparatively little research has focused on stakeholders in the context of transnational projects. Transnational projects in their entirety have become ubiquitous and very numerous over time, especially with the advent of globalization, and many exhibit an enormous level of technical complexity and resource-intensiveness, long durations, and their outcomes not only affect in both positive and negative ways the lives of millions of stakeholders but can also profoundly influence the relationship between states. Hence, given the very high economic, social and political stakes evidently associated with transnational projects - and taking into consideration the now universal interest in and the great importance being accorded by project theoreticians and practitioners to project stakeholder management and engagement - there is a need to carefully study and evaluate these projects in stakeholder perspective. Doing so can help identify and exploit existing opportunities to the fullest and also mitigate the risk of conflict or animosity arising between states with all its ensuing negative ramifications.

For this exploratory research the authors have selectively examined dozens of high-profile and well documented transnational projects in the construction, transportation, energy, industrial manufacturing and other fields across the globe. Four distinct categories were identified under which transnational projects can be grouped, namely, cooperative, collaborative, integrative, and divisive, along with a fifth overlapping category wherein projects simultaneously exhibit both cooperative, collaborative or integrative, as well as divisive character. Each category is discussed with current and prominent examples. This project category spectrum constitutes a useful contextual framework which permits careful analysis and assessment of stakeholders' key attributes, notably their respective interests, motivations and concerns regarding transnational projects, and consequently delivers important insights to the initiators, planners and executors of such projects through which practical, effective and ethical strategies and approaches can be devised and put into action which seek not only to ensure fair benefit and cost sharing among stakeholders but also that as many, if not all, stakeholders ultimately derive net benefits from the projects.

Introduction

Projects in the post-World War II era are increasingly exhibiting transnational character. Data which can deliver a reliable current estimate of the number of and investment in transnational projects at global level is non-existent but a conservative guess would run possibly into several hundred billion, if not trillions of Dollars. Transnational projects therefore constitute a sizeable share of the overall global portfolio and need to be examined carefully so that insights as to what determines their performance and lowers their risk of failure can be derived. As stakeholders are the most important consideration in every project regardless of location and time – it is after all the stakeholders who ultimately conceive, initiate, undertake, control and share the costs and benefits of projects – it is instructive to analyze the roles, responsibilities and relationships of stakeholders in the context of transnational projects especially since these projects exhibit some significant differences and pose additional challenges when compared to projects which are undertaken in a national context.

The transnationalization of projects being increasingly observed in the past few decades can be attributed to many inter-connected reasons, the most important of which is the phenomenon of globalization and its consequences which include the cross-border mobility (and availability) of capital, human resources, services and products, information and knowledge at a level which is unprecedented in history. The liberalization of national economic and investment regulatory and procedural frameworks across the globe, especially since the end of the Cold War, and the growing inclination by many states, in a regional context, to systematically harmonize and align over time their economies, policies and institutions in pursuit of shared goals and objectives for attainment of mutual benefit are also factors which have encouraged transnational initiatives. Technological innovations, the erosion of tariff and non-tariff barriers to external trade and the development of robust physical infrastructures capable of enabling and sustaining complex transnational supply chains are further major facilitative factors.

The term “transnational” has many definitions and is applied in a number of contexts. Viewed in the project context, transnational projects are often mistakenly perceived as being synonymous with high-profile complex, cost-intensive and technically challenging civil infrastructure or construction schemes undertaken usually at the inter-governmental level and which physically transcend national territorial borders even though such projects empirically constitute a very small percentage of the overall number of transnational initiatives. In fact, transnational projects span practically the entire project spectrum. For this research, the authors therefore broadly define transnational projects as those projects involving entities (i.e. stakeholders) from two or more sovereign states providing significant or crucial project input in the form of, inter alia, financing, material, human and technical resources, information, knowledge or creative input, or other forms of facilitative support including right of transit. Their participation or involvement time in the projects is variable – they can, for instance, be confined to the project conception phase, or extend throughout the project life-cycle or constituent phases, and/or include the period of time subsequent to project completion when the project benefits are realized and shared. The entities participating in transnational projects need not necessarily emanate from the public-sector; they can also be commercial or not-for-profit entities or any combination thereof. And it is not imperative that transnational projects must physically transcend national territorial borders as is the common misperception. Most transnational projects are actually confined within one state’s (i.e., the host state’s) territory. Furthermore, the authors extend their definition of transnational projects to encompass those projects which generate a considerable and sustained interest at the governmental and/or public level beyond the territorial borders of the state or the states which are undertaking them. Often this interest stems from the controversial nature of the projects in question which are seen as constituting a national security threat or standing in conflict with human rights and/or the natural environment and which consequently encounter vocal and severe criticism and opposition and awareness on a broad scale which is spread through the media.

Transnational Projects: Opportunities and Challenges

Transnational projects deliver significant and multi-faceted benefits. At the same time they are often comparatively more complex than non-transnational projects and can pose major challenges which if left inadequately addressed may render their chances of failure with its consequent loss high. Transnational projects enable the pooling of capital, technological, managerial, human, informational and intellectual resources to an extent and at a level of diversity which normally is not realizable in non-transnational projects in addition to guaranteeing access to a broad gamut of inter alia experiences, ideas, strategies, processes, quality standards and work methods which are inputted into the projects by the participating entities. They also ensure that risks are shared among these stakeholders. Transnational projects constitute the only means through which some opportunities can be availed, for example, for commercial companies seeking convenient access to new overseas national or regional markets for their products and services by setting up and operating their manufacturing facilities in proximity to target markets. Likewise, projects aiming to facilitate mobility of people, goods and services, information, energy (oil, gas, electricity) and water resources across national borders are feasible only through transnational cooperation and efforts. For the participating entities the rewards can be substantive monetarily, and in terms of image gain, organizational and professional networking possibilities, the accumulation of specialist expertise and experience, and so forth. For projects undertaken at the inter-governmental level, transnational projects go hand in hand with political benefits, which in some instances may be quite substantial, possibly contributing towards a significant reduction in tension and the consequent potential for conflict between states which ensues from the enhanced economic, social, institutional and other modes of interaction over time which are the inevitable consequence of transnational projects. The European Union, whose states and their societies have been brought closer together by countless such projects, is a case in point.

Their multi-dimensional benefits aside, transnational projects also entail numerous special challenges and obstacles for the participating stakeholders which normally they would not encounter in a non-transnational project environment. Primarily, these challenges and obstacles stem from the higher comparative technical and managerial complexity inherent to schemes transcending national territorial boundaries over those which do not. Most importantly, special consideration must be accorded to judicious stakeholder management and engagement because in comparison to the internal and external stakeholder communities of non-transnational projects the stakeholders in transnational projects in the corresponding category are usually more numerous and heterogeneous, and over time would exhibit a broader, more diverse spectrum of interests, motivations and concerns, attitudes and behaviors, expectations and perceptions which if inadequately and inappropriately addressed by the project owners, planners and executors can significantly increase the risk of the projects failing.

The individual challenges and obstacles in the transnational project and work environment have been the subject of numerous research studies and much discussion over time. A considerable body of knowledge now exists on the subject. Much of this work examines the role and extent of national cultural diversity on a global scale and its impact on individuals and organizations in different cultural environments. It is widely acknowledged that culture can profoundly affect perceptions about many major project-relevant considerations such as time, work attitude, professionalism, trust and relationship building, expressiveness, ethics etc. Failure to understand, appreciate and factor in inter-cultural differences when undertaking transnational projects thus constitutes a potential source of considerable risk and, in several observed instances, have derailed otherwise technically sound ventures.

It is now universally accepted that project management and administration is mostly founded on communication management. Communication in one language poses immense challenges of its own and many project performance surveys conducted across the globe in different industries from time to time have identified communicational deficiencies as a major cause of project failure. The communication risks are amplified in transnational projects where collectively a multiplicity of languages are often spoken by the key stakeholders whose command of a mutually agreed upon project language may exhibit a significant disparate level of proficiency from each other. Consequently, the risk of misunderstanding and miscommunications and all the possible negative consequences this entails for projects is compounded.

Culture and communication considerations aside, transnational projects encounter several additional practical complexities which can significantly increase their risk perception among stakeholders. Whereas one set of rules, regulations, restrictions and policies would normally apply to non-transnational projects this can, depending on the project in question, be doubled, tripled or even multiplied several fold in the case of transnational projects. Dealing with different, sometimes unfamiliar public administrative, legal, economic, political, social and other contexts requires special caution and additional resources and entails the possibility that conflicts, intentional or otherwise, may occur resulting in complications at best and at worst an existential threat for the projects. A host of mundane considerations, such as obtaining travel visas, the stability of inflation and currency exchange rates, profit repatriation assurances, incentive systems, the legal protection of contracts and contract dispute mechanisms, political stability, policy consistency and continuity, bureaucratic behavior, fear of arousing hostility amongst the local population and threats to physical safety – all these are frequently occurring examples of the numerous considerations which in the non-transnational context may play a peripheral or even negligible role but may constitute major practical project hurdles in the transnational context.

The Five Transnational Project Categories

Based on their research of transnational projects across the globe, the authors have identified five categories in which transnational projects can be assigned in stakeholder perspective, namely, cooperative, collaborative, integrative, divisive and a mixed category in which projects simultaneously exhibit both divisive and either cooperative, collaborative or integrative character. The choice of which of these categories to assign a transnational project to would depend on their purpose of the project and the perception stakeholders may have of it. These five categories are discussed below:

Cooperative Projects: Most transnational projects appear to fall in this category. These ventures span virtually the entire project spectrum and involve entities from the public, commercial or not-for-profit sectors or any combination of these. Prominent examples include, inter alia, corporate mergers and acquisitions, commercial industrial and service-focused joint ventures, development programs and projects sponsored by development agencies, joint scientific and technological research and development projects, public-private partnerships, outsourcing, production of movies and documentaries, and (which generally are relatively small in magnitude and complexity but collectively numerous) bi- or multilateral joint initiatives involving schools, colleges, universities and research institutes, museums, art galleries, theatres, hospitals and myriad other civic and professional organizations, associations and institutions. Typically also falling under this category are major events undertaken in periodic intervals such as the Olympic Games and other transnational sporting events and archeological excavation and even forensic exhumation projects. The motives for undertaking cooperative projects can be quite diverse, for example, commercial entities seek to enlarge their profit levels or expand their market shares, not-for-profit entities initiate schemes which are consistent with their respective missions and fields of interest, while public-sector entities may be interested to learn about alternative and possibly more innovative and efficient administrative systems. In some cases the motive may be sheer practicality as in archeological or geological expeditions which can only be undertaken on-site. As important stakeholders, state governments primarily assume the role of onlookers and facilitators, intervening directly only in occasional instances when deemed necessary in the national interest.

Collaborative Projects: Transnational projects executed in this category differ from those in the above outlined cooperative category in one major respect, namely, that they all share a common overriding and longer-term macro-objective which is to systematically deepen economic, social, cultural, political, institutional and/or other relationships between states. The states, usually at the national level, thus assume the role as the dominant stakeholders whose responsibility, through mutual agreement, is primarily to create, consolidate and sustain a framework of policies, regulations and incentives which encourages and facilitates pursuit of such ventures which, analogous to projects in the cooperative category, can span virtually the entire spectrum of projects and involve entities from the public, commercial and not-for-profit sectors or combination thereof. The main difference between collaborative and cooperative projects is the former's greater emphasis on the steering function of the states and consequent larger, active and direct role played by the public sector. Furthermore, projects in the collaborative category necessarily include those which concern areas of immense strategic importance and, in particular, often large, complex and costly schemes which aim to connect the civil infrastructures between states. For example, collaborative projects in the transportation sector would usually aim to upgrade existing or develop new road, highway and railway networks, as well as ports and airports, for the purpose of facilitating movement of people, goods, cargo and vehicular traffic across national borders. Similarly, in order to transfer energy resources (oil, gas, electricity) from energy surplus to energy deficient states projects would be needed to lay pipelines and erect complex transmission and distribution systems, often traversing thousands of miles and necessitating passage through 'transit states' which themselves may utilize part of the transferred energy volume.

Integrative Projects: Transnational projects in this category are based on the goal of states to elevate their sectoral relationships to the highest attainable level over time, i.e., usually to a very significant extent to integrate their economies, markets, infrastructure, policies, institutions and their societies. Achieving such multi-dimensional harmonization in practice can prove extremely challenging and costly as well as time-consuming as experience has shown and its realization requires a robust, comprehensive and flexible agreement framework, an intense and sustained political commitment by the states as well as societal interest, in addition to continual and extensive multi-layered cooperation, coordination and communication. Such integration can occur at the bilateral level but mostly it involves groupings or associations comprising several states. Several such clusters of states have emerged and gradually evolved across the globe. The most prominent current example is the European Union with its common market, open national borders, common institutions and common currency area. Comparatively less integrationist but large groupings are the Association of South East Asian Nations (ASEAN), the North Atlantic Free Trade Area (NAFTA), and the Arab Gulf Cooperation Council (GCC). Integrative projects span the whole project spectrum with intensive involvement by the public, commercial and not-for-profit sectors. These can range from relatively simple ventures such as the development of secondary school and university student and teacher exchange programs and launching of city twinning initiatives to pursuit of complex infrastructure development schemes which are conceived, planned and executed on a regional scale. Key stakeholders of integrative projects are the governments of the states who decide to what extent integration should and can be mutually and realistically pursued. Compared to the four other transnational project categories, the overall stakeholder community here is extremely large and heterogeneous as almost every person, association, organization or institution in each integrating state is in some form or the other, positively or negatively, affected by the process and outcomes of integration.

Divisive Projects: Projects in this category differ markedly from the projects in the cooperative, collaborative and integrative categories. Rather than helping bring states, their economies and their people closer together, divisive projects do the opposite, that is, they cause frictions or 'divisions' between them because their outcomes are perceived by their opponents as constituting a real or potential threat, provocation or challenge - economic, political, military or otherwise - which may eventually spiral out of control with potentially severe adverse or disastrous consequences over time. Divisive projects are undertaken unilaterally by states within their territorial borders, and sometimes beyond, and they reflect an evident incongruity of national interests and political and strategic goals with other states, neighboring or distant. There are numerous examples of divisive projects. Usually these tend to be larger schemes of a technical nature where security or economics is the major underlying concern. High profile contemporary divisive projects include the Iranian and North Korean nuclear weapon and missile development programs, the planned construction of large dams on major river systems in Africa, the Middle East and Asia, Chinese oil and gas exploration projects near the disputed Spratly Islands in the South China Sea, and the construction of housing settlements by the Israeli authorities in East Jerusalem. The governments of the project-implementing and the project-opposing states are key stakeholders in this project category. The occasional imposition of sanctions in response to such projects (as in the case of Iran and North Korea for instance) may however, depending on the scope, duration and intensity of the sanctions applied, drastically affect the sanctioned states which usually tend to be politically isolated and economically comparatively less developed and more prone to disruptions, causing hardship for most of their citizens which consequently would also inevitably become stakeholders.

Another category of projects which can be categorized as "divisive" are those projects undertaken within or between states which encounter strong opposition from non-governmental entities and broad sections of the general public in other states. Such is the case where concerns such as, for instance, human rights violations or damage to the natural environment figure prominently and information about these is made available to a global audience. The appalling treatment of foreign construction workers in Qatar in preparation for the World Football Championship Games in 2022 is an excellent contemporary case in point. The Ilusu dam project in Turkey which threatened to flood an area steeped in history and ancient archeological sites resulted in strong international opposition and the withdrawal of foreign financers from the project. Other examples of divisive projects include those undertaken by mining and energy corporations in the developing world and forest logging schemes which have resulted in the murder of a number of environmental activists and caused intense hardship for indigenous peoples.

Mixed Category: Mixed category projects exhibit dual character, incorporating both a divisive as well as a cooperative, collaborative or integrative component. These projects are undertaken bilaterally or multilaterally on either a cooperative, collaborative or integrative platform between states, whereby the bi- or multilateral dimension distinguishes them from divisive projects which are unilateral, but are opposed by other states. A pertinent current example is the Iran to Pakistan gas pipeline project under which Iran would supply and sell natural gas to its energy-starved neighbor and which constitutes the most economical and technically the most convenient option available but which is vehemently opposed by the United States whose intervention and threat of sanctions has so far prevented implementation of this project. Another case in point is the 45-billion Dollar China Pakistan Economic Corridor Project which envisages Chinese participation in several large transportation and energy projects in Pakistan extending from the Sino-Pakistan border to southern Pakistan as well as the development of a port on Pakistan's Arabian Sea coast. This project, which stands to deliver both China and Pakistan significant economic and other benefits during and especially subsequent to its realization, is opposed by India which historically has an adversarial relationship with both China and Pakistan and which fears that extensive collaboration between its two antagonistic neighbors in this strategic context may ultimately have highly detrimental economic and security consequences for India in future. Another example from the energy sector is the competing proposed multi-billion Dollar oil and gas pipeline projects envisaged to supply Europe with energy from production sites in Russia, the Caucasus and Central Asia, and the Middle East. Key Stakeholders in this highly complex regional constellation of strongly diverging political, economic and security interests and goals, and ideologies, include the governments of Russia, Turkey, states in the Caucuses and Central Asia, Iraq, Iran, the Arab Gulf Kingdoms and the western powers who all favor schemes which afford them the highest leverage and energy supply control.

Stakeholder Management and Engagement in the Context of Transnational Projects

Different transnational project categories present different and significant challenges and opportunities for stakeholder management and engagement. As discussed by the authors in their paper on project stakeholder governance framework which was presented at the University of Maryland's first international project management symposium in May 2014, the term stakeholder *management* basically concerns the interaction between the project and those stakeholders which have a contractual obligation or legal responsibility towards it (i.e. the primary stakeholders as defined by Cleland/Ireland). Conversely, stakeholder *engagement* centers on the interaction between the project and all those stakeholders which do not have a contractual obligation or legal responsibility towards it and are not actively involved in it though they may be affected by the project in the positive or negative sense (namely, the secondary stakeholders).

For transnational cooperative projects – and also though possibly to a lesser extent for collaborative and integrative projects given that the states involved in such projects are often geographically close to each other and cultural and other differences may not be as significant - the additional stakeholder management complexity over projects undertaken in the non-transnational context stems largely from the intercultural dimension, which often constitutes an immense challenge in its own right. Other complicating factors are the uncertainty brought about by operating in a potentially unfamiliar economic, social, political, legal, administrative and policy environment and seeking to nurture, consolidate and sustain relationships with stakeholders whose thought, behavioral and interaction patterns may deviate considerably from accustomed ones. For cooperative projects undertaken for the first time the unfamiliarity and uncertainty facets can be daunting and discouraging but with increasing transnational experience, measured by the number of projects and the length of time spent transnationally, these can be expected to gradually diminish through a process of learning, internalization and adjustment. Effective stakeholder management (i.e. of the primary stakeholders) should thus become easier.

At any rate, elevating the chances of success in undertaking transnational cooperative projects and minimizing the occurrence of complications with stakeholders, both primary and secondary, requires systematic and whole-hearted pursuit of several fundamental measures prior to project initiation, including intensive cultural training and acquisition of complete, specific and current information about the host country and stakeholders which is relevant for the projects under consideration. Lessons learned from previous projects and tapping the knowledge and experience of project managers and personnel who worked and/or who are currently working on similar projects in the host country would yield precious insights. As key stakeholders, the states hosting cooperative projects can be expected to actively encourage and facilitate such ventures by utilizing a variety of options available at their disposal ranging from public declarations of approval and endorsement, to the assurance of participation incentives (monetary and otherwise), and the simplification of cumbersome legal, administrative and procedural hurdles, to ensured active participation by their state corporations in transnational projects.

In the case of collaborative and integrative transnational projects, more intensive stakeholder management and especially engagement is needed in comparison to cooperative projects, particularly for integrative projects. This is because projects in these two categories are pursued primarily with the concurrence and active encouragement and support of states; consequently, the onus lies essentially with the states themselves to create, consolidate and sustain the requisite robust enabling environment which facilitates such projects, as well as to ensure the buy-in of such projects by their citizenry, industry and society because without broad public understanding and continual endorsement of collaboration or integration processes, it is doubtful whether these will be inclined to willingly or actively support or involve themselves in such projects. A prime challenge for states and project protagonists is hence to devise and execute an effective and flexible long-term information-driven engagement strategy which convincingly specifies and communicates to all secondary stakeholders the benefits, tangible and intangible, which result from the pursuit of such projects, and concurrently to satisfactorily address any concerns they may have about these projects. An additional engagement challenge for all states lies in ensuring adherence to stakeholder engagement best practices and upholding ethics since standards may differ significantly among states and actions which may be prohibited or frowned upon in some may be deemed permissible in others and this may prove counter-productive over time.

A more complex and difficult stakeholder engagement situation presents itself with divisive and mixed category projects where the projects undertaken by and within one state or jointly by two or more states are opposed by another state or group of states. Stakeholder engagement in this case may either simply be non-existent, which would be the case if the project-implementing states decide to ignore resistance to the schemes in question and also defiantly refuse to enter into a serious political dialogue about the projects with their antagonists, or it may assume the form of a negotiation process wherein restrictions on, modifications to, a deferment of or even a freeze on the projects are considered and agreed upon in exchange for the grant of some material concessions or non-imposition of sanctions and other punitive actions.

Concluding Remarks

Transnational projects constitute a sizeable chunk of the overall global project portfolio and, with occasional exceptions, serve as relationship facilitators between states and societies. This is of no small significance in today's global village. Extending across all project categories, they share numerous commonalities with non-transnational projects but at the same time they also exhibit important differences, in particular, their higher level of comparative stakeholder management and engagement complexity. The magnitude of complexity depends on which of the five categories proposed by the authors transnational projects can be assigned to. Overcoming the challenges and complexities is possible but can only be achieved with determination, commitment and well planned, coordinated and executed strategies.

RISK ANALYSIS AND DECISION MAKING IN CONSTRUCTION CLAIMS

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Claims in construction projects are inevitable and can result in costly litigation. Construction contract ambiguity, overtly restrictive terms, and unfairly allocated risks to one party increase the likelihood of disputes. The goal of this study is to introduce a decision making framework that evaluates claim processes. This paper outlines a comprehensive list of dispute triggers in construction projects. The causal relationship between these triggers are analyzed using Bayesian Belief Networks. The introduced diagrams becomes an input to a game theoretic approach which models parties' interactions in pretrial negotiations. Then the considerations for modeling construction claims in a game theory format are elaborated. This paper concludes that the integration of Bayesian Networks and Incomplete Information Games is an effective tool to analyze construction claims.

1. Introduction

This research shows how to analyze construction claims based on parties' information and subjective beliefs on dispute case. Section 2 introduces research objectives and the questions to be answered in this research. Section 3 is a literature review on construction conflicts and defines claims from both contractors' and owners' perspectives. Section 4 introduces various mathematical models applied to analyze construction claims, types of claims and reasoning are discussed. Section 5 provides the method used to create the main framework of analyzing individual project claims. The method explains how the current categorization can be modeled in a Bayesian Network format. Then it summarizes on game theoretic analysis of construction conflicts and elaborates on parameters to be considered in modeling a claim. The last section is the conclusion and future research opportunities potential contributions in this research.

2. Research Objective

The purpose of this study is to introduce a framework to analyze claims from economic viewpoint considering causation and reasoning as key elements for disputes. Identifying such elements requires recognizing the causal relationship between parameters that may be considered by dispute parties in their decision making. Then, the significance of such parameters in the decision making process should be measured in terms of probabilities. The product will become an input to a game theoretic bargaining model. A non-cooperative game approach can analyze each party's strategies that can lead to the most desired outcomes based on their beliefs and information on a case basis.

The result of this research will be helpful for the claim parties (contractors and owners) to select the best strategies in pretrial bargaining processes that can result in a fair amount for settlement. It will also help parties to understand the main considerations in pretrial negotiation or settlement. This paper responds to the following questions: What are the chains of causes for disputes or claims? What parameters should be considered in modeling a claim? How to incorporate these parameters into the decision making process?

3. Construction Conflicts

Construction contracts face enormous uncertainties resulting from imperfect contract documents. As a result, all contract parties are obligated to collaborate conscientiously to avoid conflicts. Any misunderstanding in such collaborations or misinterpretation of contract terms and conditions may advance conflict between parties and lead to disputes. The causes for such conflicts includes, but are not limited to, incomplete or defective plans and specifications, ambiguity in contracts, overly restrictive terms, and unfairly allocated risks to one party (Rubin, Fairweather, Guy, & Maevis, 1992). If a dispute is not resolved between the parties, the conflict will be elevated in a legal format such as a claim. A claim is defined as a demand asserted by one party on another party relating to services or products specified in the contract (Barnard, 2005).

A claim can be analyzed from different traits such as engineering, legal aspects, relationships, and project constraints. Still, approaches to the issue are fairly similar regardless of the mentioned viewing platforms. Common elements that become essential in claim considerations can be briefed as monetary values, responsible party for damages, causation and reasoning, and applicable laws and contract terms or conditions. Construction claims can be on any of the four main elements of the project: cost, time, quality, and safety. All of these elements eventually translate into a monetary compensation or time relief sought by the contractor.

Claims from different parties perspective

In construction, contracts project owners and contractors firms are typically the parties involved in claims. There are some instances that involve other agencies such as Architectural and Engineering (A/E) firms, but depending on the project type A/Es have a separate contract with either owner or contractor. As a result, given the type of contract claims against the A/E firm or any other agency can be analyzed identically to the ones between owners and contractors. In general, contractors may make a claim about changes to the work, project schedule, or work means and methods. On the other hand, owners may have concerns about contractor's failure to perform the work as specified in the contract, which includes performance (time), quality, and costs.

Contractors in construction projects face a multitude of risks. Examples of these risks are inflation, inclement weather, labor problems, material shortages, accidents, and unforeseen conditions. Such risks have monetary consequences that may hurt contractor's profitability. Contractors tend to be inveterate optimists, believing that the risk is either contractually imposed upon them, or will not occur to them; or even if the risk occurs the contract clause will not be enforced (Rubin et al., 1992). This optimism behavior makes contractors to be risk takers and increase the chance of conflicts.

Owners usually take the risk on time and budget and quality. There might be additional risks beyond these three constraints depending on the complexity of the project such as environmental or regulatory issues, or public protests. There are cases that owners claim for damages against the contractor for failure to fully perform the contract, failure to pay subcontractors, completion or repairs of defective work, late project completion or costs incurred by contractor's suspension. In most cases contractors are bonded, therefore owners usually seek after bond and surety companies for any substantial damages.

Construction Claim types

The construction claim is a process which begins with dispute between parties involved in the contract (Construction Industry Institude, 1990). The study conducted by Construction Industry Institute suggested that each party has a limited knowledge of claim process. The knowledge includes an interpretation of facts surrounding the dispute, the contract, and the applicable law. Parties' knowledge on the origins of disputes and types of claims may affect their evaluation and considerations in their decision making process.

Unresolved disputes by either contract parties climb up the dispute ladder to become a claim. Disputes and claims do not always rise because of a specific issue in the project or contract. For example competitive bidding scheme and tight economic situation have forced contractors to look further into alternative methods to recover profit after winning contracts. The alternatives may include negotiations, change orders, disputes, and claims. This phenomenon is often referred as Opportunistic Bidding.

Delay, directed change, constructive change, acceleration and constructive acceleration, differing site conditions, defective and deficient contract documents, Owner-furnished items, Impossibility of performance, Interference with performance, Defective Inspection/ misinterpretation of the contract, superior knowledge. misrepresentation, strikes, weather, suspension, default/nonpayment, termination, and warranty are amongst the most common types of claims (Barnard, 2005). Each claim for a project usually is a combination of various claim types mentioned above. This paper grouped claims into categories based on terms generally defined in a contract. Knowing these types helps contract parties to recognize the potential disputes early and prevent claims by providing adequate documentation or notification.

4. Statistical Analysis on Construction Conflicts

Yiu and Cheung use catastrophe-theory-based analysis on three variables of construction conflict, level of tension, and the amount of behavioral flexibility. (K. T. W. Yiu & Cheung, 2006). The same authors applied Moderated Multiple Regression (MMR) to the mentioned three variable system (T. W. Yiu & Cheung, 2007). This model identifies thresholds for flexible individuals that are willing to avoid/resolve construction conflicts. Aibinu et al. develope structural equation modeling technique to demonstrate the influence of organizational justice on contractors' dispute tendencies and intensity of conflict. (Aibinu, Ling, & Ofori, 2011).

Cakmak used Analytical hierarchy process (AHP) to determine the relative importance of the main causes for construction disputes. (Cakmak & Cakmak, 2014). Zhang et al rank variable by questionnaires to identify a comprehensive list of claim transaction cost variables and their relative importance in the dispute process. (Lu, Zhang, & Pan, 2015). Yiu et al. applied fuzzy fault tree analysis (FFTA) approach to conceptualize the root causes of construction dispute negotiation failure. (T. W. Yiu, Cheung, & Lok, 2015). Jelodar et al. uses a three-stage approach to identify sources of dispute (Jelodar, Yiu, & Wilkinson, 2015). Nash Equilibrium on sequential offers using extensive form games (Ho & Liu, 2004). El-adaway uses multi-agent simulation models for construction dispute mitigation. The simulation effort resulted in a algorithmic framework to estimate the mean amount of the settlement based on specific situations (El-adaway, 2008).

Construction Industry Instituted (CII) has developed research to determine the relationship between project characteristics and the likelihood of contract disputes. This research resulted in a computerized model that identifies the Dispute Potential Index (DPI) of a project. DPI is a tool used to anticipate the likelihood of disputes in a construction at different stages of the project from initiation to closeout. A complementary study has been performed by Cheung et al. on the subject matter and diagnostic approaches to identify construction disputes. The result of this study is a comprehensive list of causes for construction disputes with their respective occurrence likelihood. The ranking of these causes has been determined by designing questionnaires to ask expert opinions on the causes. (Cheung & Pang, 2013). Love et al. developed a causal diagram with the factors that influence construction disputes. (Love, Davis, Cheung, & Irani, 2011).

Omoto et al (2002) analyzed the dispute resolution processes as a two-sided bargaining model with arbitration as an outside option (Omoto, Konayashi, & Onishi, 2002). Ho and Liu propose a game theoretic based model to study people behavior in different types of claims. This model is based on Subgame-Perfect Barough et al applied game theory approaches including Prisoner's Dilemma and Chicken Game to analyze construction conflicts. (Barough, Shoubi, & Skardi, 2012).

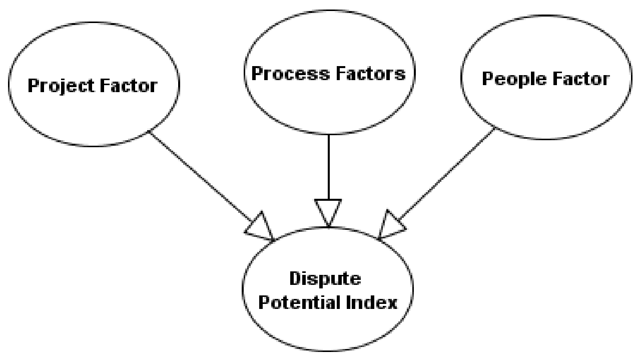
5. Method

Defining Interdependencies between causes of claims

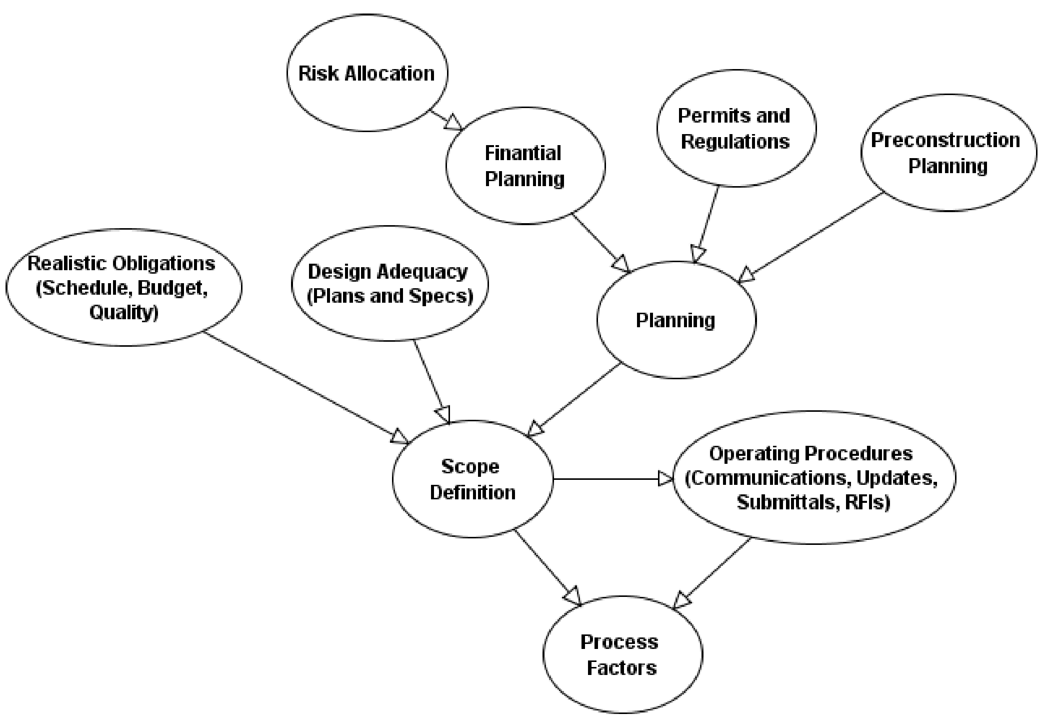
A comprehensive list of claim causes are gathered from previous studies such as CII and Cheung's researches. Then, causes are categorized into project variables that are correlated to dispute vulnerability. The variables that impact contract disputes are divided into three main groups: People, Process and Project. Issues involving People affect organizational relationships, roles and responsibilities, and individual's expectations. Process issues include all project management activities throughout the project lifecycle. Examples of such processes may include contractual language, risk allocation, scope definition, communication, and dispute resolution. Project characteristics define technical issues with the nature of the project such as complexity, environmental limitations, and unidentified project risk (Diekmann & Girard, 1994) .

Bayesian Network is a type of statistical model that represents a set of random variables and their conditional dependencies. Below is the graphic model for conditional dependencies between the causes of claims in a Bayesian Network (BN) format. There are two sets of Bayesian Networks created for owner and the contractor. The intent of the BN model is to calculate party's subjective belief on the probability of being held liable at the court. In addition, each party may calculate beliefs of their opponent on the opponent's estimates on prevailing the case. These subjective beliefs will be used in the Game theory model discussed in the next section for parties' decision making.

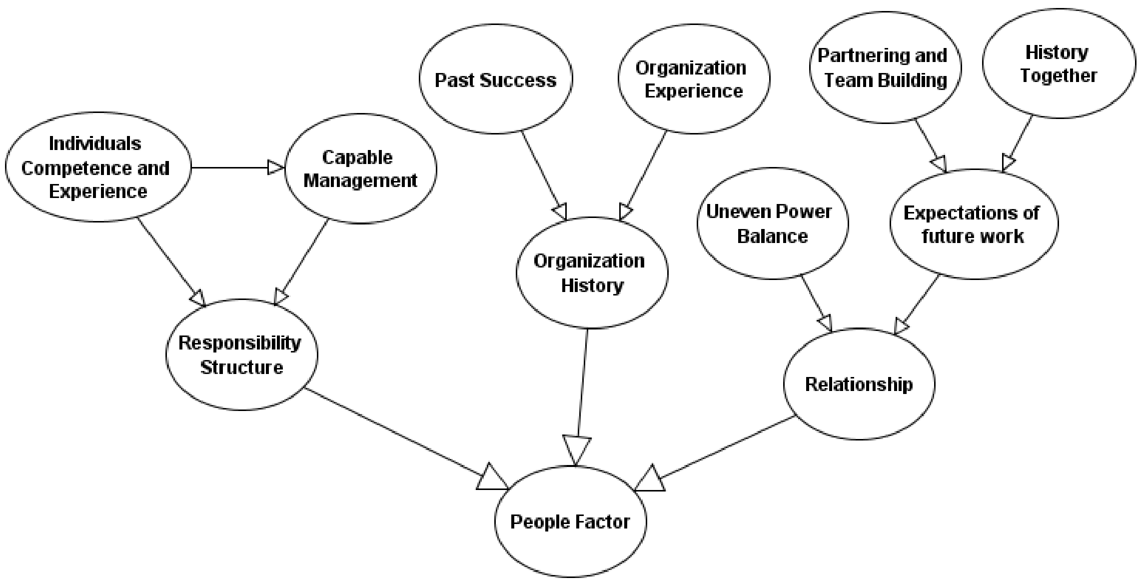
Main causes for claims



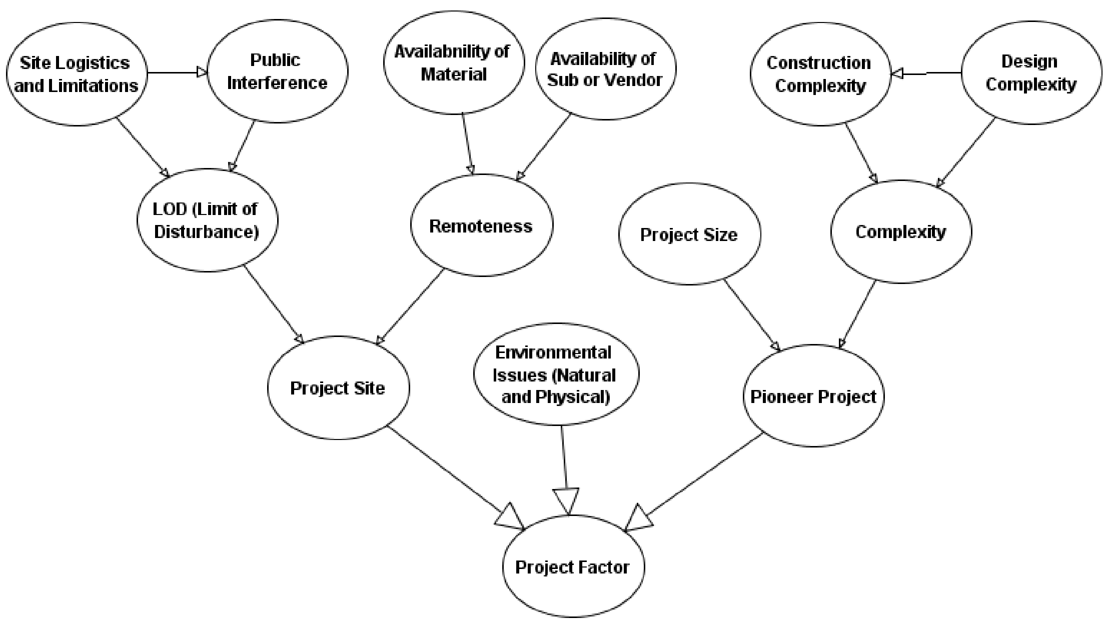
Process factor



People factor



Project Factor



Game theory Application in Negotiations

Decision theory is a mathematical tool used to identify the values, uncertainties and other issues relevant in a given decision, its rationality, and the resulting optimal decision for a single agent. Game theory, on the other hand, is a tool to analyze interactive decision making for multiple agents (also called players). In game theory each agent has a set of available actions where each action taken by any agent may affect the outcome of other agents. Game theory can model the behaviors of agents and provides best strategies leading to the best possible outcomes. This interactivity between agents is the major difference between classic decision theory and game theory models (Maschler, Solan, & Zamir, 2013).

Pretrial settlement bargaining involves interaction between the claim parties, contractors and owners. Therefore, game theory is a great tool to analyze these negotiations. This type of game is often analyzed by non-cooperative games where each agent wants to maximize its own payoff given their available options.

There has been tremendous progress on litigation decision models, where theoretical models developed mostly based on pure economic outcomes. There are various models used for such analysis that were briefly discussed in the literature review. Although, the economic outcomes are considered to be a key driver to the disputes, there are other parameters that might play a crucial role in litigation decision making. The following section is the breakdown of all important parameters in the subject matter.

Game Theoretic Analysis of Construction Claims

There are multiple variables in the analysis of claims. I found it appropriate to define all these variables to clarify different ways that settlement games can be modeled. The following discusses different types of techniques used to analyze settlement games and introduces the main variables and parameters involved in such games.

Players

The primary players of construction claims (litigants) are General Contractors (Plaintiffs) and Project Owners (Defendants). Other players that are considered in sophisticated models include judge or jury, attorneys, experts, and other contracting agents (i.e. A/E firms, Sub-contractors, Consultants, Commissioning Agents, etc.).

Actions and Strategies

Action is Parties' (players) choice on the available options at each stage of the game. For example Contractor's action can be submitting a proposal, filing for claim, or asking for settlement amount. On the other hand, Owner's actions are accepting the proposal or offer, rejecting, or sending counterproposals. Some models allow multiple rounds of actions or proposals and some other only consider the final action (take-it-or-leave-it offers).

Depending on the rules of the game there are limited allowable actions at each decision opportunity of players. Moreover, actions chosen at one point may limit future actions or transfer private information to the opponent. The set of actions each player takes during the game is called player's strategy. Players choose their strategy considering both outcomes of their own actions and their opponent's action.

Outcomes and Payoffs

The result of the strategies played by parties is the outcome. There are a broad range of outcomes, from the contractor not pursuing the claim and no amount transfer between the parties, or the judge ruling an amount to be transferred from owner to contractor.

The numerical value of the outcome associated to each party is called the payoff. In the literature, payoffs are modeled as either dollar amounts or utility functions. Using the utility function in the calculations allow us to model risk preference of the parties. In other words, by using utility function a party can be considered risk averse or risk taker.

Timing

The sequence of play and duration of the claim are the two topics of interest of the timing parameter. The early settlement models are developed mostly based on general theoretical models of bargaining processes. These models are called axiomatic, which were initiated by Nash (1950). After developments and improvements of these models, a strategic approach was suggested to capture more details of the settlement negotiations.

In the strategic approach, parameters, such as sequential versus simultaneous offers, play an essential role in the analysis. In the sequential model, each party may offer and wait for the other player's response. In simultaneous offers, actions from either party cannot be observed by their opponents, or it may not have influence on the opponent's decision for game strategy.

Another way that time can affect the settlement analysis is the duration of the claim. Disputes and claims in reality have a finite length of time. In other words, there is always a termination to the claim either by court date, settlement, dripping the case, or even by a statute of limitations (not filing the suit in a timely fashion). As a result, there are different analyses in the literature that consider multiple phases for pretrial negotiation.

Information

The information that contractors and owners have at each stage of the project can vary due to obtaining it from different sources, perceiving the current situation differently, or receiving updates on the subject matter. Information can be either on the facts of the case, opponent's estimation and beliefs, Judges' verdict, or type of the players.

If players are exactly sure about a judge's verdict in a given case being reviewed in the trial, the game is called *perfect information*. In reality none of the players can exactly predict the verdict, which is called *imperfect information*. In such games if the information is shared knowledge between contractor and owner the analysis of the game is *Symmetric*. In cases that each party obtains private information game is considered to be *Asymmetric.* Asymmetric games can be one sided (only one party has private information) or two sided.

Prediction

The main purpose of settlement models is to make a prediction about the outcome of bargaining. In the recent literature, the notion of equilibrium has been used for modeling. Most of the simplified models and earlier works in the literature used the notion of cooperative game theory, where the solution to the game should be efficient (no money is wasted in the process). Nash Bargaining Solution (NBS) is an example of axiomatic solution that applies to cooperative games. However, claims and disputes are non-cooperative conflict between the parties, and it is reasonable to analyze them with the notion of non-cooperative games. In the strategic format of non-cooperative games, players predict the payoffs conditional to the opponent's belief.

When there is uncertainty about the information, as in incomplete information games, typically each player may consider their opponents' knowledge in addition to their own knowledge on a situation; they also may consider their opponent's knowledge about their own knowledge, and so on. This notion is defined as hierarchies of beliefs in context of incomplete information games.

In this context, the Bayesian approach has been recognized as the most widely accepted statistical decision making approach for games with incomplete information (Maschler et al., 2013). In this method, players have probability distribution over parameters that are unknown to them. Actions taken by each player are based on their beliefs defined in that distribution. Players also have beliefs about each other's probability distribution, which updates their prior belief on the subject matter. As a result, an infinite number of hierarchies of beliefs form between players. The challenge of the theory is to incorporate these hierarchies of beliefs into a model.

6. Conclusion

The two main variables in claims are liabilities and damages. Liabilities often depends on the specifics of the case and contract. In other words, the probability of owner being held liable in the court is defined by project characterization. The proposed Bayesian Belief Network is an effective tool to measure the liability element. On the other hand, damages is defined by parties' behavior in the dispute process. In other words, initial proposal for the original dispute amount, settlement offers and any responses such as acceptance, rejection, or counteroffers are indicators of the damages incurred. The true amount of damages and liabilities are to be determined by the court in the discovery and decision processes; however, parties' belief on the liabilities and damages defines their expectations amounts to be paid to either settle or pursue the case in the court.

Each party may have private information about the liabilities and damages of a specific claim. The information difference causes different beliefs on parties' estimate on these two parameters. Larger belief gaps often causes parties go to the court rather than the settlement process. The information can be acquired at any point in the dispute process.

As a result the belief gap created prior to the dispute may vary over time during the dispute by acquiring additional information. Bayesian game theory is an effective tool to model such interaction between the claim parties.

Contractor and owners may not have a common prior belief over the probability of prevailing at trial and the amount of damages. The asymmetry in initial beliefs may be due to differences in each party's perception of the information they have or optimistic opinion of their lawyer on obtaining favorable verdict. These assumptions increase the probability of failing to reach an agreement in the settlement process. During the bargaining process either or both parties may learn new information revealed from discovery process or their own investigation. The new information becomes a basis for parties to update their beliefs on the amount of damages and prevailing at trial. The updated probability is calculated in the proposed Bayesian Network by defining scenarios within the model in the form of subjective beliefs. The beliefs of party on its own case and beliefs on the opponents case becomes an input to the proposed game theoretic approach. The game theory approach is being used to analyze parties' threshold in acceptable settlement ranges and to define best strategies to avoid claims and maximize outcomes given the available information.

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Collaboration Networks for Megaprojects: The Case for Skyscrapers

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Abstract: This study aims to investigate the dynamics of project networks composed by megaprojects (i.e. skyscrapers) and their collaborations of stakeholders, and to analyze the influence attributed by past collaboration experience, locations, and roles of stakeholders. In particular, a dynamic network model that includes key project features and stakeholder characteristics was developed based on 43 completed skyscrapers taller than 300 meters in China. Based on the project network, the quantifiable network relationships, the dynamic evolution, and its influence by different geographic locations were analyzed. The findings suggest a growing trend of the collaboration and help AEC companies make better decisions in selecting future collaborators.

Keywords: Collaboration networks; Megaproject management; Dynamic network; Network analysis; Project organizations; Social Network Analysis

INTRODUCTION

Megaprojects can be viewed as complex networks of actors, or heterogeneous stakeholders, including owners, designers, contractors, and so on. Lack of previous cooperation experience and dynamic organizational relationship over time within a megaproject team may further increase the risk of project failure (Flyvbjerg, 2014; Han et al., 2009; Lundrigan, Gil, & Puranam, 2015; Ruuska, Artto, Aaltonen, & Lehtonen, 2009). Therefore, how to construct an efficient collaborative team and an effective organizational network have become critical to improve megaproject performance (P. S. Chinowsky, Diekmann, & O'Brien, 2009; Ruuska et al., 2009). Meanwhile, identifying and retaining competitive in the emerging markets have become important strategies of architecture, engineering, and construction (AEC) companies, owing to the increasing competition in the AEC industry. Those strive to enhance their market competitiveness by building flagship megaprojects, developing strategic partnerships with other organizations, and increasing social capitals (Castro, Galan, & Casanueva, 2009; P. S. Chinowsky et al., 2009; Skaates, Tikkanen, & Alajoutsijärvi, 2002). Therefore, clients, design firms, contractors, and sub-contractors may form inter-organizational partnerships and collaboration networks for short-term project-based performance targets and long-term market competitiveness (Dubois & Gadde, 2000; Sedita & Apa, 2015).

Nevertheless, the formation process of an inter-organizational network is rather complicated. The network evolves dynamically over the course of project plan, design, and execution. Current research primarily focuses on stand-alone projects or cross-project collaborations of a single organization, as well as social network, communication network, and information sharing in static and homogeneous networks (Bygballe, Jahre, & Swärd, 2010; P. Chinowsky & Taylor, 2012). More research is needed to empirically analyze the dynamic networks in the AEC industry from larger inter-project and inter-organizational perspectives, in order to understand the formation mechanisms and evolution characteristics of inter-organization collaboration networks of the megaprojects under different influences.

Therefore, a case study of skyscraper projects (more than 300 meters in height) was selected to investigate the formation process and dynamic evolution of inter-organizational collaboration networks in megaprojects. Skyscraper projects are challenging due to the heavy investment, tight construction schedule driven by return on investment, applications of new technologies, and so on, and also involve hundreds of organizations that demand tremendous organization and coordination, thus is typical of the megaproject (Ireland, 1985; Kaming, Olomolaiye, Holt, & Harris, 1997; Le & Li, 2013; Wood, Tsang, & Safarik, 2014). So this study attempt to investigate the formation process and evolution characteristics of the inter-organizational collaboration network in skyscrapers.

LITERATURE REVIEW

Inter-organizational project teams or coalitions are commonly formed in the AEC industry in order to accomplish the project target. For larger projects, such temporal inter-organizations may involve a number of stakeholders. The successful delivery of an AEC project is dependent on two fundamental elements: the ability to plan and manage the technical components, and the ability of project participants to effectively form a high-performance team (P. S. Chinowsky et al., 2009). Effective communication, coordination, and information sharing are also important between each project sub-teams.

In order to reduce the trust risk and shorten the learning curve for a collaborated project, organizations expect to cooperate with competent teams with more collaboration experience. Organizational capability and collaboration experience are the key factors that influence the complexities of a megaproject. Lack of competence is a common barrier to adopt and implement relational transaction practices (Erik Eriksson, Nilsson, & Atkin, 2008), which may subsequently cause delays and cost overruns (Bosch-Rekveldt, Jongkind, Mooi, Bakker, & Verbraeck, 2011). To the organizations that seek for collaboration, previous alliances can be considered active information exchange networks in which the organizations understand the reliability and specific abilities of their present and potential partners. Moreover, previous empirical findings confirmed that the form of coalitions in the AEC industry is principally based on past collaboration experience in order for better commitment and trust (Bygballe et al., 2010; Castro et al., 2009). Research has also demonstrated that trust, including companion trust, competence trust, and commitment trust, is one of the most important social factors in inter-organizational collaborations (P. S. Chinowsky et al., 2009; Newell & Swan, 2000). Repeated collaboration practices among coalition members that are likely to share the same objectives, working methods and values. Over time, these members are able to build a collaborative community, eventually reinforced by co-location and collaborative intensity. Inter-organizational relationships between project network actors, developed over the course of multiple projects, may also lead to opportunities for learning, reduced supervisory costs and a reduced risk of project failure (Sedita & Apa, 2015). Therefore, repeated collaborations have become industry norms and best practices in constituting effective project organizations.

However, no AEC project is carried out in a vacuum situation without consideration of specific project contexts (Engwall, 2003). There may be different connections between projects, while companies are not only involved in a single project (Engwall & Jerbrant, 2003). Thus, the cross-project and inter-organizational collaboration research at macro-level is equally important as a project-based micro-level study (Phua, 2004). Such greater perspective of inter-organizational collaboration has shaped the specific supply chain relationships in AEC industry. Comparing to a supply chain in the manufacturing industry, a construction supply chain is more complex, highly specialized, and involves a larger number of key participants, such as project clients, consultants, the main and specialist contractors, and various suppliers. As the core of the project organizations, their competencies, and interests to put resources in the process and carry responsibilities are essential are successful project deliveries (Meng, 2012; Ruuska et al., 2009).

METHODOLOGY

Inter-organizational collaboration relationship is more complicated as the project become more complex. As a result, the network features of such project networks become more representative. Skyscrapers are clearly complex and large-scale projects that involve many organizations and vast financial investments. Therefore, we choose skyscraper projects as representatives of complex megaprojects in this study, to analyze the characteristics of the inter-organizational collaboration network.

We firstly created a skyscraper dataset that contains all the built skyscrapers over 300 meters in China. Over the last several years, the build of skyscraper has become an emerging megaproject market in China. Council on Tall Buildings and Urban Habitat (CTBUH) reported that 13 skyscrapers that are over 300 meters were completed in the year of 2015 globally, while 9 of them were built in China. In 2016, 6 of 10 skyscrapers that are expected to erect are from China, all of which are above

300 meters' tall. For each skyscraper project, project attributes (height, geographical location, start and complete time, etc.), core project organizations (project client or investor, design company, general contractor, specialty sub-contractor, engineering supervisor, etc.), and organization attributes (headquarter location and organization ownership property) were collected. Secondly, different network models were built based on the dataset. Using the completion date of individual skyscraper projects as the longitudinal time stamp to indicate the different formation stage of the network, the dynamic change of the whole network and individual networks were modelled and calculated through SNA. Network density, network centralization, and centralization index were examined in the whole network.

Parameters of whole networks and individual networks of SNA are usually used to study inter-organizational network. For the analysis of whole networks, indices such as density, network centralization, and centralization index are used to measure the proportion of all possible ties that are actually present, quantifies the dispersion or variation among individual centralities and betweenness centralities, and some other structural properties of whole networks. The collaboration index R_d is also proposed as follows to measure the level of collaborations based on previous performance.

$$R_d(n) = (\sum_{i=1}^{n}\sum_{j=1}^{m} S_{i,j} - S'_n)/S'_n \quad (1)$$

Where, n represents the year; m represents the number of projects; $S_{i,j}$ represents the number of construction organizations for project j in a given year i; S'_n represents the real accumulated number of construction organizations until the year n.

The data used in the study is resourced from Skyscraper Centre of CTBUH and the Mega Projects Case Study and Data Center (MPCSC) database developed by the Research Institute of Complex Engineering & Management (RICEM) of the Tongji University in China. Design organizations include architectural firms, structural firms, and mechanical and electrical firms, while contractor organizations consist of general contractors, curtain wall sub-contractors, steel structure sub-contractors, and mechanical and electrical subcontractors.

RESULT AND DISCUSSION

Collaboration Based on Past Experience

Collaboration index R_d of different types of organizations from 1996 to 2015 is shown in Figure 1. Experienced organizations started to award another skyscraper project until the fifty year. On average, the collaboration index that based on previous experience increased gradually. The characteristics of design firms, contractors, and supervisors are different despite their similar overall growth trends. Contractors have the highest index, almost twice as high as designers and supervisors. This indicates that experienced contractors have a higher chance to win new projects in Chinese skyscraper AEC market, making more difficult for new contractors to enter in the market. On the contrary, designers and supervisors have a similar trend of slow progress, indicating that there is still room for newcomers to enter the market. For instance, foreign designers constantly participate in the design competition for skyscrapers in China, reflecting the intense competition in this market.

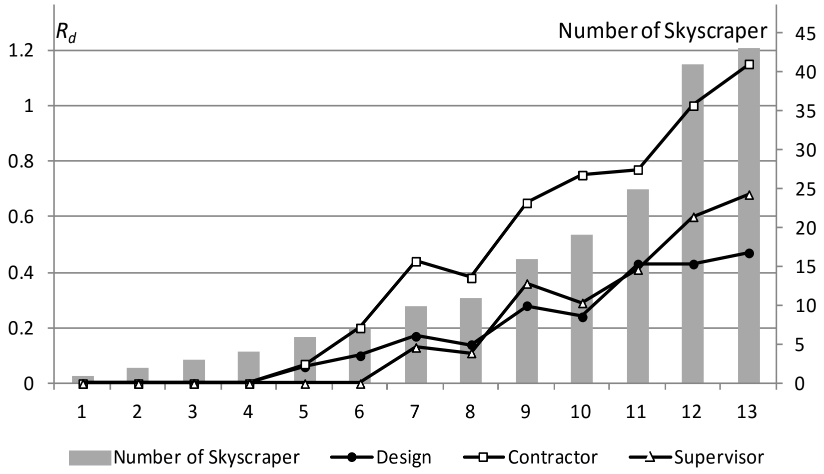

Figure 1. Collaboration index (R_d) of different types of organizations from 1996 to 2015.

In addition, the relationship of the collaboration index R_d and the number of skyscrapers shows certain correlation. The result of linear regression demonstrates that the repeated collaboration indices and the number of skyscrapers are linearly correlated, with R^2 values 0.8995, 0.9113, and 0.9547 (p-value less than 0.001), respectively. Such correlation denotes that organizations with similar project experience are easier to acquire new project opportunities as skyscraper projects increase.

Inter-organizational Collaboration Network

Typical parameters including density, network centralization, and centralization index are used to analyze the formation process, main characteristics and network evolution in the whole network. Figure 2 illustrates the trends of network centralization and centralization index over time. Network centralization of the whole network reached 7.84% in the second year and the peak 11.97% in the seventh year (Year 2009). It stayed at 8.75% averagely with a standard deviation of 0.0203 despite small fluctuations, showing the smaller differences between individuals of the whole network. This result of network centralization is reasonable when compared with other megaprojects. It is smaller than inter-organizational collaboration networks in a stand-alone megaproject, like 23.23% in the Shanghai Expo construction (Li et al., 2011), but larger that in a wider range of metropolises or megacities, such as 6.75% in a three-year (2008 to 2010) inter-organizational collaboration network of infrastructure projects in a major city of China (Li, et al., 2013). On the other hand, centralization index reflects the degree of dependence on an intermediate in the whole network. Such indicator has an overall upward trend with larger fluctuations. The peak value of the centralization index is 24.05% in this study, similar to the value in the study of Shanghai Expo (23.59%) (Y. Li, Lu, Kwak, Le, & He, 2011). The most recent value of 18.99% in this study is slightly higher than the value of 17.18% in a city-level infrastructure megaprojects in China (Y. k. Li, Chong, He, & Guo, 2013). Due to the high dependence on an intermediate in the network, the network may have "structural holes" that emerge when two separate clusters possess non-redundant information (Burt, 2009). Thus, a network that bridges structural holes can provide additional value to the network as well as the social capitals in the network.

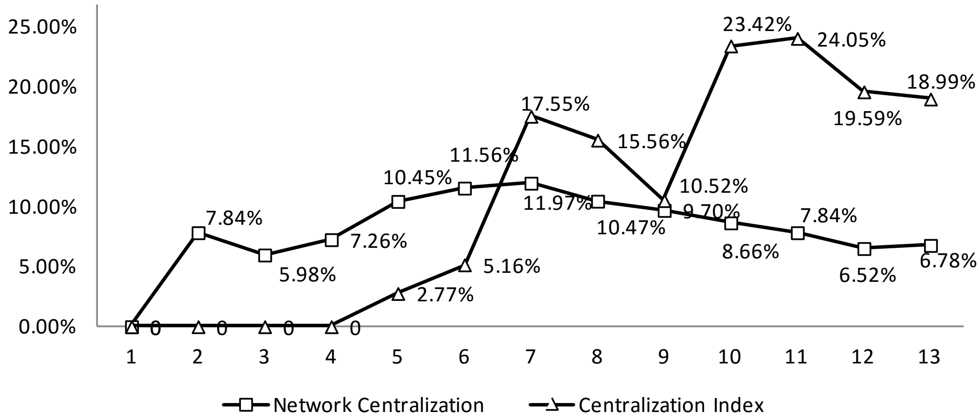

Figure 2. Trends of network centralization and centralization index of in the skyscraper case study.

We further analyzed the relationship of the number of skyscrapers with network centralization, centralization index, and network density, and the results are shown in Figures 3, 4, and 5. As the number of skyscraper projects grew, network centralization increased during the first several years, and decreased after reaching the peak number in the seventh year (year 2009), showing a polynomial function (R^2=0.86) between the two variables (Figure 3). Centralization index and the number of skyscrapers also correlate with a polynomial function shown in Figure 4 (R^2=0.88). The centralization index drops after the eleventh year (Year 2013) in which the maximum value was 25%. In Figure 5, network density and the number of skyscrapers shows an exponential relationship (R^2=0.96). The density value reached a stable 0.07 as project number increased. However, the density value of the whole network is lower than aforementioned two reference parameter, 0.3106 of Shanghai Expo and 0.1332 of infrastructure network, respectively (Y. Li et al., 2011; Y. k. Li et al., 2013), possibly owning to the loose connection between participated organizations and the disperse geographical locations of skyscrapers in China.

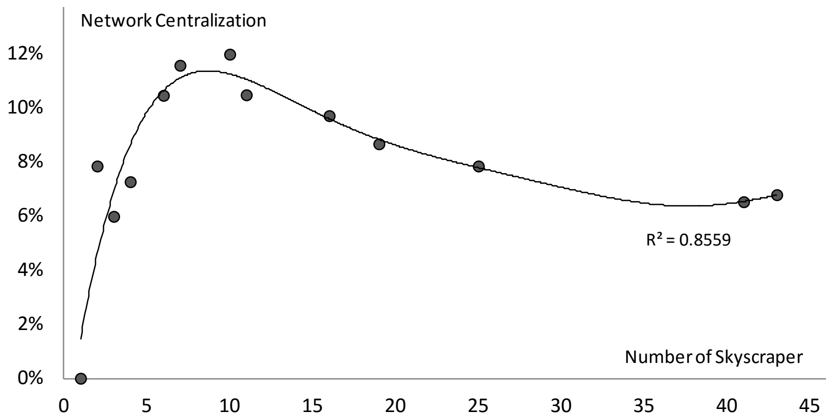

Figure 3. The relationship between network centralization and the number of skyscrapers.

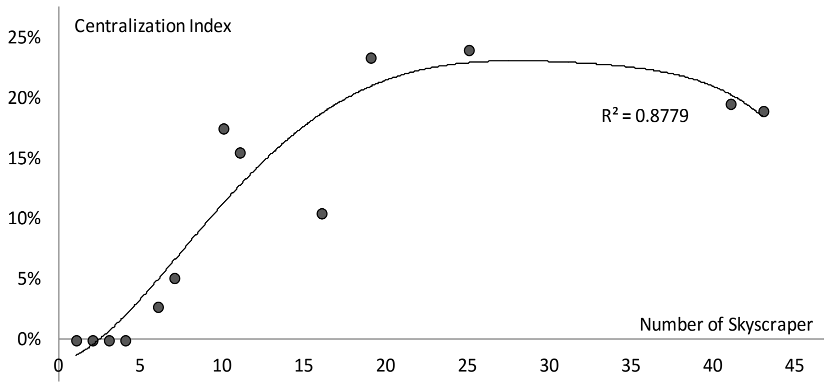

Figure 4. The relationship between centralization index and the number of skyscrapers.

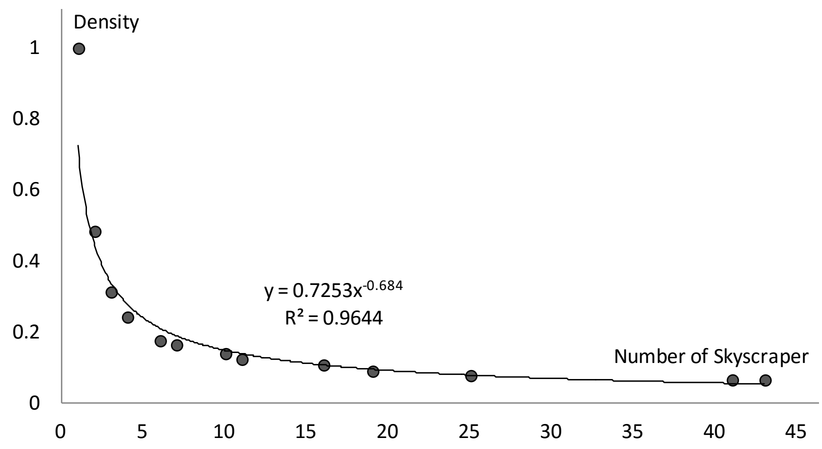

Figure 5. The relationship between network density and the number of skyscrapers.

CONCLUSION

In a specific kind of megaprojects, inter-organizational collaboration networks are gradually formed. Previous experience not only help organizations to possess important positions in the network, but also provide a better opportunity to accumulate social capitals and to increase market competitiveness. Owners and clients of megaprojects tend to choose their collaborators that have strong past experience, leading to a “winner takes all” phenomenon. At the same time, contractors are easier to be connected to better network positions comparing to design firms and supervisors which have more competitive markets.

Although several key organizations exist in the inter-organizational collaboration network of a specific kind of megaprojects, there are not much centrality differences among individual organizations and no significant change of network centralization over time, indicating that new organizations are constantly entering the market and striving to become strong competitors. However, centralization index of the whole network demonstrates an upward trend, and positively correlates with the number of the skyscraper projects, signaling possible structural holes in the network that need to be carefully examined to avoid information manipulation.

This study of inter-organization collaboration networks extends the previous emphasis on static networks and limitation of a stand-alone engineering project, to dynamic and evolutionary collaboration network. The research findings help to further understand the form and evolution of inter-organization collaboration networks in megaprojects. It will not only provide suggestions to project clients on how to constitute high efficient project team, but also offer guidance to AEC firms on how to enter and remain competitive in the megaprojects market.

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2016 UMD Project Management Symposium

How much important is IT project management for Olympic Games success? Rio2016 Case Study

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ABSTRACT

Information technology has an important role in many businesses and in Olympic Games is not different, but when we think about IT project management, immediately a question comes up. How much important is IT project management for Olympic Games success? Information technology department in general has the second biggest budget in the Organizing Committees for Olympic Games (OCOGs). Due to the improvements in sports and consequently their dependency from technology, we can say that is almost impossible to realize games without a huge technology set of products and services. Considering as well, that technology is one of the infrastructure areas that provides services to the others functional areas, manage professionally a portfolio of projects became mandatory, not only for technology, but also to the entire committee in order to achieve the games organization goals. Olympic Games is a megaproject which needs to be planned and managed based on recognized best project management practices. Scope, time, cost, and quality are the minimal aspects that must be managed for functional areas in an integrated manner. Manage IT projects it is not an easy thing, especially because IT projects are the ones with the highest rate of failure, which means that usually these projects do not achieve their goals and realize the benefits planned usually affecting companies businesses.

Keywords: Project Management, Olympic Games, Information Technology, Major Sports Events, Megaproject, Rio2016

1 INTRODUCTION

Olympic Games are a megaproject that involves and integrates many companies and resources, which means hundreds of stakeholders. Information technology in this environment has a main role providing goods and services to support stakeholders operation. Technology project management has been discussed broadly, and for Olympics success, it shows up more crucial. Organizing Committee for Olympic Games (OCOG) functional areas depend on technology goods and services to work and support their operation. Technology is one of the six Games infrastructure providers that support all functional areas, as shown by figure 1 below:

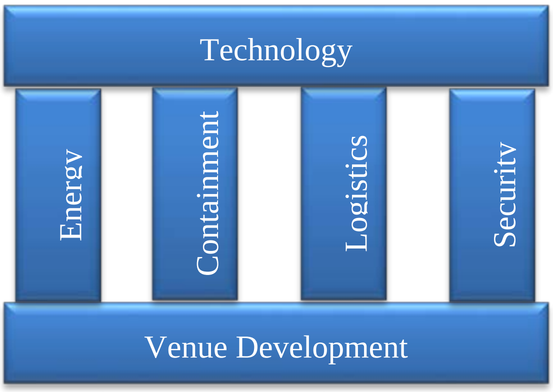

Figure 1 - Venue infrastructure providers

To provide its services to internal and external clients technology needs some suppliers and partners, which must be integrated, and aligned with Olympics project management practices, assumptions, tools, timeframes, and goals. This scenario demands more professionalism in project management, and makes it more critical to the Olympics goals achievement.

Technology has one of the biggest budgets in the OCOGs. For an example, in Rio2016 the budget is distributed according to the table 1 given below:

Table 1- Rio2016 Budget Distribution

Area	Percentage
Administration and Commercial	26%
Technology	19%
Infrastructure Projects	13%
Sports and Ceremonies	10%

Area	Percentage
Accommodation	10%
Games Services	8%
Marketing Rights and Contingencies	6%
Transport	4%
Engagement	4%

As shown in the table 1 above, technology has the second biggest budget in Rio2016 demonstrating the investment in IT and its importance to The Games (Rio2016 Organising Committee of Olympic and Paralympic Games, 2016). Without Technology supports, Games are almost impossible to be performed nowadays.

As demonstrated in the figure 1, technology depends on Venue Development, Energy, Containment, Logistics, and Security to implement its services on the venue level. This means that align assumptions, scope, and time with these areas must be the main Information Technology project management objective to turn Technology Functional Area able to provide its products and services on time, on budget, and according to the scope aligned. All of the venue infrastructure providers must have a portfolio of projects aligned among them, but the issue presented here is the timeframe of each functional area conception and its maturity on the project management. Integration it is not easy in a regular project and in a megaproject like as Olympics shows up more complex and difficult to reach, due to the quantity of stakeholders, projects, assumptions, and constraints to cope with. Another variable that comes up in the context is that IT project management must be as simple as possible to ensure its uses, and to make it possible to standardize.

In order to analyze the Information Technology project management in Olympic Games this research will try to answer the research question "IT project management impacts on Olympics Games success?"

According to the structure of this paper it will present research methodology applied, a literature review that covers project management, Olympic Games, IT project management, and project management success. It will discuss the impacts of IT project management on Olympic Games success using Rio2016 as a case study.

2 RESEARCH METHODOLOGY

The methodological approach of the research was qualitative and the main technique to collect and analyze data was content analysis from the literature review of papers on project management, IT project management, project management success, Rio2016 and Olympic Games. It was used a systematic analysis to identify keywords contained in papers selected from the scientific databases. The search of articles was based on the keywords "project management", “Project Management Success”, “Rio2016” and "Olympic Games” and the period being considered was the last 5 years.

The other technique of data collection was observation and participation of researcher and interview IT Project Managers with Games previous experience and IT clients of the Rio2016 Organizing Committee for the Olympic Games to understand the importance of IT Project Management to The Olympics business.

3 LITERATURE REVIEW

3.1 Olympic Games

Olympic Games are the most important multi-sport event in the world, which are divided in summer and winter editions. There are adults and youth Games, both of them have summer and winter editions. Summer and Winter Games happen every four years, which means that every 2 years an Olympic event happens. Future games editions are shown in the figure below:

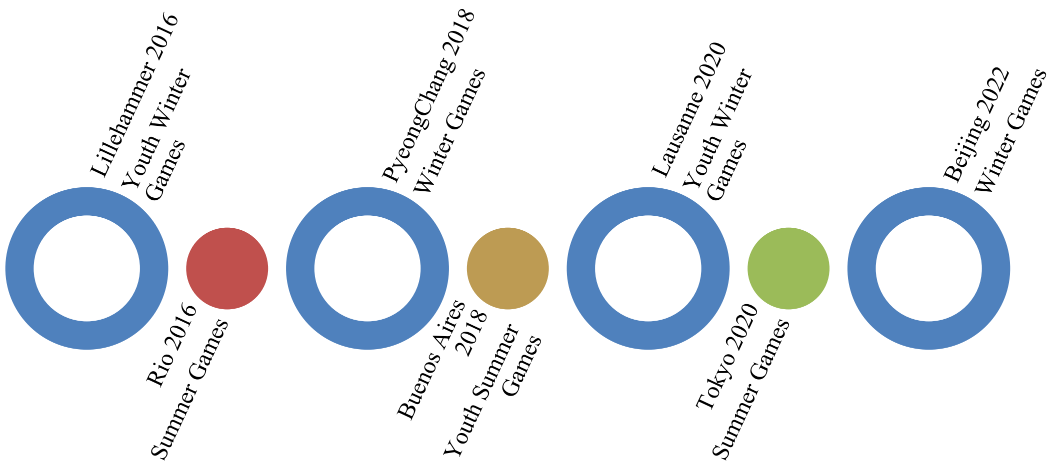

Figure 2 – Future Games Editions

International Olympic Committee is the owner of Olympic Games rights. To host one edition of The Olympics cities have to participate of the bidding process. The host city election takes place seven years before the Games, but the actual candidature process is launched 10 years before and lasts for a period of approximately three years (International Olympic Committee, 2016). Olympic and Paralympic Games happen in the same city, one after another. For example, in summer Games, Olympic Games happen in August and Paralympic in September. Olympic Games in general must demand a huge investment from the host city to build venues according to the Olympics requirements (The London Organising Committee of the Olympic Games and Paralympic Games, 2013).

Olympic Games are complex and demands project management usage since bid process (GARGALIANOS, TOOHEY, & STOTLAR, 2015).

At least, time, cost, scope, and quality must be managed in Olympic Games project in a professional manner (EAGER, 1997).

Olympic Games have been increasing every edition in cost, size, and complexity, which creates difficult to have many candidates as host cities (CHAPPELET, 2014) (MÜLLER, 2015).

3.2 Megaproject

According to (FLYVBJERG, 2014) Megaproject is a type of project that cost at least 1 billion dollars, takes many years to be developed, involves many stakeholders, and affects many people. Olympic Games project fits 100 percent on this concept.

Megaproject demands a huge investment, is risky, scope changes significantly over time, usually has public and private entities participation, and, often creates legacy, such as venues, bridges, airports, seaports, and others.

Megaprojects are well known as infrastructure projects, complex projects are another possible name, and its planning process is complex and tough to do.

Megaprojects usually become extremely complex due to the quantity of stakeholders involved in and as a result there a lot of challenges, surprises, issues, and problems to deal with (GIEZEN, BERTOLINI, & SALET, 2015).

Many projects managers have tried to keep megaproject planning as much as simple, understanding that this strategy creates a good advantage for them (GIEZEN, 2012).

3.3 Project Management

Project management is the application of knowledge, skills, tools, and techniques to project activities and tasks to meet the project requirements (PROJECT MANAGEMENT INSTITUTE, 2013).

Currently, project management knowledge and skills has been more expected and demanded from professionals especially in Information Technology field.

At least, the content of project management published by Project Management Institute via Project Management Body of Knowledge is expected to be used to manage projects.

Project management has been widely applied worldwide. Information Technology and its professionals are one of the biggest areas that invested a lot of money on tools, training, and, methodologies to improve their project management competencies.

3.4 Project Management Success

The concept of project management success is related to achieve project goals established in Project Management Plan. Usually, time, cost, and scope aspects achievement are considered in project goals and objectives. This means that if a project time, cost, and scope variables were achieved according to the project management plan, the project success is reached.

3.5 Rio2016

For the first time, South America hosts an edition of Olympics. Rio de Janeiro was chosen in 2009 to host the 2016 Olympics edition, and since there the city and Organizing Committee created by plan the Games have been working on Olympic Games planning.

Rio2016 Olympic and Paralympic Games will be performed in four regions of the city: Barra da Tijuca, Copacabana, Maracanã, and Deodoro. In these regions competitions will be performed. Main Press Center, International Broadcast Center and Athletes Olympic Village are located in Barra da Tijuca region (Rio2016 Organising Committee of Olympic and Paralympic Games, 2016).

Rio de Janeiro city is responsible to provide the public infrastructure to the Games, such as transportation. City is also responsible to build some Games venues in a legacy mode.

Rio2016 Olympic Games will be performed from 5 to 21 August, and Paralympic Games will be performed from 7 to 18 September 2016.

According to (Rio2016 Organising Committee of Olympic and Paralympic Games, 2016), Rio2016 numbers show the magnitude of the project, as given below:

- 10,500 athletes from 206 countries, 42 sports, 32 competition venues spread across for regions of the city, 39 test events, 2 technical rehearsals, 7.5 million tickets, 100,000 chairs, 11 million meals, 60,000 clothing hangers, 34,000 beds, 45,000 volunteers, 6,500 employees, 85,000 outsourced staff.

3.6 Rio2016 Technology Department

Rio2016 Technology Department is divided into 6 functional areas, as listed below:

- Technology Program Office (TPO)
- Service Delivery (SDE)
- Technology Systems (TSY)
- Results (RES)

- Telecommunication (TEL)
- Venue Technology Services (VTS)

Functional areas listed above are responsible for providing products and services based on a catalogue, which is presented to all OCOG functional areas.

Technology Program Office is the area responsible for controlling the portfolio of projects, provides support in project management to the other technology areas, develops process and procedures, creates the department governance rules and procedures, and mobilizes technology teams.

Service Delivery is responsible for technology service desk, and to provide products, like as computers and printers to the entire committee.

Technology Systems is responsible for providing applications and systems to the entire committee.

Results is the area responsible for Results Systems Test, Sports Timing and Scoring, and Results processing and distribution on the venue level.

Telecommunication is responsible for providing Fixed and Mobile Telecommunication products and services to the committee.

Venue Technology Services is responsible for collecting functional areas requirements on venue level, venue project management, requests infrastructure services, such as spaces and commodities to host technology goods and services, containment, power, security, logistics, for technology operation on the venue level

Technology department provides goods and services in competition and non-competition venues (hotels, airports, transport garage, logistics distribution center, accommodation villages, athletes village, press and broadcast center)

To provide goods and services to the others functional areas and clients, technology uses many partners and contractors, which are managed by projects.

For technology purpose, each venue is considered one project per type of event Games, Test events, and, Technical Rehearsals.

Technology goods and services provided for functional areas and clients includes: desktops, laptops, printers, radios, mobile phone, landlines, wired and Wi-Fi internet connectivity, network services, TVs, TV signal, videoboards, public and sport scoreboards, projectors, audio systems, intercom, software's, games applications (Commentator Information System, workforce planning), timing and scoring equipment, 3G dongles, tablets, Uninterrupted Power Supply (UPS) units, service desk service, and others.

4 RESULTS AND FINDINGS

Information technology provides a lot of goods and services to OCOG functional areas and clients. To deliver its goods and services Information Technology department uses project management largely. Technology tries to apply as much as possible the knowledge published in PMBOK in its projects. IT projects are managed using CA

Clarity, MS-Project, and standardized documents, and have been achieving its objectives and goals. Researcher observed that some projects were postponed, and presented delays, as often seemed in IT projects, but without significant impacts on functional areas services and deliveries.

For example, Venue Technology Manager (VTM) has a deployment plan that shows all spaces in a venue that requested technology goods and services, and TEC dependency of VED (space, air-conditioning), NRG (power), LOG (furniture), SEC (venue perimeter security) and containment. VTM is able to see the project critical path, and understand the effect of a postponing or delay in a specific cause on the project as whole. Basic project management techniques like as WBS, critical path method, PERT, resource constraints, assumptions and constraints reviews are applied in venue technology project planning.

Every Olympic Edition, functional areas are more dependent of IT goods and services, and this could be seemed clearly in Rio2016 Organizing Committee. To work on venue level since the beginning of construction Functional Areas needs to have mobile services available, at least, but usually they request much more IT support for their operation.

Time, Cost, and Scope aspects have been consistently managed by IT project managers in order to keep the projects on track. OCOG establishes that over cost usually experienced in a megaproject like this (PATEL, BOSELA, & DELATTE, 2013) is unacceptable situation, and based on that IT projects have been led to achieve the cost goal, at least, but ideally, projects must have savings. OCOG functional areas, clients, partners, IOC, and technology project managers interviewed considered IT project management highly important to Olympic Games success due to the broadly usage of IT by clients, and, the sports competition technology dependency. There is no functional area without technology support, as well as, sport that could be performed without technology support.

5 LIMITATIONS

The study was conducted only in Rio2016 Organizing Committee, which makes difficult the extrapolation of results and findings. A study including more OCOGs must be performed in order to extrapolate the results.

6 CONCLUSION

Organizing Committees for Olympic Games have been increasing their dependency of Information Technology goods and services every Games edition, due to the improvements in sports and clients and customers demands by information availability. Information Technology departments, companies and professionals have been investing a huge amount of money to improve their project management competencies and Olympic Games business has been following this tendency. In Rio2016 researcher observed that Information Technology issues could impact on the entire committee, and because of this Information Technology department has been applying modern project management techniques to ensure to its clients that IT projects will be delivered according to the objectives and goals established and agreed with clients. A small failure in IT projects can stop sport competition, impact on ticketing sale, generate errors on timing and scoring results capturing, processing and publishing, as well as, all mobile, radio, and network telecommunication services. Due to, the importance of IT services and products and it is largely impact on Games services, OCOGs executive boards have been demanding more professionalism to the IT departments. Technology project management success or failure affects directly on Olympic Games success and OCOG, partners, and sponsors image. By this reason, IT project management has been considered highly important to the Olympics, by OCOGs and IOC.

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Managing Owner's Cost and Developing Earned Value Metrics

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Abstract

The presentation is focused on the development of a total project cost management system for an owner using a case-study of a local DOT agency. The paper outlines a set of processes that were implemented to manage costs from the design stage transitioning to construction and closing out the project. The presentation further discusses several data points tracked from an engineer's estimate (developed during design phase) that are used to derive a conceptual cost estimate for future projects with similar items. The item costs during the construction phase is validated using quantities summarized on a monthly basis in the form of a 'Progress Estimate'. The progress estimate costs are utilized to develop the burn-rate used to forecast the project's health, calculate earned value metrics and pro-actively manage contracts and change orders. Additionally dashboard style reports were developed to display earned value metrics using real-time project information. Our discussion involves challenges faced in areas of cost management concepts, communication, information sharing, and the consistent use of defined processes by sections within departments.

Contents

Introduction:

AACE International defines total cost management (TCM) as follows:

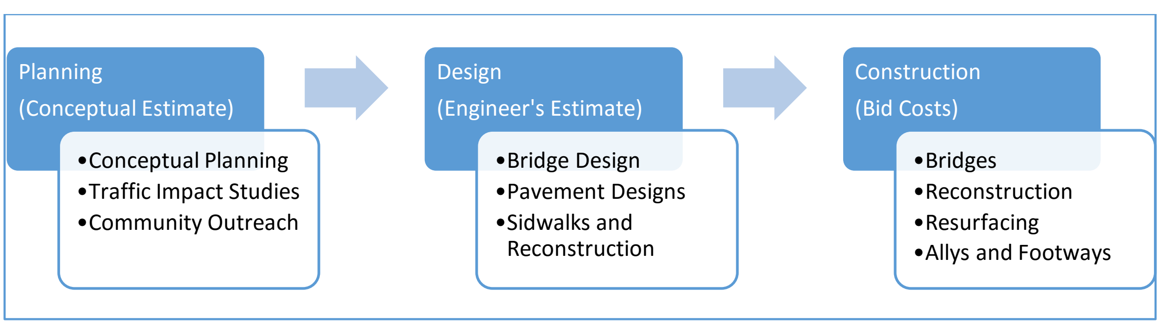
"Total cost management is the effective application of professional and technical expertise to plan and control resources, costs, profitability and risks. Simply stated, it is a systematic approach to the managing cost throughout the life cycle of any enterprise, program, facility, project, product, or service. This is accomplished through the application of cost engineering and cost management principles, proven methodologies and the latest technology in support of the management process."[i]

There are several publications including Project Management Institute (PMI) that provides guidelines to support an owner/agency in developing a framework to support cost management through the lifecycle of capital improvement projects.

Owner/agency organizations supported by civic tax funds are faced with challenges that include the implementation of defined internal processes, assigning staff resources with required skills and communication protocols that must be seen to be transparent. Total Cost Management for an organization touches almost every aspect of its operations including managing projects/programs (project management), managing internal and external resources (resource management) and costs accounting (finance/fiscal management). In this case study the existing internal process for obtaining additional funding when a contract exceeds its budget is both time consuming and paper intensive. Having the ability to estimate project costs and establish more accurate budgets and Engineer's estimates greatly enhances successful outcomes for the agency's program. A cost management system that uses data for bid items from previous similar projects will provide that ability.

Prior to establishing a Cost Management, and eventually a Project Management Information System it is necessary to understand the culture of the organization. The culture defines the degree to which the PMIS will be combined with existing tools and placement of resources with needed skill sets. It is equally important that such initiatives are supported by the highest levels of an organization and backed up with robust training and skills enhancement plans. Dependent on the organization, a project is conceptualized in multiple ways and sometimes takes years to materialize. This article is a discussion and a record of experience in establishing a cost management system for an organization that is engaged in regional public works projects using traditional (design – bid – build) project delivery method.

Figure 1 | Project Life Cycle for the Organization:



Organization Challenges:

Owner agencies are mandated to maintain a transparent and auditable accounting of all project costs, including conceptual costs during the planning stage, an engineer's estimate at the design stage and bid costs during the construction stage. The following is a list of challenges faced during each stage while implementing a cost management system.

Planning Stage

- Planning phase estimates are performed in isolated silos and are conceptual at the best. These estimate or goals are not clearly communicated to the next phase. Usually planning initiatives results in multiple projects generated for design and construction phase.
- Engineering designs are performed by design consultants; who are required to utilize uniform cost category (UCC) values to identify project items. However the lack of enforcement in using the UCC codes leads to inconsistency with bid items for construction phase.
- Inconsistency in using UCC creates during design phase leads to delays in identifying bid items (pay items) with issues during construction phase.

- Design Stage
  - The design project manager lacks resources to develop project estimates during the design phase and lack the ability to validate a project estimate prior to the advertisement for construction. This is a major budgeting issue for an agency in forecasting a construction budget which is dependent on an engineer's estimate and has to be finalized prior to the advertisement.
- Construction Stage
  - The construction supervisor lacks the tools and resources to track and compare prices on on-going construction costs. The contractor submits the progress payment on a monthly basis along with their schedule update. The internal process to approve a contractor's progress payment takes more than 30 days and therefore on a mid to small size project at any given time the approved cost data is lagging almost 60 to 90 days from the current date.
  - The legacy processes and tools caused delays in reporting real-time project status. This leads to the organization reacting to manage project issues rather than being pro-active to address real concerns.
  - Weekly and monthly project status meetings do not provide any useful information and the lack of real-time project data prevents the organization from managing costs efficiently.

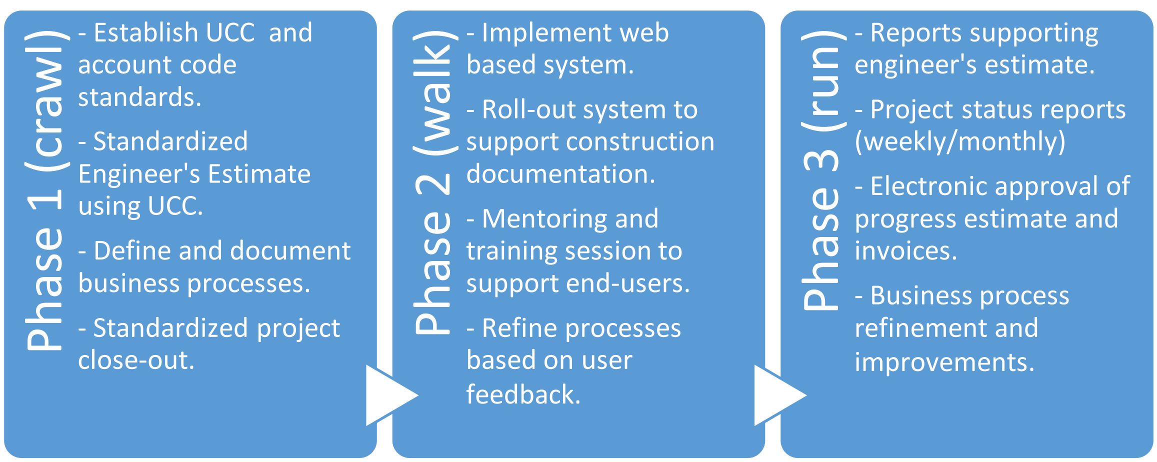
Owner's Perspective:

The goal was to develop or update a cost management system and to bring current business processes up to speed in time for project delivery while being able to utilize current technologies to support cost management through the project life cycle. The intent is to develop an integrated system. The system includes modifying business processes and deploying tool sets to streamline development of project costs from an engineer's estimate, then tracking project bid costs through the award process and tracking actual costs through the construction phase.

Objectives to develop a cost management system are includes the following:

- Utilization of UCC from the design phase to standardize cost items for tracking managing through construction phase.
- Develop and modify business processes to manage and track project costs and funding sources from planning to construction phase.
- Develop internal resources and training plans to support and educate users with cost management concepts and benefits to overall organization.
- Provide a set of tools for the design project managers to review the engineer's estimate using a combination of data points collected from past engineers' estimates, contractor's bids as well as actual construction costs.
- Provide and develop a system to allow the construction inspector to record pay items through the use of a daily report and the construction supervisor to approve recorded pay items on a monthly basis to develop project estimate.
- Develop reports and dashboards to provide current project status with cost and schedule comparison along with the ability to forecast cost projections.
- A three phase approach was taken to develop cost management system for the client.

Figure 2 | PMIS Phase



Establishment of UCC:

The uniform cost category (UCC) existed in the agency in different forms. The three digit item codes were established almost 20 years ago to group project items with construction divisions. The following table provides list of general items grouped by cost category.

Table 1 | Cost Categories

Cost Category	Description
100	General Requirements Items
200	Excavation and Concrete Items
300	Storm Drain and Utilities Items
400	Bridge Items
500	Asphalt Concrete Items

600	Miscellaneous Concrete Items
700	Landscape Items
800	Signs and Signals Items

The agency defined higher levels of cost categories. Design consultants on their discretion further identified cost (pay/bid) items as related or needed for the work scope. There was no consistency by design consultants in organizing cost items. The method adopted was different between consultants and between projects designed by the same consultant. The lack of consistency made it almost an impossible to generate an agency wide cost control system using cost categories. We found that the end product was achieved by a mixing of cost codes. The consultants used code numbers from a past project or a number that was available from a numerical sequence. Items numbers used consistently on project by a consultant A would not match with similar scope items designed by consultant B.

The agency internal accounting (fiscal) was managed using a 26 character cost account code associated with each project. The 26 character cost account code was divided in to the following categories.

Table 2 | Account Codes

Account Code Categories	**Description**
Segment 1 (4 character)	Department ID
Segment 2 (6 character)	Project ID
Segment 3 (4 character)	Section ID
Segment 4 (6 character)	Funding Source ID
Segment 5 (6 character)	Type of Cost ID

Implemented Solution:

In order to implement a permanent solution and to achieve the desired goal, our first step was to identify characteristics and requirements for both UCC and account codes. The UCC code is also called bid codes, bid items, and cost items; these terms are used interchangeably in this discussion.

UCC:
The UCC codes define items with a desired measure of units associated with each item. Such a system is not new and has been adopted by several local and state agencies throughout the nation. The purpose of publishing a UCC is to provide a uniform (consistent) value or a code that can be tracked across multiple projects as well as throughout a project life cycle.

The agency adopted a hybrid version of a UCC structure that keeps the old cost categories as pre-fix and suffix of 3 digits would allow identification of a specific items.

Figure 3 | UCC Categories

Cost Category			Item Number		
1	2	3	4	5	6

For Example:

400 340	Steel HP 10 x 42 Bearing Pile	LF
200 010	Class 1 Excavation	CY
300 090	Flowable Backfill for Utility Cuts	CY

The UCC process resulted in a list of 3,600 standard items used by the agency in the past 20 years. This list consisted of line items, its description and units of measure. Design consultants were asked to utilize similar lists in preparation of an engineer's estimate; which is a requirement of design submissions. The agency followed up with several training sessions for design consultants as well as in-house design project managers (agency staff) to educate and promote the use of UCC codes for future projects.

Initially there were several challenges faced as the change was a daunting task for the agency. However quick adoption by design consultants eased the transition to the use of UCC. During initial roll-out there were several items that needed to be modified and added to the list to accommodate items missed during the prior internal review. Design consultants used 'other' as a type of cost category quite frequently. As a result, several iterations were required to revise and fine tune the engineer's estimate classified by UCC. As mentioned earlier the Engineer's estimate is now a requirement for Project Scope and Estimate (PS&E) deliverable. It required consistent efforts from the agency project managers to curtail the old practice and drive the use of the correct UCC to support cost management throughout the project life cycle.

The benefits of utilizing a UCC includes a readily available standard code for items of work, which can be used to track costs through project development life cycle. It allows an agency to record estimated costs of a project at various design stages, record costs of bids, calculate the spending rate through actual costs as well associated change order costs. Recording these various data points allows an agency to develop certain project specific trends to improve the accuracy of the Engineer's estimate and budget planning for project delivery. The integrated system stores costs at all data points in a centralized system which is then used in various reports to support the owner agency decision making.

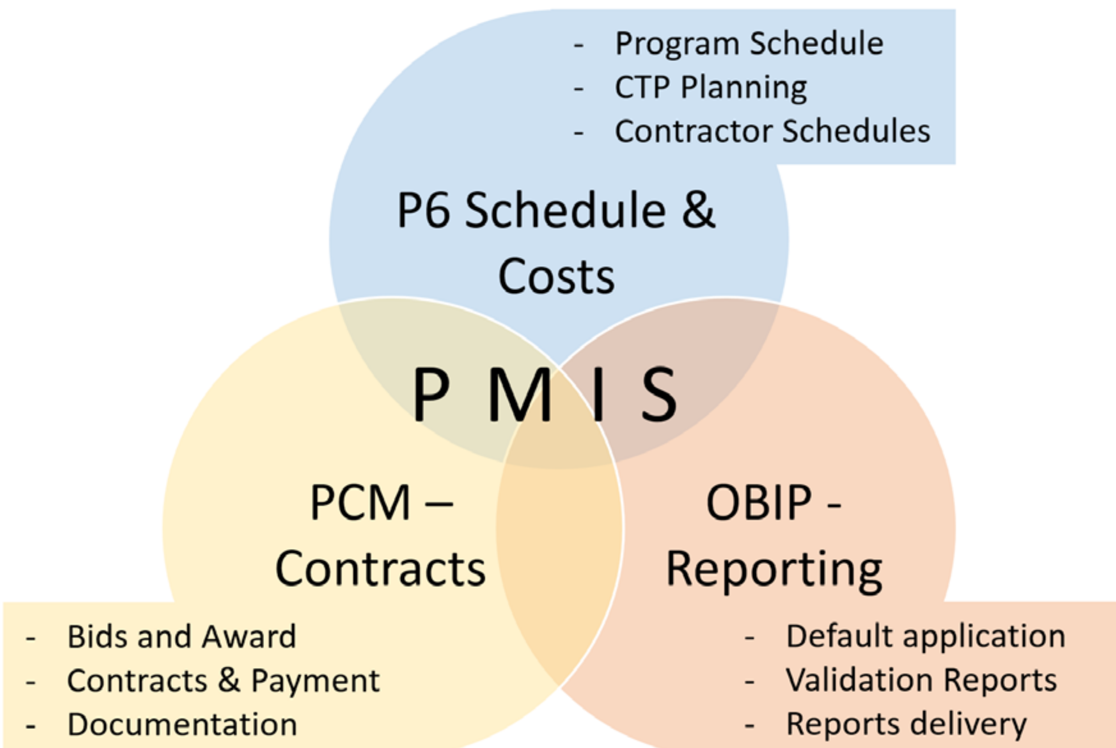
Account Codes:
It was envisioned that six characters of the UCC code will become part of a 26 character account code. However, due to requirements of the accounting system and processes of the accounting department; it was determined to tag cost items in an integrated system. This allowed flexibility of assigning one or multiple account codes. There was no change proposed to the accounting system or account codes during the implementation. Several reports to support the accounting

department and processes to award contracts and payment estimates were modified so that account codes are included in the integrated system.

Technology:

As the UCC and account codes were finalized; the agency invested in a web-based system using an off-the-shelf product. The integrated system is defined as the Project Management Information System (PMIS). The products selected included Oracle-Primavera Contract Management - Release 14.1 (PCM) and Oracle-Primavera P6 - R 8.4 (P6). The proposed systems were integrated using custom development to support certain functionality required by the agency. It reported data collected by these applications using Oracle – BI-Publisher – a default reporting tool. The following infographic displays the integration of the various applications to support cost management.

Figure 4 | PMIS Components

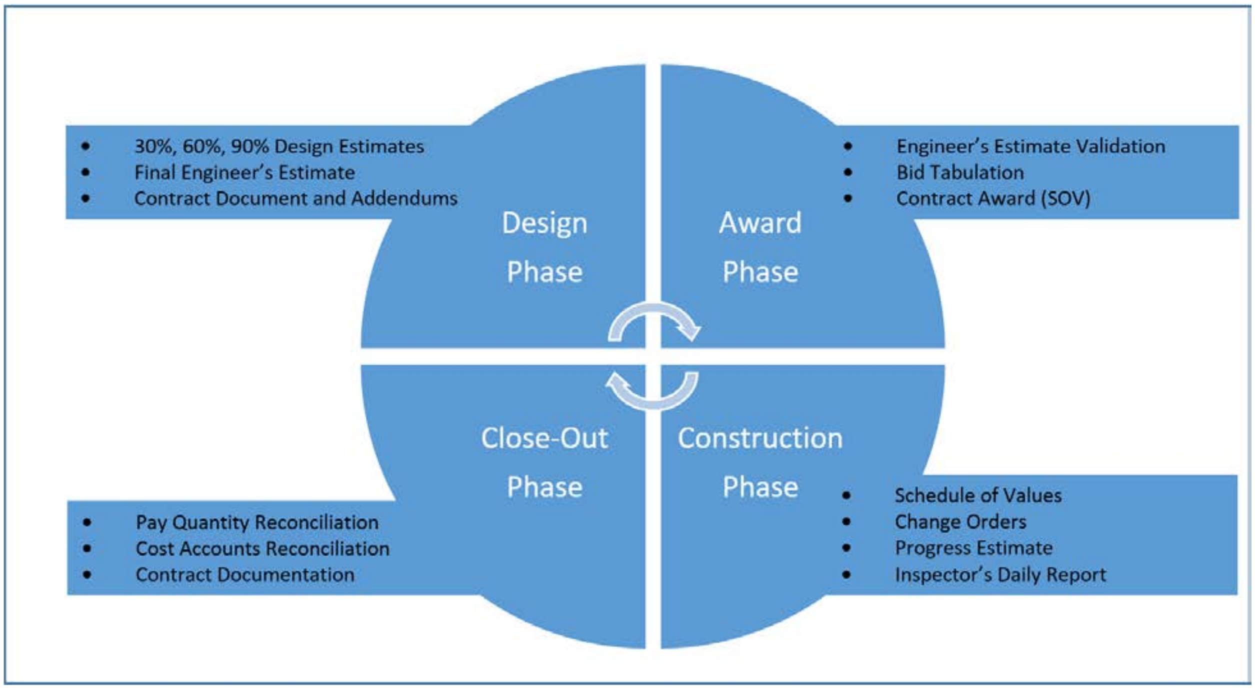


The PMIS consisted of off-the-shelf product, however each application was customized and configured specifically to meet the agency's requirements. One aspect of such configuration change involved renaming some of the native fields in PCM including a module such as Bids and Award for agency's utilization. The Bids and Award module allowed the agency to record engineer's estimate linked with accounting codes and UCC code values to establish basis for the contract and subsequently consumption in IDR and progress payment. After the advertisement, the module is used to record contractor's bid to be compared against each and with engineer's estimate. The module also allowed to generate or create a contract document between the agency and the selected contractor with contract line items. These contract line items carried the association with UCC code established at the time of preparation of engineer's estimate. Such built-in functionality allowed the agency to promote the use of UCC code across departments thorough the life of a project.

Cost Management:

To develop a complete cost management system for an agency, several modules of these applications were used and a few custom solutions were embedded to support the agency practices. The use of these application in development of cost management solution is the focus and not on implementation of PMIS.

Figure 5 | PMIS and Project Phases



In addition to the phasing of the project life cycle, the cost break-down structure for the agency includes three distinct silos.

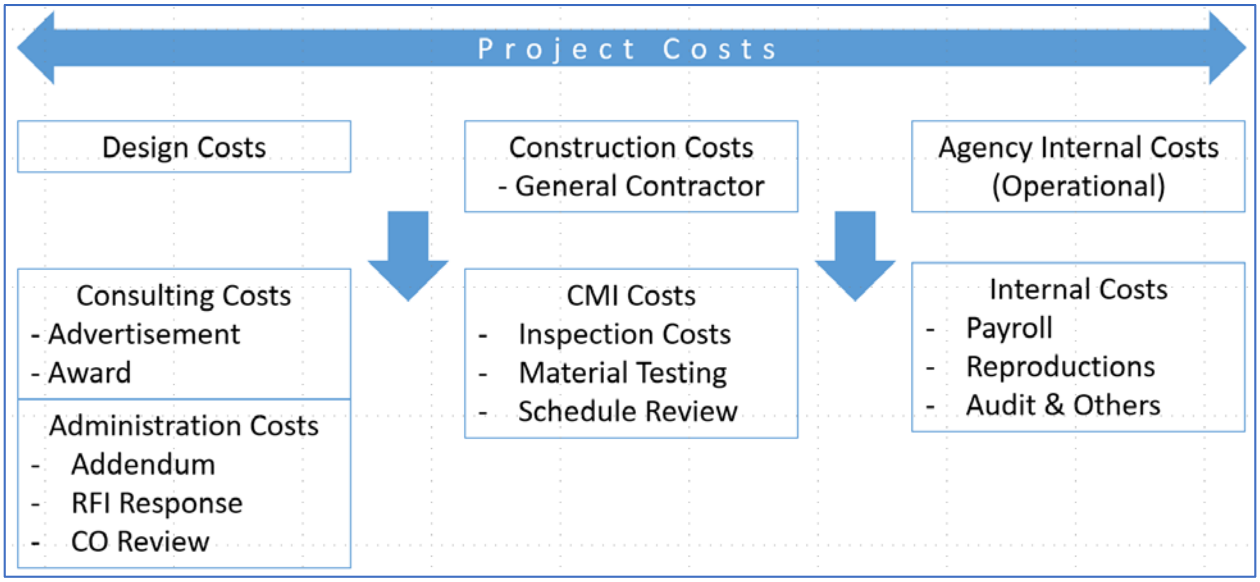
Operational Costs:

At the time of this implementation, the agency's finance system would record agency's direct or indirect costs related to the design or construction projects under the operational budget for the agency. There are several factors that needs consideration prior to including operational costs associated with the project within the project costs accounting. The focus of the agency is to be able to manage project costs and eventually include operational costs distribution with project costs.

Design Costs:

The design costs are estimated by the design project manager at the start of the project. However, due to the nature of the work these estimates are actually an estimate at the best and are often modified due to specific design aspects of the project. The account codes are generated at the time of award of design of a project. The codes are used to track the award costs, associated addendum (change order) and invoices (actuals) costs for the design portion of the project. The design disbursement of payments includes funding for advertisement and the award phase of the project. This forms the basis of cost tracking for the project.

Figure 6 | Project Costs



The design costs continue to accrue through the life of the project. During the award phase design costs are associated with preparation of contract item addendums, response to bidders, organizing pre-bid meetings and participation of construction bid evaluation report. The relative accuracy of an engineer's estimate is needed to establish the budget for the construction phase.

The challenges faced to track project specific design costs are listed below.

- Design consultants more often combine invoices for multiple design tasks awarded under a single design contracts. To mitigate this issue a unique task identifier was generated at the time of design task award. The consultants were required to submit separate invoices for each task including hours associated with the task. This resulted in accurate accounting of actual design costs associated with the project.
- Design consultants would not submit an invoice if the amount for the invoice is negligible or the amount is included in an invoice for another project. This issue is understandably a concern for both design consultant and the agency; however in order to support accurate project reporting it was mandatory that design consultants submit design invoices on a monthly basis when the invoice amount is greater than $500. In the event an invoice amount is less than $500; consultants were allowed to carry forward the amount in a future invoice for the project.

The future phase of PMIS implementation would include design consultants uploading/emailing the monthly invoice to be captured and stored in the PMIS.

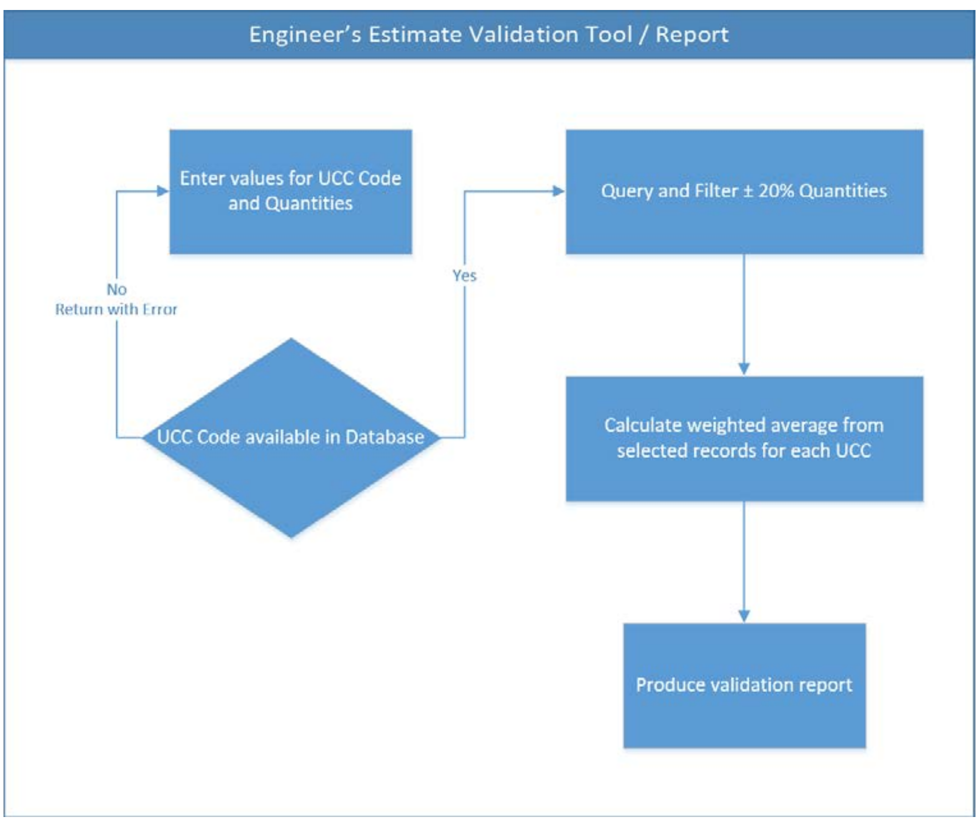
The design costs also includes costs associated with the advertisement of the project, community outreach activities and construction contract award activities. This phase includes all associated costs up to when the construction contract is awarded. The costs incurred by the agency related to advertisement and award falls under operational costs while costs incurred by the design consultants are included in the design phase. This separation was not desirable due to minimal amount associated with the ad and award process.

The PMIS would provide an interactive tool to a design project manager to generate a report based on UCC code information to verify the accuracy of the engineer's estimate. This report ties the UCC code value with costs from different phases, different bids, schedule of values and change order costs to derive an estimated cost for any of the selected UCC codes. The deliverable from a design consultant includes engineer's estimate as part of PS&E package, which is recorded in PMIS along with account codes and UCC values in the Bids and Award module. The record from the engineer's estimate forms the base for recording bids, schedule of values and change orders for the project and managing costs for construction project.

Estimate Validation Tool:

The custom developed report through a window allows users to enter one or multiple UCC codes for an engineer's estimate validation. The unit costs are derived based on the average unit costs of historical records depending on the quantities entered in the input form. The report identifies all items (including contract items, change order items, and forced account items) that has quantities within a 20% range of quantities entered. This method provides additional check for accuracy in validating the engineer's estimate and eliminates any fluctuation due to outliers. The following flow chart indicates the reporting process utilized to develop a validation tool for the engineer's estimate.

Figure 7 | Projects Flow for Validation Tool



The analysis utilizes a method which accounts for estimated quantities thus improving accuracy of the estimated costs. Once the unit costs are derived, the estimated costs are simply calculated using multiplication with the quantity entered in the validation tool. The following is an image of a sample report of validation tool.

Figure 8 Validation Report

Engineer's Estimate Validation Tool

Project Name: Test Project 1234

Advertise Date: 01-Feb-16

UCC ID	UCC Description	Unit	Quantity	Unit Price	Estimated Costs	No. of Items
400 340	Steel HP 10 x 42 Bearing Pile	LF	200	$ 47.69	$ 9,538.00	12
200 310	Class 1 Excavation	CY	4,500	$ 34.43	$ 154,935.00	7
300 090	Flowable Backfill for Utility Cuts	CY	750	$ 20.00	$ 15,000.00	3
					$ 179,473.00	

Report Date: 02/01/2016

The general formula to derive unit price is based on standard weighted average of available units and unit costs.

Equation 1 Weighted Mean Average

$$Weighted\ Mean\ Average\ (X) = \frac{\sum_{i=1}^{n} WiXi}{\sum_{i=1}^{n} Wi}$$

Bid Costs and Evaluation:

The Engineer's estimate along with account codes and UCC values are recorded in the Bids and Award module in the PMIS. Bids from the contractors are verified for its compliance with the contract requirements and then recorded in to the PMIS alongside of engineer's estimate for each contract line items. The PMIS allows cost comparison between bids within the project. However additional reporting functionality allows the project manager to compare bid items using a UCC code alongside costs from other projects from same contractor or average of costs to date. Such a comparison allows the agency to develop a trend and identify uneven pricing for unit price items.

The following is a report with attributes that were generated to support informed decision making process for contract award.

Figure 9 | Bid Costs Comparioson Report

Project: Resurfacing Urgent Needs

	ITEM #	LINE ITEM	QTY	UNIT	PRICE	TOTAL	ENG ESTIMATE	ENG TOTAL	DIFF	% DIFF	Suggested UP
XYZ LLC - Bid # :1	100470	MAINTENACE OF TRAFFIC	1.00	LS	$150,000.00	$150,000.00	$66,000.00	$66,000.00	$84,000.00	127.27%	n/a
	100530	ARROW BOARD PANEL	200.00	UD	$25.00	$5,000.00	$45.00	$9,000.00	-$4,000.00	-44.44%	$ 155.00
	100010	CLEARING AND GRUBBING	1.00	LS	$5,000.00	$5,000.00	$5,000.00	$5,000.00	$0.00	0.00%	n/a
	100000	TRAFFIC CONTROL SIGNS	200.00	SF	$16.00	$3,200.00	$12.00	$2,400.00	$800.00	33.33%	$ 20.00
	100840	DRUMS FOR MAINTENANCE OF	100.00	EA	$80.00	$8,000.00	$40.00	$4,000.00	$4,000.00	100.00%	$ 65.00
	100520	HOT MIX ASPHALT FOR MAINT	5.00	TON	$200.00	$1,000.00	$500.00	$2,500.00	-$1,500.00	-60.00%	$ 375.00
	100250	AGGREGATE FOR MAINTENACE	75.00	TON	$75.00	$5,625.00	$140.00	$10,500.00	-$4,875.00	-46.43%	$ 110.00
	100220	CELLUAR PHONE	3.00	EA	$1,500.00	$4,500.00	$1,000.00	$3,000.00	$1,500.00	50.00%	$ 1,000.00
	100230	DIGITAL CAMERA	1.00	EA	$800.00	$800.00	$1,500.00	$1,500.00	-$700.00	-46.67%	$ 1,500.00
	100160	ENGINEER OFFICE NO. 2	1.00	LS	$10,000.00	$10,000.00	$15,000.00	$15,000.00	-$5,000.00	-33.33%	n/a
	100140	CONSTRUCTION STAKEOUT	1.00	LS	$10,000.00	$10,000.00	$5,000.00	$5,000.00	$5,000.00	100.00%	n/a
	100860	PORTABLE VARIABLE MESSAGE	400.00	UD	$65.00	$26,000.00	$300.00	$120,000.00	-$94,000.00	-78.33%	n/a
	100830	TEMPORARY ORANGE CONSTRUC	500.00	LF	$3.00	$1,500.00	$10.00	$5,000.00	-$3,500.00	-70.00%	$ 10.00
	100245	TEMPORARY PAVEMENT MARKIN	20.00	EA	$150.00	$3,000.00	$140.00	$2,800.00	$200.00	7.14%	n/a
	100345	REMOVAL OF PREFORMED PAVE	2,500.00	LF	$2.00	$5,000.00	$0.50	$1,250.00	$3,750.00	300.00%	n/a

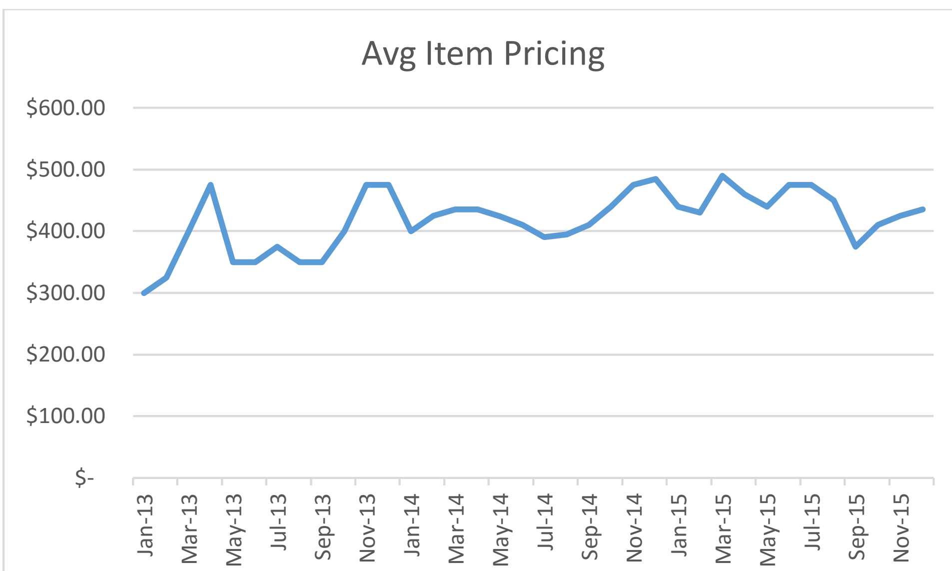
Reports similar to shown earlier supported DOT's project manager's to compare cost items across all projects and across all companies using past bids and actual project costs. Such reporting allowed DOT to develop long-term trending for cost analysis not available previously and to identify uneven and unbalanced bids. An unbalanced bid is one containing lump sum or front end loaded bid items which do not reflect reasonable actual costs plus a reasonable proportionate share of the bidder's anticipated profit, overhead costs, and other indirect costs, which the contractor anticipates for the performance of the items.

There is no prohibition per se against a contractor submitting an unbalanced bid unless the agency has adopted a specific contract requirement precluding heavy percentages of cost on items performed early in the project. Such unbalanced bids may appear to be the lowest ultimate costs to the agency, however it may not be accepted due to uncertainties and reasonable doubt in performance of work and intention of the contractor.

The availability of on-demand reports to provide trend analysis allowed the agency to either reject the unbalanced bid or develop supporting documents for negotiation. Such trending allowed the agency to be better informed in negotiation of change orders, force accounts and review of engineer's estimate. The data warehouse of cost information tagged with a unique value in terms of UCC codes provides a tool that the agency would leverage for costs related project decisions.

The following is an example of trending report developed for regularly used construction items.

Figure 10 | Trending of Item Pricing



Construction Costs:

The construction costs are derived from the winning bid for the construction of the detailed design in the bid drawings. The agency has an internal process to advertise, collect bids, bid review and notice of award for each construction project. The PMIS plays a vital role in the agency's effort to manage and control costs providing real-time costs information linked with schedule activities. The challenge for the agency is to have the ability to reconcile installed costs with budgeted costs in real-time, usually installed costs are not available. The agency relies on approved progress estimates along with approved schedule updates to track and monitor progress; thus the agency relies heavily on the contractor to provide information for estimate and schedule updates.

Installed Costs:

Collecting and reporting installed costs on real-time basis is the real challenge for the agency. The solution using PMIS relied heavily on inspector's daily report (IDR) data to develop real-time costs information. Pay items of the awarded contract are made available in the IDR module for field inspectors; that allowed inspectors to record daily installed quantities on a daily basis.

The quantities recorded by inspectors are summarized in the report and combined with the unit price from the budgeted contract to provide real-time installed costs. UCC code values of each line item was configured to be a primary key linking budgeted cost items with installed items. The IDR module would allow a record using quantities that are in budgeted contracts and approved change orders. The total available quantities for installation is current using this method.

CPM Schedule:

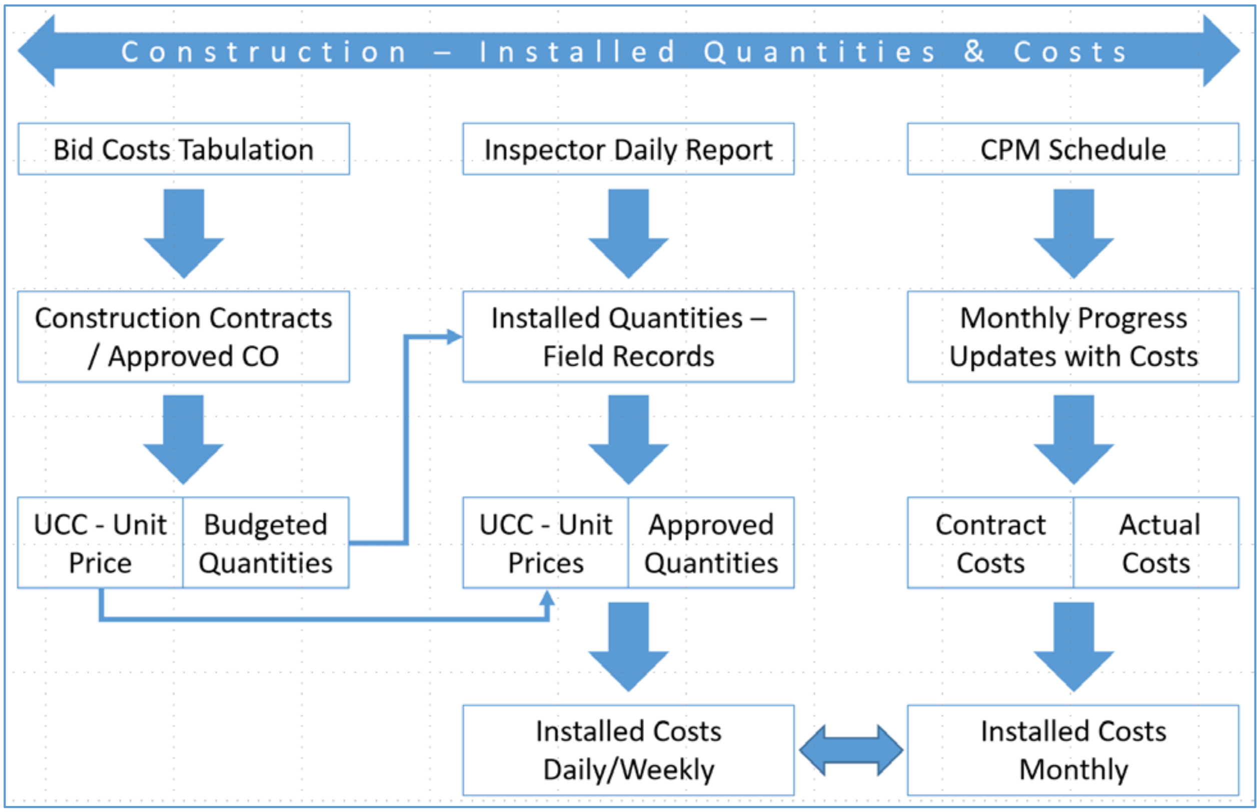
The agency specification required the contractor to submit cost loaded schedule and monthly status updates to support progress estimates. However, due to the complexity involved in reporting directly from the contractor developed P6 schedule, the agency maintains an in-house milestone construction schedule cost loaded using UCC code. These schedules are utilized to manage the agency program and projects in Primavera P6. The following attributes are used to maintain current information in the program schedule.

- Resources in P6 are coded using the UCC value to enable use across projects. The $1/hr unit costs is configured for each resource (represented by UCC code) allowed the agency to use either resource units or costs for reporting and comparison purpose.
- Data sharing between PCM and P6 is used to transfer the costs data between applications. This allowed reconciliation of budgeted costs and actual costs between the two applications. This functionality subsequently allows us to generate earned value metrics for all levels of project participants including field engineers, resident engineers and the agency management.
- CPM schedules were imported in a separate P6 database for review and analysis of monthly updates submitted by the contractor. An approved monthly schedule is a requirement to process the progress payment.
- The baseline of approved program schedule is created using contractor's approved cost loaded ICPM to develop and manage cash-flow for the agency.

Actual Costs:

Since the CPM schedules are developed by contractor, it is difficult to incorporate actual costs from contractor's schedule in to the PMIS managed by the agency.

Figure 11 | Costs Reconciliation



However, this issue was resolved leveraging PCM using the following process steps.

- Contract pay items (budgeted contracts and approved change orders) are available in IDR module in which field inspector records daily installed quantities. These installed quantities and pay items are linked using UCC codes across the PMIS.
- The actual recorded daily pay quantities are signed and accepted by the contractor at minimum on weekly basis using internal work-flow.
- The accepted quantities are then used to process and approve a monthly progress estimate that is in-line with accepted monthly schedule update.

The reports using the installed quantities and costs are usually the latest and therefore provides near real-time update on the project progress. Such reporting allowed the agency to report on installed quantities within 7 days of installation as IDR's are required to be approved by the contractor. The data sharing between PCM and program schedule in P6 resolves the issue of the inability to connect the contractor developed P6 schedule with the agency maintained program schedule.

The following is a sample of report that collected schedule data from P6 to display time percent complete and installed costs from PCM to display installed costs.

Figure 12| Project Status Report

Project Name:	Reconstruction of Footways		
Contract No(s): **Contractor: Field Office:**	ABC 1234 | | Local Construction Company Inc Address Line 1, City, State, ZIP [1234567890]		
NTP: 06/29/15	**OCD**: 06/29/16		**RCD**: 07/29/16
Org. Duration:	366	**Org. Contract Amount:**	$ 1,182,515.30
Time Extension:	30	**Approved EW Amount:**	$ 30,470.00
Revised Duration:	396	**Revised Contract Amount:**	$ 1,212,985.30
		Estimate To Date:	$736,146.27
Duration to Date :	257	**Installed To Date:**	$756,146.27
Duration % Complete:	64.90%	**Cost % Complete:**	60.69%
Remaining Duration:	139	**Remaining Balance:**	$ 476,839.03
NTP = Notice to Proceed	OCD = Original Completion Date	RCD = Revised Completion Date	

Additional reports provides a tool for field inspectors and resident engineers that would provide on-demand comparison of project items to display contracted quantities and installed quantities to-date.

Earned Value Metrics:

An Earned value management system is project management and control system that integrates work scope, schedule and resources to enable objective comparison of the earned value to the actual cost and the planned schedule of the project[ii].

In a single integrated system EVM is able to forecast performance issues early to effect timely decision making. At the agency the purpose of developing earned value metrics was to support the reporting of standard key performance indicators (KPIs) for the program. The metrics would forecast project performance and be used as a tool that allows the agency to monitor and accumulate Earned Value on a weekly or monthly basis. EV is used as a KPI in this case not an indicator to the project status.

Figure 13 | Report with Status and EV Metrics

Contract No	Description	Area Engineer |	Field Office Address	Contractor	Start Date	Dur	Days Add	Comp Date	Days Used	% Time	Amount Awarded	Amount Added	Current Const. Cost	Amount Paid Amount Installed	% $ Paid % $ Inst.	Estimate to Complete	SPI
ABCD1234	Resurface & Rehabilitaton Project	Construction Supervisor	Field Office Address	ABCD llc	3/30/15	180	0	9/26/15	348	193.33%	$996,660	$0	$996,660	$776,666.11 $694,155.33	77.93% 69.65%	$ 219,992 $ 29,660	1.28 1.44
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/5/2015		**LAST EDIT DATE:** 8/5/2015		**DATE OPENED:** 8/5/2015		
BCDE1234	Site Imporement	Construction Supervisor	Field Office Address	BCDEF LLC	11/19/15	120	0	3/18/16	114	96.00%	$2,268,936	$0	$2,268,936	$646,006.62 $1,701,814.71	28.60% 75.34%	$ 1,612,930 $ 145,833	3.32 1.28
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/5/2015		**LAST EDIT DATE:** 8/5/2015		**DATE OPENED:** 8/5/2015		
CDEF1234	Highway Section 3	Construction Supervisor	Field Office Address	ABC INC.	8/10/15	239	0	4/5/16	215	89.96%	$1,988,808	$0	$1,988,808	$907,484.96 $1,524,664.30	45.63% 76.66%	$ 1,081,323 $ 123,674	1.97 1.17
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/5/2015		**LAST EDIT DATE:** 8/5/2015		**DATE OPENED:** 8/5/2015		
DEFG1234	Areawide Sidewalk Improvements	Construction Supervisor	Field Office Address	TEST 123.inc.	4/23/14	365	365	4/22/16	689	94.38%	$866,000	$0	$866,000	$64,215.40 $64,215.40	7.42% 7.42%	$ 801,785 $ 65,350	12.73 12.73
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/7/2015		**LAST EDIT DATE:** 8/7/2015		**DATE OPENED:** 10/27/2015		
EFGH1234	Resurcing Highway Sector 1	Construction Supervisor	Field Office Address	ABCD LLC	6/22/15	239	90	5/16/16	264	80.24%	$2,608,486	$207,176	$2,815,661	$2,601,140.50 $1,988,768.04	92.38% 70.63%	$ 214,521 $ 342,631	0.87 1.14
											CREATED DATE: 8/5/2015		**LAST EDIT DATE:** 8/5/2015		**DATE OPENED:** 8/5/2015		
FGHI1234	Geometric Safety Project	Construction Supervisor	Field Office Address	ABC INC.	8/10/15	366	0	8/10/16	215	58.74%	$1,127,910	$0	$1,127,910	$314,532.04 $357,385.57	27.89% 31.69%	$ 813,378 $ 556,094	2.11 1.85
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/5/2015		**LAST EDIT DATE:** 8/5/2015		**DATE OPENED:** 8/5/2015		
GHIJ1234	Location Test and Boring Hole Study	Construction Supervisor	Field Office Address	MCI Technologies	8/31/15	366	0	8/31/16	194	53.01%	$335,180	$0	$335,180	$0.00 $15,301.80	0.00% 4.57%	$ 335,180 $ 164,330	N/A 11.61
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/5/2015		**LAST EDIT DATE:** 8/5/2015		**DATE OPENED:** 8/5/2015		
HIJK1234	Repaving for Utility Relocation	Construction Supervisor	Field Office Address	Local paving	3/25/15	549	0	9/24/16	353	64.30%	$5,086,629	$0	$5,086,629	$0.00 $1,456,021.38	0.00% 28.60%	$ 5,086,629 $ 1,899,985	N/A 2.25
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/7/2015		**LAST EDIT DATE:** 8/7/2015		**DATE OPENED:** 8/5/2015		
JKLM1234	Conduit System and New Construction	Construction Supervisor	Field Office Address	HQL Contracting	12/14/15	365	0	12/13/16	89	24.38%	$922,715	$0	$922,715	$0.00 $20,880.00	0.00% 2.26%	$ 922,715 $ 886,715	N/A 10.77
MONTHLY STATUS NOTES:											**CREATED DATE:** 8/5/2015		**LAST EDIT DATE:** 8/5/2015		**DATE OPENED:** 8/5/2015		
Report Date: February 12, 2016																	

The metrics include a combination of schedule and cost indicators. Schedule indicators include schedule delays, time used in comparison with original duration and duration with change orders. Schedule Variance calculated as the difference between planned and earned value (PV-EV) was used in conjunction with the project's CPM schedule to measure on time completion. This is because the Critical Path ultimately determines the project's duration, and big dollar activities that are not critical have the propensity to hide the impact of poor performing small budget critical activities.

Cost indicators included cost variances, percent of costs completed in comparison with original costs and costs with change orders. Composite indexes included baseline execution index and various ratios of cost and time to derive performance indexes.

Dashboards:

Standard P6 EPPM dashboards were also used to communicate project status information to the agency's management. Dashboards in P6 EPPM were customized to meet the agency's needs by using the specific thresholds for performance indexes. The use of dashboards eliminated the need of printing ad-hoc reports, and provided the management a unified source of real-time information on project status.

Figure 14 | Schedule Performance Dashboard in P6 EPPM

Schedule Performance

Legend: Critical Warning Acceptable Exceptional

	As of Today		Forecast at Completion	
	Schedule	Cost	Schedule	Cost
Agency Program	**5d early**	**$210 over**	**on schedule**	**$51,941 over**
2289_MA-2647	*No Progress*	*No Progress*	*No Progress*	*No Progress*
2326_MA-2716	*No Progress*	*No Progress*	*No Progress*	*No Progress*
2371_NB	*No Progress*	*No Progress*	*No Progress*	*No Progress*
MDTA Project 2372	38d early	$1,470 over	on schedule	$53,201 over
MDTA Project 2372	39d early	$1,260 under	on schedule	$1,260 under

Page: 1 of 1

Figure 15| Earned Value Performance Dashboard in P6 EPPM

Earned Value Performance

Legend: Critical Warning Acceptable Exceptional

	As of Today		Forecast at Completion	
	Schedule	Cost	Schedule	Cost
Agency Program	**$31,550 under**	**$210 over**	**$4,660,691 under**	**$21,943 over**
2289_MA-2647	*No Progress*	*No Progress*	*No Progress*	*No Progress*
2326_MA-2716	*No Progress*	*No Progress*	*No Progress*	*No Progress*
2371_NB	*No Progress*	*No Progress*	*No Progress*	*No Progress*
MDTA Project 2372	$15,376 under	$1,470 over	$191,697 under	$12,973 over
MDTA Project 2372	$16,173 under	$1,260 under	$197,188 under	$10,876 under

Page: 1 of 1

Conclusion:

The development of any cost management system needs to be customized to meet the client's requirement. In our case study, the cost management system was designed and developed using a combination of applications and customized reports to support the agency. Some of the lessons learned from development of a cost management system that provides a holistic approach for an agency using the traditional project delivery model to execute construction projects follows:

- The proposed system requires a disciplined approach in data entry, data validation especially during the design and construction phases to maintain checks and balances of the system.
- Several challenges including a lack of documentation on institutional knowledge and the clarity of responsibility by project stake holders can provide non-technical problems.
- The communication system needs to be focused on project delivery. Historically it was dependent on using email clients, and disconnected from any project referencing.
- The proposed system must be scalable so it can be further developed based on required complexity and analytical requirements for the client.
- Due to lack of skilled internal resources and contractual arrangements, the agency faced a challenging task to maintain the system. A single consultant was not engaged and resulted in a lack of consistency in development.
- The owner agencies are uncertain about required roles to manage a cost management system and struggle to utilize the skill sets of inter-departmental resources.
- Project participants lack the ability to see the big picture and establish long term goals for the continuous development of a cost management system.

The following is a list of benefits achieved by the agency during the process.

- The process allowed to standardized cost items under UCC across the department in each phase of the project.
- Improved the quality of engineer's estimate to support to increase accuracy in the budget for the construction projects.
- The implementation of PMIS allowed to record actual costs during construction phase to develop earned value metrics.

The process with focus on total cost management is important because for publically funded agency additional funding for the change order takes long time; however having an accurate budget due to improved engineer's estimate reduces the need for the change order.

References:

[i] Definition of Total Cost Management – Total Cost Management Framework – Second Edition published by AACE International
[ii] Definition of Earned Value Management – Total Cost Management Framework – Second Edition published by AACE International.
iii Earned Value Project Management – Quentin W. Fleming and Joel M. Koppelman – 2006
iv – Oracle – Primavera Contract Management R -14 – Support Files and Knowledgebase.
v – CPM Scheduling for Construction : Best Practices and Guidelines – Christopher W. Carson -2014
vi – 2008 Standard Specifications for Construction and Materials – State of Maryland
vii – 2001 Standard Specifications for Roads and Bridges Construction – State of Delaware

Analyzing the Effectiveness of Project Management Course: A case study of American College of Dubai, UAE

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ABSTRACT

The purpose of this paper is to examine the effectiveness of project management instructional methodology and course content on achievement of course learning outcomes. We present the case of project management course taught at the undergraduate level in American College of Dubai, UAE. This course is run as a specialization course in the Bachelor of Business Administration Program. The pedagogy includes a range of techniques such as traditional lectures, case studies, and team based projects, which are used as assessments. The course learning outcomes are aligned with the QF Emirates , as required by the UAE Ministry of Higher Education & Scientific Research and correspond to Knowledge, Skills, and Competence dimensions. Achievement of the course learning and overall student satisfaction with the course is investigated through a survey. Furthermore, we analyze student success on the course. Specific recommendations for improvement of course content, and pedagogy is presented.

INTRODUCTION

The larger purpose of business education is to prepare future managers, educators, and entrepreneurs who can perform in a dynamic business environment (Bratianu, 2015). In doing this, business education focuses on various learning outcomes such as knowledge transfer, development of specific skills, and critical thinking (Gosling, & Mintzberg, 2003; Roglio, & Light, 2009). Furthermore, this successful delivery of learning outcomes largely depends on the effectiveness of the instructor who facilitate the development of mental models in the students. The students then are aware of the reality and the context in which they are operating, and process all information/ data necessary to make effective decisions.

The development of such mental models requires the instructors to apply active learning styles. Active learning requires the students to perform meaningful activities, and reflect on what they are doing. Specifically, the instructors would employ techniques such as collaborative learning (students working together to achieve common goal), cooperative learning (students engaged in learning activities that promote mutual accountability to achieve common goals, and face-to-face interactions to develop interpersonal skills, and self-development).

The teaching techniques in project management education closely reflect these trends. According to Austin et al (2013) managers in healthcare related projects need to rely more on "soft skills" as they need to be more people focused rather than process oriented. Smith et all (2008) in Poston and Richardson (20..) state that universities are responding to this need by developing project management courses, offering project management degrees and certificate programs. Poston and Richardson (20..) propose that collaborating with the industry itself as one of the effective tools of teaching and learning will give students a “real world” hands-on experience. Poston and Richardson (20..) emphasize on exposing students to “soft skills” such as communication skills, critical thinking, leadership, collaboration and team-work, as a part of classroom activities so that they learn to develop, practice and apply these skills in the “real world” when managing projects.

On the other hand, educators also need to reflect on the learning outcomes that are intended to be achieved at the end of the course. Various outcomes such as development of applied knowledge & skills, interactional abilities, personal attributes (Toohey, 2002), influences on student behavior, and cognition from collegiate experiences (Cheng, 2001), and problem-based learning (Hager & Butler, 1996) have been proposed.

For the purpose of the study, we use Qualifications Framework Emirates (known as QF Emirates) developed by National Qualifications Authority -NQA, brought into effect through Federal Decree Number 1 ‘Establish and Maintain National Qualifications Authority by President His Highness Sheikh Khalifa Bin Zayed Al Nahyan of United Arab Emirates. While the QF Emirates comprehensively and objectively compares all qualifications delivered in the United Arab Emirates, it also specifically describes specific learning outcomes to be achieved in terms of knowledge, skills, and competence. These three strands of learning outcomes comprehensively cover cognitive abilities, application of knowledge to specific contexts, development of specific skills, and development of competence leading to demonstrable professional and personal development.

Thus, the objective of this paper is to investigate the influence of instructor’s effectiveness and assessment tools on the achievement of three specific learning outcomes- knowledge, skills, and competence.

In the subsequent literature review, we reflect on specific pedagogy applied in teaching project management courses, especially in universities.

LITERATURE REVIEW

Various pedagogical tools that can be used in the effective delivery of project management course. We find that techniques that promote collaborative working and reflection have been increasingly used by the instructors so that students gain knowledge, and acquire skills, and develop competence in project management. The most relevant studies from extant literature has been summarized in Table 1 below.

Table 1. Summary of Literature Review

Author (Date)	Variables	Methodology	Findings
Kriger, Thomas J; Scheuermon, William E. (2016)	Teaching pedagogy, pedagogical innovation, info technology tools,	Case study on the use of project management tools	Promoting collaboration among students across several courses is a conceptually sound and valuable idea.
Robin S. Poston, Sandra M. Richardson (2011)	Project management educational program, Project management skills, Degree offerings, Technical skills, General project management skills	A case study on the collaborative effort between a university and local chapter of the PMI.	Greater collaboration between professional bodies of project management such as Project Management Institute (PMI), mentoring of student by faculty, and project professionals, and providing regular feedback to the students on their performance in the program
Ssegawa, Joseph K.; Kasule, Daniel(2015)	Student’s perception of the acquisition of knowledge in the following area & the assessment of learning outcomes using the learning technique prayer was used for project management	Students' perceptions were obtained by means of a self-administered questionnaire containing open-ended questions. Content analysis was used to	“Prayer” as a technique to teach project management allowed students to better understand concepts of project management, communication,

		analyze the responses.	and presentation skills through the application of collaborative learning techniques
Caroline Bayart, Sandra Bertezene and David Vallat, Jacques Martin(2014)	• Interactivity with teachers • Interest of students • Perceived quality of pedagogy • Performance of learning process	The research is an exploratory investigation resorting to the use of a serious game to evaluate the evolution of the students' competencies in project management, through questionnaires processed using a structural "learning model."	This research shows indeed that the use of "serious games" improves the knowledge acquisition and management competencies of the students with the evidencing of significant factors contributing to this improvement.
Mgr. Dušan Kucera, MBA(Dec 2013)		This research discusses the requirement of project management at the secondary schools level so that students have already developed critical thinking when they enter higher education institutions	This paper discusses the need for introducing project management and project thinking at secondary schools

METHOD

The objective of this research study is to understand the influence of instructor's effectiveness on the achievement of student learning outcomes in project management course delivered at the undergraduate level in the university. Hence, in line with this objective, we have adopted a positivist stance, and quantitative research methodology.

Items

A survey instrument comprising of two independent variables – Lecturer Effectiveness (LT), and Assessment & Feedback (AS) was developed. Lecturer effectiveness was measured using five items while Assessment & Feedback was measured using three items. We have considered five dependent variables- Knowledge (K, measured using six items), Skills (S, measured using four items), Autonomy and Responsibility (AR, measured using four items), Role in Context (RC, measured using four items), and Self Development (SD, measured using four items). The items used to measure the two independent variables- LT and AS were based on the instrument developed by Wilkins and Balakrishnan (2013) who investigated the effect of student experiences with the quality of teaching, academic program, and resources provided on the overall student satisfaction. The items for the dependent variable ST was also based on Wilkins and Balakrishnan's work to measure overall student satisfaction (ST). The items to measure the three learning outcomes- knowledge, skills, and Competency (comprising of Autonomy and Responsibility, Role in Context, and Self Development) were based on the National Qualification Framework United Arab Emirates QF Emirates.

Sample and Procedure

100 students of the American College of Dubai who were pursuing their undergraduate program in business administration were identified. These students had studied project management as a part of the program. The students were identified by the Office of Institutional Research, and the survey instrument was handed out to the students by the instructors in the class room. Instructions on how to complete the questionnaire were provided to the students along with the instrument. Out of the 100 questionnaires administered to the students, 41 instruments were returned which we found to be complete, giving us a healthy response rate of 40%.

The reliability of the items was established using Cronbach alpha. SPSS version 16 was used for the analysis. Table 2 summarizes the items

Table 2. Internal Reliability of Items

Construct	Items	Cronbach Alpha
Independent Variables		
Lecturer (LT)	• Makes the subject interesting • Are experts in the field • Used language that I understand • Student has contact with lecturer as needed • Lecturer sympathetic towards students' problems	0.82
Assessment & Feedback (AS)	• Variety of assessment methods used • Involved on-going assessment • Student received detailed and helpful feedback	0.70

	•	
Dependent Variables		
Knowledge (K)	• gained specialized knowledge related to project management • developed an understanding of theories and knowledge in other fields related to project management • developed a comprehensive understanding of methods and problem solving techniques related to project management • understand the critical approach to develop new concepts in project management through my knowledge of project management • am familiar with the latest research and current practices in project management • familiar with the latest research and current practices in project management	0.85
Skills (S)	• developed technical, analytical, and creative skills to solve problems in managing projects • have developed skills to evaluate, select, and apply the appropriate methods to solve problems and identify solutions • developed research skills related to project management • developed advanced communication and information technology skills to explain and evaluate project management concepts	0.90
Autonomy & Responsibility (AR)	• take responsibility to develop and manage complex work procedures in project management • can manage technical or managerial work in complex work environments • can work effectively as an individual or a team member when working on a project • can accept responsibility for my views and decisions when I start work	0.84
Role in Context (RC)	• can work independently without lot of supervision • can take responsibility for setting the goals for myself and for other members of my team at work • am able to collaborate with other qualified experts and work in their group • can take responsibility for professional development and mentoring of individuals	0.81

	working in my team	
Self-Development (SD)	• undertake regular professional development and keep myself updated about new knowledge in project management • am able to learn new knowledge or concepts related to project management independently while I am working • can contribute to development of ethical standards and resolve ethical issues when I am working	0.69

FINDINGS

It is to be reiterated that this is an exploratory research, and the purpose of this paper to is to present the initial findings that indicate the relation between the instructor's effectiveness in the class room and the achievement of student satisfaction and learning outcomes in project management course. As such, we have used descriptive statistics and specifically cross-tabulations for data analysis. Table 3 summarizes the cross tabulation results between the lecturer effectiveness (LT as independent variable) and Overall Student Satisfaction (AS), and Learning Outcomes (knowledge, skills, and competence as dependent variables).

Table 3. Lecturer's Proficiency and Achievement of Learning Outcomes

	Strongly Disagree achievement of learning outcome (%)	Disagree achievement of learning outcome (%)	Neutral (%)	Agree achievement of learning outcome (%)	Strongly agree achievement of learning outcome (%)
Lecturer's Proficiency	Knowledge				
	2.2	4.3	39.1	39.1	15.2
	Skill				
	2.2	19.6	28.3	39.1	10.9
	Competence-Autonomy & Responsibility				
	2.2	6.5	26.1	37.0	28.3
	Competence- Role in Context				
	0.0	8.7	19.6	54.3	17.4
	Competence- Self Development				
	2.2	4.3	39.1	39.1	15.2

It may be inferred from the above table N that lecturer's proficiency may significantly affect the achievement of learning outcomes. While 54.3 % of the respondents believe that the lecturer's proficiency effects them acquiring project management knowledge, 50% of the respondents agree or strongly agree that it helps them acquire project management skills. Interestingly, the strongest influence of lecturer's proficiency is on developing project management competence among the students, where 65.3% of the respondents report acquiring autonomy and responsibility competence to manage projects, 71.7% of the respondents strongly agreed or agreed to have developed competence specifically to work in project contexts, and 54.3 % of the respondents strongly agreed or agreed that lecturer's proficiency in the course lead to their self -development.

Discussion

As the data have shown, majority of the respondents strongly believe the lecturer's proficiency has a significant impact on their learning ability which also implies that the lecturer has sufficient knowledge and understanding of the subject he/she is teaching and is well equipped in terms of his preparation for classroom instruction, i.e., has a comprehensive understanding of methods and problem solving techniques in project management and uses research and current practices in project management. The lecturer is encouraged to select his/her pedagogy to deliver the course. His/her effectiveness is evidenced by the high percentage (65.3%) of the respondents' response that they have acquired the competency-autonomy and responsibility as required. It is indicated that 71.7% of them have acquired this competence in managing projects.

Table 4. Quality of Assessment and Feedback; and Achievement of Learning Outcomes

	Strongly Disagree achievement of learning outcome (%)	Disagree achievement of learning outcome (%)	Neutral (%)	Agree achievement of learning outcome (%)	Strongly agree achievement of learning outcome (%)
	Knowledge				
Assessment and Feedback	2.2	19.6	28.3	39.1	10.9
	Skill				
	4.3	15.2	28.3	32.6	19.6
	Competence-Autonomy & Responsibility				
	4.3	15.2	28.3	32.6	19.6
	Competence- Role in Context				
	0.0	8.6	19.7	54.2	17.5
	Competence- Self Development				
	2.2	4.3	39.1	39.1	15.2

It may be inferred from the above table N that quality of student assessment and feedback may significantly impact the achievement of learning outcomes. While 50

% of the respondents believe that the assessment and feedback facilitates acquisition of project management knowledge, 52.2% of the respondents agree or strongly agree that it helps them acquire project management skills. However, 47.9 % of the respondents remain neutral or disagree that the quality of assessments and feedback helps them to acquire project management knowledge.

Interestingly, the strongest influence assessment and feedback is on developing project management competence among the students. This is similar to the above where 52.2 % of the respondents report acquiring autonomy and responsibility competence to manage projects, 71.7% of the respondents strongly agreed or agreed to have developed competence specifically to work in project contexts, and 54.3 % of the respondents strongly agreed or agreed that lecturer's proficiency in the course lead to their self -development.

Discussion

As the table shows, 52.2% of the respondents generally agree that the assessment may be an indication that only more than half of the respondents believe that the assessment and feedback significantly affect the achievement of learning outcomes but almost half of them say otherwise. This is corroborated by almost 50% of the respondents who stayed neutral or not sure enough, which may imply that the quality of the assessment tool may need some improvement in terms of meeting the learning outcomes. However, in terms of providing feedback, majority of the respondents (71.7%) strongly agree or agree that they have developed competence significantly which may imply that the quality of the assessment may have achieved the leaning outcomes coupled by their strong belief that the lecturer is proficient enough (54.3%) in delivering the course.

The course is using a range of assessments such conventional written exam, case analysis, reflection papers and comprehensive project work which form a significant weightage of the total assessment. These assessments provide an opportunity for the students to practice concepts of project management, reflect on such learning and apply this knowledge to produce deliverables such as project proposal or to conduct a project audit. In order to achieve these outcomes the students will be required to develop specific technical, analytical and problem solving skills.

Apart from developing project management skills and acquiring conceptual knowledge the students also develop project management competence. The case studies challenge the students with complex real world situations where one is required to make decisions as a project manager. Furthermore, through assessments such as comprehensive project work, the students are encouraged to work independently with minimal supervision from the faculty. As a part of the comprehensive project work the students based on their learning and interest the students are encouraged to select project topic. Furthermore, the students assume responsibility to be current in their field of interest by referring to project management journals, books and other learning resources available at ACD. Being engaged in such continuous learning process also leads to their self-development.

CONCLUSION

In this study we have investigated the role of the lecturer and quality of assessments in achieving course learning outcomes pertaining to project management knowledge, skills and competence. The result of these study shows that there is a significant impact of the role of the lecturer and the quality of the assessment in delivering effective learning. The study provides an important input to the curriculum design and process of selecting the appropriate faculty. Furthermore, this investigation serves as a pilot study where we have attempted to evaluate the achievement of learning outcomes along a standard framework; QFEmirates. Thus we have an opportunity to replicate the research design to other courses being offered in the BBA program. This will enable us to have a comprehensive framework to evaluate the courses objectively. This will lead to overall improvement of the BBA program quality offered at ACD.

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Program Management Improvement Team: A Best Practice Based Approach to Process Improvement and Program Governance at the National Nuclear Security Administration

Wayne Abba[1], Russell Archibald[2], Michael Haase[3],
David Pells[4], Miles Shepherd[5], Marc Zocher[6]

ABSTRACT

The National Nuclear Security Administration (NNSA), a semi-autonomous agency within the U.S. Department of Energy, applies technical capabilities to global nuclear security challenges. NNSA's strategic goals are to maintain and enhance the safety, security, reliability and performance of the U.S. nuclear weapons stockpile without nuclear testing; work to reduce global danger from weapons of mass destruction; provide the U.S. Navy with safe and effective nuclear propulsion; and respond to nuclear and radiological emergencies in the U.S. and abroad. NNSA's Office of Safety, Infrastructure and Operations (NA-50) plans, directs and oversees the maintenance, operation and modernization of infrastructure and facilities at eight NNSA sites. With an annual budget of approximately $1.5 billion, NA-50 plans, funds, directs and oversees many projects ranging in size and complexity each year.

In September 2015, NA-50 established a Program Management Improvement Team (PMIT) to enhance program, portfolio and project performance through the identification, development and sharing of best practices and to help ensure the achievement of cost-effective, timely, measurable and quality results in support of the NNSA mission. The PMIT is comprised of a small cadre of private industry program management experts who meet with NA-50 federal program managers quarterly to discuss and share successful leading-edge program management practices. This paper will describe the purpose, activities and results to date of the NNSA's PMIT.

SCOPE OF NNSA'S INFRASTRUCTURE RESPONSIBILITIES

The NNSA enterprise consists of more than 6,000 facilities located at eight sites in seven states. The primary NNSA sites are:

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[2] Archibald Associates LLC, 220 N. Zapata Hwy, Laredo TX 78030, russell_archibald@yaho.com
[3] M-Con Strategic Solutions, 2301 Yvonnes Way, Dunn Loring, VA 22027,michaelhaase@mconsolutions.com
[4] PM World Services, Inc., 3829 Canot Lane, Addison TX 75001 pells@pmworldinc.com
[5] Miles Shepherd Projects Ltd., Salisbury, England, UK, miles.shepherd@msp-ltd.co.uk
[6] BayForge Co., 7253 NE New Brooklyn Rd., Bainbridge Island, WA 98110, marc.zocher@gmail.com

- Kansas City National Security Campus (Missouri)
- Lawrence Livermore National Laboratory (California)
- Los Alamos National Laboratory (New Mexico)
- Nevada National Security Site (Nevada)
- Pantex Plant (Texas)
- Sandia National Laboratories (New Mexico)
- Savannah River Site (South Carolina)
- Y-12 National Security Complex(Tennessee)

The$12.9 billion FY 2017 President's budget request for the NNSA represents an increase of $360 million, about 3 percent over the FY 2016 appropriations level. With an annual budget of approximately $1.5 billion, NA-50 is responsible for enabling safe operations, ensuring effective infrastructure and providing enterprise services to NNSA programs and national laboratories, plants and sites to meet the 21st Century needs of the NNSA Nuclear Security Enterprise now and in the future.

NNSA INFRASTRUCTURE PROJECTS, PROGRAMS, AND PORTFOLIOS

NA-50 plans, directs and oversees the maintenance, operation and modernization of infrastructure and facilities that comprise a complex enterprise. With over $50 billion in real property assets, 41,000 employees, 36 million square feet of buildings including 400 nuclear facilities and 2,000 miles of roads on 2,160 square miles of land, the scope of NNSA infrastructure is vast. This enormous effort requires the planning and execution of hundreds of projects within a smaller number of programs, all managed within portfolios of facilities. These facilities include production, fabrication, testing, and secure transportation and storage of nuclear/radioactive materials and equipment, plus very advanced laboratory, computing and communications facilities.

NNSA has the complex challenge of safely operating and modernizing the nuclear security enterprise, a challenge made more difficult as NNSA's infrastructure is failing at an increasing frequency due to its age and condition. Half of NNSA's facilities are over 40 years old, 30 percent date to the Manhattan Project era of 70 years ago, and 12 percent are excess to current needs. Nearly two-thirds of NNSA's aging and brittle infrastructure is less than adequate to meet mission needs. Deferred maintenance is at an all-time high of $3.67 billion, posing an increasingly unacceptable risk to the safety of workers, the public and the environment. NNSA's capability to achieve programmatic goals obviously depends upon safe and reliable infrastructure.

NNSA INFRASTRUCTURE MANAGEMENT CHALLENGES AND SOLUTIONS

NNSA's sites are managed by experienced private contractor companies, in some cases in partnership with major universities, under the direction of Federal Government personnel in NNSA's Headquarters and Field Offices. The major infrastructure management challenges include:

- The safety of employees, the general public and the environment related to both active and excess facilities, some of which are contaminated
- Allocation of available funds to satisfy conflicting priorities between the overall NNSA mission demands and enterprise safety and operational demands
- Aging facilities, with some buildings dating to the 1940s, combined with a large backlog of deferred maintenance across all sites

The analytical methods and performance measures NNSA used for the 70 years prior to 2015 to drive infrastructure investment decisions were based on financial metrics that did not capture the relative importance or actual condition of facilities. Furthermore, these investment decisions were stove-piped to individual sites, and in some cases individual facilities, resulting in projects that were prioritized based on site-specific criteria rather than being screened systematically at the enterprise level. While this approach did result in maintenance and upgrades for some facilities, it did not factor in or prioritize supporting infrastructure and facilities that are critical to the mission. The deferred maintenance on critical facilities added fragility to mission objectives and the need to find better ways of performing the right maintenance on the right facilities.

NNSA’s long term goals include ensuring that infrastructure investments are prioritized at an enterprise level to enable mission results and reduce enterprise risk. In short, the current strategy is to fully consider the long term health of NNSA as an interdependent unit rather than following the historical, sub-system (site-by-site) approach. An enterprise view considers the health of the organization when making investments and NNSA needed to change the processes and develop new tools to support an enterprise-wide prioritization model.

In 2015 NNSA developed innovative management tools to facilitate a data-driven process that leads to risk-informed investment decisions at the enterprise level. These efforts include deploying, for the first time, an NNSA infrastructure Enterprise Risk Management (ERM) methodology that better measures the “consequence to mission” and the “likelihood of the consequence occurring.” To measure “consequence,” NNSA created a Mission Dependency Index (MDI), combining the impact to mission if the asset were lost, the difficulty to replace the asset, and the interdependency of assets, to calculate a score from 1 to 100. To measure "the likelihood of the consequence occurring," NNSA is deploying the knowledge-based condition assessment tool BUILDER to compare inspection data against known failure curves to predict system wear and identify the optimal time to invest. The keystone to NNSA's ERM is the G2 Enterprise Management Information System, which NNSA developed to capture and analyze its enterprise information and topology.

NNSA'S AWARD-WINNING G2 ENTERPRISE MANAGEMENT INFORMATION SYSTEM

The Project Management Institute (PMI®) awarded the initial version of the G2 system a Distinguished Project Award for 2010[7] (the first ever bestowed on a government IT project), in recognition of the speed with which it was created, the uniqueness of the "Agile" development methods used in its creation and refinement, and the management usefulness of the resulting information system. Over the next five plus years the G2 System continued its advanced development and its application to the total NNSA enterprise. It is noteworthy that the Association for Enterprise Information (AFEI) also awarded its 2015 Excellence in Enterprise Information prize to NNSA for the G2 System.[8]

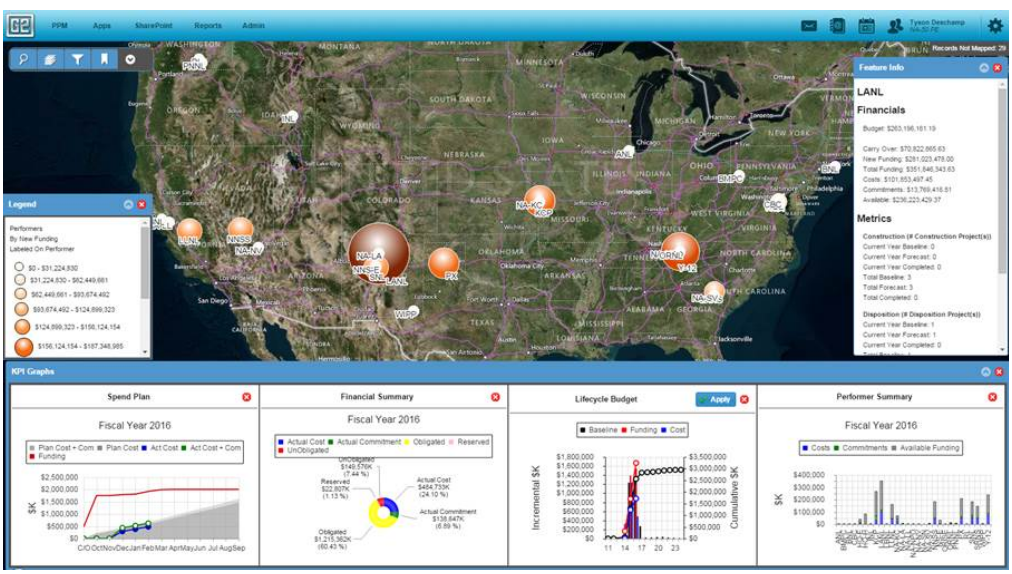

Figure 1. NASA's G2 Enterprise Management Information System uses best-in-class business practices to prioritize and manage scope, schedule, and cost.

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[7] http://www.pmi.org/en/About-Us/Press-Releases/PMI-Honors-National-Nuclear-Security-Administration.aspx

[8] NNSA press release, dated Feb 17, 2016

It is a monumental effort to change how a $1.5 billion per year program is managed. The G2 System has helped NNSA revolutionize its infrastructure management and decision-making processes. Each month, G2 enables NNSA to review and analyze data in new and holistic ways. People are empowered, processes are innovative, and technologies are revolutionized. Using the Agile approach, the G2 System is upgraded every 8 weeks to incorporate new and more powerful features.

For example, the G2 project prioritization tool resulted in a new, innovative process to deliver value and ensure NNSA meets long-term/strategic goals to arrest the declining state of its infrastructure. NNSA reengineered its Recapitalization program management processes, resulting in major improvements in performance and safety. Before G2, it took NNSA months to provide Congress with a complete picture of its Recapitalization program projects. Using G2, NNSA now produces clear, complete and accurate quarterly reports that are sent to Congress within days of each quarter's end. NNSA developed a risk-based Recapitalization prioritization method that the program applied for the formulation of the FY 2017 budget. This was important because NNSA only had enough funds for one-third of the proposed infrastructure projects and needed to make sure the highest priority projects received the limited funds.

THE NA-50 PROGRAM MANAGEMENT IMPROVEMENT TEAM (PMIT)

Based on a previous successful experience using independent program management experts, the NNSA Deputy Associate Administrator for Infrastructure established the PMIT in 2015 to support NA-50's management improvement initiatives. In order to highlight executive sponsorship and to ensure enterprise-wide support, the PMIT was announced in a memo from the NA-50 Associate Administrator to NNSA sites and headquarters leaders in September 2015. That memo included the PMIT charter, as shown below.

PMIT Charter

Purpose

Enhance program, portfolio and project performance by sharing best practices including methods, processes and tools for planning, executing and controlling scope, schedule, costs, risks and opportunities. This continual, self-driven improvement will assure that NA-50 achieves cost-effective, timely, measurable and quality results in support of the NNSA mission.

Process

The PMIT is comprised of a small cadre of private industry program management experts who will meet with NA-50 federal managers quarterly to discuss and share successful leading-edge program management practices. NA-50 may invite M&O Partners, Field Office experts, and others as needed to participate in PMIT meetings. The PMIT will not score/rank NA-50 or M&O Partner performance/practices nor establish new requirements. The PMIT will serve as a no-fault, non-attribution, safe forum to share experiences, discuss examples of successful initiatives, and provide opportunities to link participants to help one another improve their project, program and portfolio management performance. NA-50 and M&O Partners are encouraged to increase cross-communication and group-learning by openly sharing lessons with the PMIT – both the ones that worked and the ones that didn't work and why.

Products

A Management Best Practices List will be created to identify and share notable best practices. This document will be discussed and updated at PMIT meetings. The "best practices" that will be compiled are meant to be superior and/or unique approaches, not merely good or adequate approaches. If management practices at specific sites are not documented as "best practices" it should not be interpreted to mean those sites are doing less than good sound management practices. Furthermore, the defined "best practices" are not meant to be requirements to be adopted by every site for every situation, but rather a road map that could be used for improvement if applicable to a site.

A PMIT Meeting Report will be developed following each meeting by the PMIT members. The PMIT Meeting Report should include a record of topics discussed and any findings and recommendations the PMIT members may have.

Meetings

PMIT Meetings will be 3-4 times each year, lasting 2-3 days. A draft agenda will be prepared in advance of each PMIT meeting to allow NA-50 to comment on and suggest timely topics and meeting participants. Participants must feel free to openly share management challenges within their respective organization as well as best practices. The host M&O Partner/entity will be given time on the agenda to highlight issues/efforts unique to them.

Membership

The Executive Sponsor for the PMIT is Kenneth Sheely[9] and the Executive Director for the PMIT is Jessica Kunkle[10]. The Executive Sponsor and Executive Director will approve the meeting dates, agendas, locations, and determine what additional participants will be invited to each meeting.

[9] NNSA Deputy Associate Administrator for Infrastructure (NA-52)
[10] Director of the NA-50 Program Management Office (PMO)

The PMIT member list is as follows:

Wayne Abba – Private sector management expert
David Pells – Private sector management expert
Miles Shepherd – Private sector management expert
Marc Zocher – Private sector management expert
Michael Haase – Executive Secretariat [11]

RESULTS TO DATE

Meeting Number 1 – December 2015: The first PMIT meeting was held in December 2015 at Oak Ridge National Laboratory in Tennessee, with approximately 20 participants. Presentations and discussions covered NA-50 mission and plans, tools and systems being employed, enterprise risk management and other topics. In their Outbriefing report, the PMIT highlighted the following very positive observations: strong leadership and teamwork; standardization of processes; excellence of G2 program management information system; and impressive system tools, including MDI, BUILDER, MAP and AMP. They also commended NA-50 for the enterprise perspective, especially related to multi-site planning, stakeholder participation and supply chain management, and for promoting agility as a philosophy and culture. The PMIT recognized NA-50's organizational program and project management (P/PM) maturity, suggesting that NA-50's management approach might also be recognized as a P/PM best practice.

The PMIT identified some potential issues, including sustainability, documentation and institutionalization. Suggestions for consideration included expanding enterprise planning to the strategic level, consideration of long-term strategy for G2, and strategizing for dealing with P/PM on larger projects.

Meeting Number 2 – February 2016: The second PMIT meeting was held at Lawrence Livermore National Laboratory (LLNL) in California, in conjunction with "Deep Dive" planning meetings of NA-50 leadership with LLNL managers. Meetings included more than 50 participants. Presentations and discussions covered status, issues, needs and plans associated with facilities and infrastructure at the site. In their Outbriefing report, the PMIT highlighted the following positive observations:

Best practices at LLNL

- Visible engagement/support of LLNL leadership
- Integration of infrastructure with programs
- Space optimization modeling

[11] These members are authors of this paper.

Other positive observations demonstrated by LLNL

- Clear support of NA-50 goals and initiatives
- Active site/lab participation in development of NA-50 tools and solutions
- Use of multiple tools for analysis, prioritization and planning
- Involvement of program staff (critical stakeholders) in infrastructure planning
- Emphasis on future work force and external community during planning

Best practices by NA-50

- The Deep Dive approach to engaging with sites (increasing knowledge and teamwork)
- Excellence Awards (NA-50 presented awards to LLNL individuals and teams)
- Enterprise level supply chain management (for cost savings and efficiencies)

Other positive observations demonstrated by NA-50

- Visible involvement and commitment of NA-50 leadership
- Active engagement with multiple stakeholders
- Open and frank discussions and communications
- Long term planning rather than focused on annual budgeting
- Enterprise-wide planning rather than individual sites
- Visible emphasis on program, portfolio and project management
- Visible emphasis on risks and risk-informed decisions
- Emphasis on sustainability
- Recognition of tool limitations
- Breaking large projects into smaller sub-projects to reduce risks and facilitate annual budgeting
- Engagement with sites on tool development and pilot projects

The PMIT identified some issues, including potential roadblocks, funding, stakeholder involvement and project management resource availability. Suggestions for consideration included expanding enterprise supply chain management, expanding sustainability to incorporate health and safety, investigation of additional tools, use of six-sigma approaches for selected process improvements, continued emphasis on data quality, expansion of project planning to cover entire facility life cycle, additional emphasis on resilience, more attention on organizational sustainability and possible use of site project management offices.

CONCLUSIONS AND LESSONS LEARNED THAT MAY BE USEFUL TO OTHERS

The PMIT for NNSA's Office of Safety, Infrastructure and Operations is just getting started, but the experience to date suggests some useful lessons that may apply to other organizations and programs.

Positive results have been reinforced from employing traditional best practices such as visible leadership support, active stakeholder engagement, effective communications, emphasis on risk management, thorough planning, and use of good modern software tools and project/program management methodologies.

The independence of the PMIT has also been a positive factor resulting in increased NNSA cross-complex communication and an understanding that PMIT members are looking to share "good practices" rather than an audit or assessment posture at NNSA sites.

More importantly, we have already seen evidence of NNSA implementing several best management practices:

- Enterprise-wide approaches to planning, prioritizing and budgeting projects across a large organization involving thousands of facilities
- Enterprise-wide supply chain management, implemented practically through use of pilot projects, selected system procurements and national suppliers
- Adaptation and effective use of best-in-class software tools, some developed by other government agencies, to support both enterprise and site-specific characterization, analysis and prioritization of facilities and infrastructure
- Effective proactive long term planning by a government agency rather than relying on the reactive planning associated with annual budgeting

We think these approaches could be useful to any large government or private enterprise that maintains, upgrades, operates and then disposes of a large number of facilities, buildings or infrastructure.

The PMIT is helping to highlight good practices by NNSA and its site contractors, along with other program management issues that might warrant additional attention in the future.

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http://nnsa.energy.gov/

Embrace Conflict: Using Conflict to Build Constructive Teams

By Evan Piekara

Abstract

Conflict can occur in any environment, and the success of a project is dependent on how leaders manage and resolve conflict. Issues can occur with various stakeholders (project team, client, and other influencers), and addressing these problems head-on can be the difference between meeting project demands and escalating tensions to the point of damaging the project outcome and team and client relationships.

This presentation and paper will address how to build teams that harness the positive aspects of conflict and mitigate issues before they metastasize into project and relationship-damaging discord. The paper will review common sources of conflict, the conflict lifecycle, and strategies for resolving conflict.

Conflict as an Opportunity for Communication and Growth

Since its inception, IBM has been regarded as an innovative and evolving company. Big Blue's ability to anticipate and adapt to conflict has contributed to the company's longevity and success. In the 1990s, IBM bundled products and reintegrated divisions in an effort to provide customers with fuller products and services.[1] This transition fostered greater complexity and conflict among sales and delivery, as well as among previously independent divisions. Managers were not escalating or addressing conflicts across units leading to a loss of service and the erosion of competitive advantages that IBM had taken decades to forge.[2] Without greater accountability and communication, IBM would continue to suffer losses in market share and customer satisfaction.

IBM recognized that setting and communicating expectations and collaborating across units was critical to resolving conflicts. IBM developed the Market Growth Workshop that brought managers, salespeople, and frontline specialists together to identify, discuss, and develop action steps to address conflicts across business units.[3] The company developed a simple template that clarified expectations and forced people to document and assess issues discussed during the Market Growth Workshop. Documenting, tracking, and clarifying these issues helped to hold people accountable and manage expectations. What could have been a catastrophic spiral of coalitions between silos, finger-pointing, and selling of business units, ultimately become a way for IBM leaders to communicate, take action, and use processes and personnel to address high-stakes and highly-visible conflicts. Today, Forbes has ranked IBM as one of the world's most valuable brands.

Embrace the Inevitable: Working with Conflict

[1] https://hbr.org/2005/03/want-collaboration-accept-and-actively-manage-conflict
[2] https://hbr.org/2005/03/want-collaboration-accept-and-actively-manage-conflict
[3] https://hbr.org/2005/03/want-collaboration-accept-and-actively-manage-conflict

Embrace Conflict: Using Conflict to Build Constructive Teams

By Evan Piekara

Generational differences, tight deadlines, and the need for getting more done with less has made conflict an inevitable part of the work environment. Coupled with these demands is our innate desire to be liked, which has created a tendency to avoid conflict. While sidestepping conflict may avoid arguments, this tactic is not always constructive. Think of the person who repeatedly turns in work past deadlines. While not addressing this conflict upfront may enable the tardy coworker to save face, it lowers team morale, particularly of those who are working overtime to meet deadlines. It also enables the tardy coworker to continue their practice of missing deadlines, and it adds strain to the project manager who cannot rely on deadlines to be met. In today's increasingly connected society, conflict no longer can be avoided. Countless sources facilitate opposition and place the project manager in the difficult position of navigating diverging views.

Table 1: Sources of Conflict[4]

- Basic needs
- Values
- Resources
- Interests
- Perception
- Love

Today's project manager not only needs to be able to identify the type of conflict, but also have a range of techniques in their toolkit to mitigate, address, and harness it.

Defining Conflict

Conflict is "the result of disagreement caused by perceived or actual opposition of interests, needs, and value.[5]" Conflict, in its essence, causes tension and stress and has many harmful effects that can damage a team.

Table 2: Harmful Effects of Conflict[6]

- Lower productivity
- Increased stress
- Frustration due to time lost to address conflict
- Reduced trust
- With us or against us mentality
- Win/Lose mentality (Someone wins while someone loses)
- Lose/Lose mentality (we both lose no matter the outcome)

[4] Management and Strategy Institute
[5] Management and Strategy Institute
[6] Management and Strategy Institute

Conflict can hinder efforts, damage relationships, and lower productivity when warning signals are not identified and project leaders do not effectively channel these warning signals into productive dialogue. However, conflict, when balanced appropriately, can strengthen team dynamics, enhance creativity, and lead to better solutions.

Table 3: Positive Effects of Conflict[7]

- Energizes teams
- Increases creativity
- Encourages stronger emotional skills
- Enhances negotiations
- Questions status quo
- Discovers others' needs, values, and perspectives

Project managers today must be adept at reading personalities, assessing situations, and using a range of tools and techniques to prevent conflict from metastasizing into a toxic situation.

Assessing Conflict

The extent that conflict will impact the project often depends on the personalities and degree to which the conflict has grown. Conflict tends to follow a lifecycle and addressing conflict earlier often leads to a higher ability and willingness of all parties to reach a win-win resolution. At first, conflict might start small as people mask their emotions and feelings. They will likely seek win-win resolutions, have mutual respect for the other participants, and be willing to reach a resolution before conflict escalates. Additionally many people have not become entrenched in their opinions, deadlines may be further away, and there is less pressure to reach a resolution. Project managers should attempt to instill a culture where issues are discussed openly, perspectives are shared, and positions are not hardened. For instance, removing ambiguity by explicitly setting and documenting deadlines and expectations is one way to ensure communication and clarify needs.[8]

As conflict devolves, it becomes important to identify the initial warning signals of hardening positions, intense debates, and the forming of coalitions in order to mitigate conflict from becoming full-blown. As conflicts continue, debates become more intense, actions rather than words are shared, and coalitions begin to form. In these stages, conflict becomes win/lose as one

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[7] Management and Strategy Institute
[8] http://www.forbes.com/sites/augustturak/2012/09/10/the-3-secrets-to-conflict-resolution/

side looks to gain at the expense of the other. It is important during meetings to take minutes or notes and review these notes, document requests and timelines in email so that there is a paper trail where expectations can be reviewed and re-visited.[9]

When conflict reaches maturity, participants take a lose/lose approach by seeking victory at all costs. This stage is when discussions break down, threats are made, people are separated, and the conflict could eventually end in a complete impasse or breakup. Project managers must adeptly direct conflict at this stage or face a war of attrition.

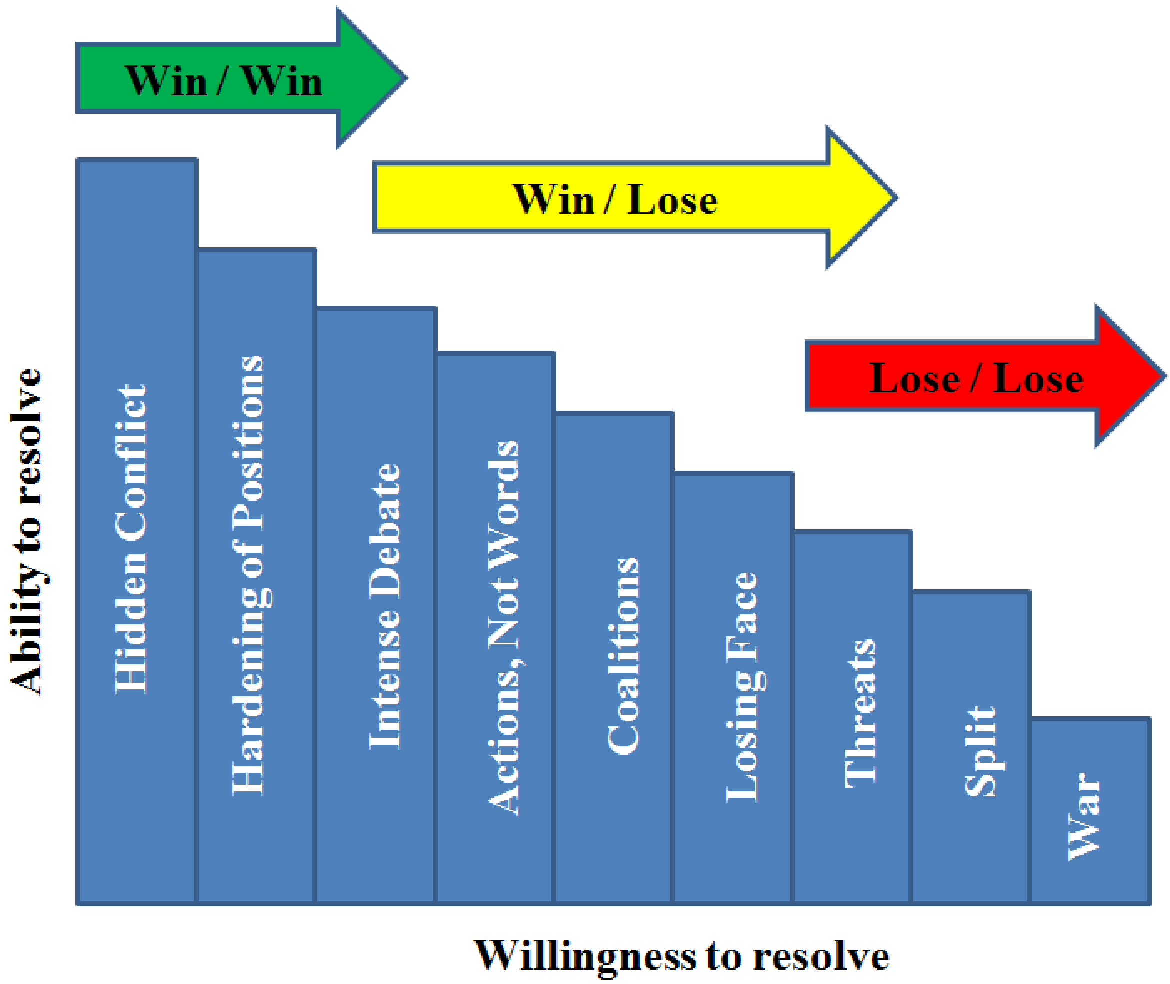
Table 4: Warning Signals of Unproductive Conflict[10]

- Emotions dominate facts
- Fear and mistrust increase
- Perspective is black and white
- Information is restricted
- Solutions not based on logic

Project managers must actively monitor conflict to ensure that disagreement remains productive and does not devolve into all-out war. Several warning signals should such as the intensifying of debate, actions as opposed to words, and forming of coalitions, should alert the project manager that the group should take a step back and re-assess the situation, communications, and review or set ground rules for future discussion.

Table 5: Conflict Lifecycle[11]

[9] http://www.forbes.com/sites/augustturak/2012/09/10/the-3-secrets-to-conflict-resolution/
[10] Management and Strategy Institute
[11] Management and Strategy Institute



Managing Conflict

As one goes through the conflict lifecycle, one must be mindful of the personalities involved and the approaches that can be used. Approaches may vary depending on your personality, who is involved, and the situation. Below are several approaches, when they tend to successfully work, and when they might exacerbate the situation:

Table 6: 6 Conflict Management Approaches[12]

Approach	Successfully Use	Backfires
Accommodation	• Care little about the outcome • Are wrong • Have little power	• Resent position after • Appear weak • Make others appear strong
Avoidance	• Time is short • Have less power	• Care about the relationship • Use repeatedly

[12] Management and Strategy Institute

	• Relationship has no value • Desire to block progress • Issue is trivial	• Creates a future expectation • Harms image
Collaboration	• Desire to preserve relationship • Critical to reach ideal solution • Prefer to cooperate as a strategy • All issues can be addressed • Need a win/win outcome	• Ethical or moral issues • Time sensitive • Trivial issues • Irresolvable irreconcilable differences • No mutual respect
Compromise	• Need a non-optimal solution • Time and resources are limited • Equal power • Only way win/win solution	• Resents later • Negatively impacts relationship • Negotiations take time • If you can still collaborate
Domination	• More important to be right than preserve relationships • Have the authority • Issue is trivial • Emergency	• Used too often • Anticipate adverse response • Haven't attempted to collaborate first
Revenge and Self-Harm	• Seek revenge • Opposition wants revenge • Need to win no matter what • Willing to face loses	• Opportunity to collaborate • Losses outweigh gains • Damages reputation, relationship • Need to negotiate with opposition in the future

Relationships, personalities, and circumstances may influence which approach works best for a given situation. The shrewd project manager is able to assess the people involved, their actual vs. perceived power, and devise a strategy based on this information. At times, the project manager may need to shift between approaches to adapt to the opposition. While this may not work in every circumstance, the project manager can follow these basic steps when addressing conflict:

Table 7: Six Steps to Managing Conflict[13]

Step	Description	Statement
1. Confirm	Paraphrase to show understanding	"Yes- I understand that…"
2. Empathize	State the other person's perspective	"I understand why you feel…"
3. Prepare	Pivot from their perspective	"I think that we may need to consider…"

[13] Management and Strategy Institute

4. Provide reasons	Build a case for an alternative perspective	Outline rationale
5. Deliver negative statement	Show you do not agree	"I think we should…"
6. Offer compromise	Provide an alternative solution	"This is why I feel that we need to…."

These steps may vary depending on the reactions and approach of the opposition, what is at stake, and whether the opposition adopts a win/win, win/lose, or lose/lose mentality. For instance, if the opposition takes a lose/lose mentality, there may not be the opportunity to offer a compromise and one may need to take on more of a domination approach to reach an outcome. This approach is often taken in hostile takeovers, and while not ideal, it is often the only approach available given the personalities, situation, and timeline.

Building a Conflict-Embracing Culture

There are several strategies to employ in order to foster a culture where perspectives are freely shared and people can respectfully disagree. At the outset, project managers should seek to build rapport, establish camaraderie, and develop a culture where people are comfortable with each other before conflict even arises. Thus, when conflict does arise, it is easier to get people to share their points of view and respectfully disagree. Moreover, teams and businesses should begin to design processes before conflict even surfaces so that there is a defined path for addressing conflict.[14] On the one hand, team-building at the beginning of the project forges connections, and enables the project manager to assess personalities. On the other hand, establishing processes creates formal paths for conflicts to follow so that expectations can be appropriately managed.[15]

As conflict arises, one point to emphasize is that the team is looking for the optimal solution and that this is merely business rather than personal. Doing so shifts thinking away from personal attacks and toward exploring alternatives.[16] Another way teams build conflict-embracing cultures is by regularly scheduling "challenge events" where there is open discussion on the status quo and how processes can, and should, evolve over time.[17] Doing so highlights the need for change and creates an opportunity for people to share and explore alternatives. A third approach is recognizing employees who regularly challenge norms by highlighting their ingenuity, providing positive reinforcement, and viewing questions and comments as teachable moments.[18] Finally, setting procedures and ground rules for addressing conflict in your team can prevent people from drawing disagreement into danger areas.[19] For example, firms may end with

[14] http://www.businessweek.com/smallbiz/content/feb2011/sb2011024_744270.htm
[15] http://www.businessweek.com/smallbiz/content/feb2011/sb2011024_744270.htm
[16] https://hbr.org/2013/10/nice-managers-embrace-conflict-too/
[17] https://hbr.org/2013/10/nice-managers-embrace-conflict-too/
[18] https://hbr.org/2013/10/nice-managers-embrace-conflict-too/
[19] https://hbr.org/2013/10/nice-managers-embrace-conflict-too/

a “start doing, continue doing, stop doing” assessment at the end of each meeting or feedback session so that positives along with feedback can be shared.

Conflict can be healthy and provide an opportunity to learn, build better solutions, and grow. Warning signals should foster discussion that prevents conflict from becoming toxic. Periodic meetings where people can express ideas in a safe environment can be one tool that fosters conflict-embracing cultures.[20] When facilitating these meetings, it is important to ensure everyone participates and that opinions are shared, respected, and valued.[21]

Conflict Provides Perspective

In today’s interconnected society, conflict is unavoidable, and today’s project manager must come equipped with the tools and skills to embrace conflict. While many fear or avoid conflict because they feel that it could damage relationships or take too much time to overcome, many others are learning that conflict can be healthy and should be embraced. Conflict provides perspective, and addressing it up front may prevent friction from developing to the point where relationships are damaged, ideas for improvement are not shared, and even more time will need to be devoted to meeting demands or re-building relationships. Fostering a culture that questions that status quo, is comfortable sharing opinions, and that is curious learning about ideas and perspectives will create a dynamic team that is more able to adapt to the multiple conflicts that inevitably will come. Be ready to embrace it with open arms.

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[20] http://www.huffingtonpost.com/matt-tenney/embracing-conflict_b_4136135.html
[21] http://www.terihill.com/archives/751

Assessing habitats of vulnerability in African cities: A case of poverty housing in Ibadan Metropolis, Nigeria

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Most cities in developing countries have witnessed unprecedented rapid urbanisation and urban growth which many researchers have likened to 'urbanisation of poverty'. The physical manifestation of this phenomenon has triggered urban residents' exposure to disaster risk due to the proliferation of unplanned, informal settlements, insecurity of tenure, and inadequately maintained essential/infrastructural services. Lack of good practices in urban planning/housing development and risk reduction initiatives have increased the vulnerability of city dwellers, as more than a billion urban residents are living in deplorable conditions. This study aims to assess the housing and urban vulnerability of an African city to natural and man-induced hazards. A well-structured questionnaire survey administered to 156 households in Bere, a pre-colonial community in the core area of Ibadan metropolis, to provide a clear picture of the degree of residents' exposure to disaster risks and their coping capacity. The study advocates the strengthening of local institutional capacity and provides policy recommendations on how to mitigate disaster risk and reduce vulnerability.

Keywords: Cities, Developing countries, Disaster Risk Reduction, Vulnerability, Urbanization, Housing, Urban poor.

1.0 Introduction

The unprecedented pace of urbanisation and urban growth have made developing nations' cities vulnerable to multiple disaster risks due to the high concentration of people, overstretching of the city's inadequate resources such as essential services, urban infrastructure and economic assets (Mitlin & Satterthwaite, 2013). Like many other cities in developing countries, Nigerian cities are being confronted by what many authors describe as urbanisation of poverty (Ravallion, Chen, & Sangraula, 2007), characterized by substandard housing, inadequately maintained basic and infrastructural services (WHO/UNICEF, 2012).

Most urban residents and their assets in Nigeria are increasingly vulnerable to natural and human-induced hazards (I. Adelekan et al., 2015) as a result of low income, insufficient resources and their inability to secure protected lands. These low-income neighbourhoods usually located on marginal lands near flood plains, steep slopes, seashores and other hazardous areas (Hardoy, Mitlin, & Satterthwaite, 2001).

There is a need to develop a better understanding of the underlying causes and influence of a multitude of disaster risks emerging from natural and man-induced hazards in vulnerable cities in Africa, so as to provide policies that will lead to a reduction of disaster risk and vulnerability. This study focuses on the assessment of poverty housing and urban poor's vulnerability characteristics in Bere communities located in the core area of Ibadan metropolis through households' survey, measuring the conditions of physical, social, economic and environmental characteristics of the selected community. It provides a better understanding of root causes, the degree of vulnerability, exposure to disaster risk and coping capacity. The study concludes by advocating policy recommendations in view of scaling up efforts to reducing the vulnerability of the urban community and its inhabitants through disaster risk reduction strategies.

2.0 Housing quality and urban vulnerability

Most cities and urban areas of developing world are identified by unplanned urbanization and poorly managed urban growth. This uncontrolled built environment creates issues that are compounded by the impact of climate change on inhabitants, housing and infrastructure (I. O. Adelekan, 2012). The exposure of city dwellers to environmental risk and vulnerability are due to the intersections of the physical processes—ineffective urban planning, inadequate housing/infrastructural development, and attitudinal actions of urban poor—consumption patterns and lifestyle choices (Blaikie, Cannon, Davis, & Wisner, 2014).Also, Parry (2007) affirms the challenges of high concentration of people with increased social and physical vulnerability (poor socioeconomic conditions and lack of reliable basic services and infrastructures) are aggravated by the impacts of climate change and hazards.

In Ibadan metropolitan city, for instance, an evaluation of housing and urban environmental quality by Coker, Awokola, Olomolaiye, and Booth (2008) confirm the precarious conditions of seventy-two percent of houses in the core area of the city. They are structurally unfit for habitation and also lack basic amenities such as clean water, sewage disposal and proper drainage system. They are susceptible to floods and other risks because they settle in an array of substandard houses, poorly designed and constructed close to flood plains or riverine areas. It is evident that in the developing world, most of the urban poor are residing in risky places as a result of lack capacity and fewer resources.

3.0 Urban planning and development management in African cities

In most developing countries, cities are facing challenges of rapid urbanisation and urban growth with corresponding inadequate municipal services and failed infrastructures, as well as the spread of illegal housing development. For example, over sixty percent of the urban residents living in slums in Africa (UN-Habitat, 2013), and their assets are most susceptible to disaster risks (I. Adelekan et al., 2015), as a result of failure to strictly adhere to appropriate planning and land use management. This development trends usually lead to land use conflicts, slum proliferation, increase vulnerabilities and disaster risk (Pelling & Wisner, 2012). Regardless, (Wamsler, 2006) affirms that urban growth, whether planned or unplanned, rarely plays a distinct role in reducing disaster risk.

In most African cities, the urban planning policies and building codes guiding the land use/development are not regularly updated to meet urban growth's new direction. The local planning authorities are ineffective, ill-equipped to enforce planning regulations and ultimately lack the capacity to oversee urban development management so as to reduce disaster risk (Parnell, Simon, & Vogel, 2007). For example, the local authorities that are responsible for monitoring and enforcing urban development planning and building codes in all the urban districts in Ibadan fail to meet expectations (I. O. Adelekan, 2012).They have limited resources and power to play these important roles (Satterthwaite, 2011). In other to revitalize urban planning processes, concerted actions must be taken by all levels of governments, and respective local communities with the collaboration of the relevant international institutions so as to build sustainable resilience for city residents particularly in developing countries.

4.0 Research methods

The research is based on primary data drawn from questionnaire administration and field observation. Secondary data were sourced from academic journals, textbooks and government documents. A household survey of housing, its neighbourhood characteristics and urban vulnerability to disaster risk in Bere, an urban indigenous community situated at the core of Ibadan metropolis. The study employed systematic random sampling technique to choose each household in the selected study area.

A semi- structured questionnaire was carried out to understand how vulnerable the human settlements and, their residents to natural and man-induced hazards. The questions were centred on households' socio-economic and demographic characteristics of respondents, housing quality; physical/structural conditions of the housing stock, as well as assessment of basic/infrastructural services, residents' environmental conditions and, flood risk perception /coping capacity.

This research was carried out in Bere, a traditional community located at the heart of the metropolitan city of Ibadan-Nigeria. The Bere community is under the category of highest density areas, one of the three major classifications of residential land use characteristics in urban areas Ibadan (Adigun, 2013; Afon & Faniran, 2013). A random sampling was adopted to select one of the traditional communities from high-density residential areas of the heart of Ibadan city.

4.1 Overview of the study area

The city of Ibadan, the administrative headquarter of the old western region of Nigeria and now Oyo state's capital. Ibadan (Figure 1) is the third largest metropolitan area, by population in the country, after Lagos and Kano with a population of 2.55 million people with about 634.3 kilometre square and equivalent of 828 persons per square kilometres, one of the highest densities in the country. Out of this population figure, the core area of Ibadan has 1.34 million residents (I. O. Adelekan, 2012; Ayeni, 1994).The urban growth and urbanisation witnessed in the city are widely attributed to the influx of rural-urban migrants, due to the availability of economic opportunities such as the presence of industries, an array of institutions and infrastructural services (Owoeye & Ogundiran, 2014). This unprecedented development overwhelmed the little resources available, and inadequately maintained services (Salami, Von Meding, Giggins, & Olotu, 2015).

Ibadan metropolitan city is known as flood prone area with several cases of flooding records since 1902. The unprecedented flood incidences that killed hundreds of people and destruction of properties of residents worth millions of naira. More than 500 hundred, and 130 people lost their lives in flood disasters that occurred on 31st of August 1980 and 26th August 2011 respectively (Agbola, Ajayi, Taiwo, & Wahab, 2012).The poor sewage disposal of domestic and industrial waste largely contributed to flood incidences due to blockages in river channels.

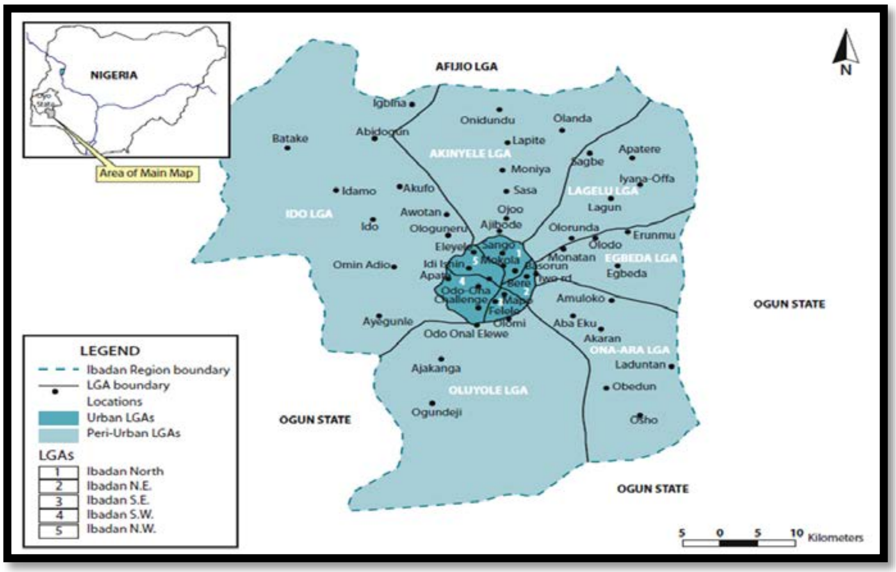

Figure 1: Map of Ibadan showing the urban core of the city.
Source:(I. Adelekan, 2010)

5. Results: Housing and urban vulnerability characteristics of Bere community

5.1 Demographic features

In this study, the results indicated that 108(69%) of the 156 households' respondents surveyed were male while 48(31%) were female (Table 1). Sixty-six (42%) of the head of households sampled were between the ages of 41 and 50 years while (25%) were above 50 years old. Fifty-one (33%) were below the age of 40 years.

Table 1: Demographic Characteristics of Households' head in Bere Community

Parameters	Frequency (n=156)	Percentage (%)
Gender		
Male	108	69.2
Female	48	30.8
Marital status		
Single	13	8.3
Married	131	84.0
Widowed	9	5.8
Separated	2	1.3

Others	1	0.6
Age		
18-20	2	1.3
21-30	28	17.9
31-40	21	13.5
41-50	66	42.3
51 above	39	25.0
Total	**156**	**100**

Source: Fieldwork (2015)

5.2 Socio-economic profile of the respondents

Household size: Majority of the households' respondents (64%) had between 4 and six persons while (16%) and (15%) of the sampled residents had between 1 to 3 and 7 to 9 persons respectively. Only (5%) of the inhabitants surveyed in the study area were 10 and above in their households.

Households' head: Out of 156 head of the households sampled (Table 2), 149(95%) of them were male, and just 7(5%) are a female head of the homes. This indicated that the community is dominated by the male head of the household.

The level of education and occupation: Most of the residents surveyed (85%) in the selected population had very low education qualifications. While just 9(6%) of the head of households had post-secondary school education, fourteen (9%) did not have formal education. The households' education status mostly affected the nature of their occupation or employment, as the majority of respondents engaged in the informal economy. Seventy-two (46%) of sampled population are traders, (37%) and (5%) are farmers respectively while (1%) each are civil servants and professionals.

Monthly income: The study shows that the (74%), the majority of the respondents' earnings in a month in the study areas is less than N20, 000. While (17%) of sampled households' monthly income are between N20,000 and N40,000, nine (6%) of the households' head are jobless with no monthly income.

Land tenure security: Only 29 homes (19%) of the respondents approved their properties while (59%) of all the buildings sampled were not approved. Another (21%) of respondents were not sure of the tenure security status of their houses.

Table 2: Socio-economic characteristics of Households' head in Bere Community

Parameters	**Frequency (n=156)**	**Percentage (%)**
Household's head		
Male	149	95.5
Female	7	4.5
No of children		
None	2	1.3
1-3	76	48.7
4-6	72	46.2
7-9	3	1.9
Above 10	3	1.9
Households' size		
1-3	25	16.0
4-6	99	63.5
7-9	24	15.4
10+	8	5.1
Total	**156**	**100**

Source: Fieldwork (2015)

5.3 Physical/structural characteristics of building stock

Age of the buildings**:** The research indicates (Table 3) that most of the buildings (95%) were timeworn and years of construction are between 10 years and above. Five percent (5%) of the respondents' houses were aged between one and nine years.

Wall construction materials: As shown in Table 3, most of the buildings sampled (95%) in the selected community utilised substandard building materials like mud for their houses with less than (5%) used quality materials such as cement blocks. This is responsible for a higher proportion of timeworn, run-down buildings and large numbers of indigenous people living in low-quality housing that cannot protect inhabitants under hazard conditions.

Structural conditions of the buildings: The structural stability of the sampled houses are in deplorable conditions. The results indicated that (57%) of the Bere households' dwelling units need major repair, and another (35%) need minor repair. Also, only twelve buildings (8%) of the surveyed houses are in good conditions. Therefore, most of these houses and their inhabitants are susceptible to natural hazards such flooding and heavy windstorms.

Table 3: The physical/structural characteristics of Households' dwellings

Parameters	Frequency (n=156)	Percentage (%)
Age of the building		
1-3	1	0.6
4-6	1	0.6
7-9	6	3.8
Ten years and above	148	95.0
Wall construction materials		
Mud	114	73.1
Cement block	15	9.6
Sun-dried brick	6	3.8
Bamboo with mud	21	13.5
Structural conditions		
Needs minor repair	54	34.6
Needs major repair	89	57.1
In good condition	12	7.7
Others	1	0.6
Total	**156**	**100**

Source: Fieldwork (2015)

5.4 Basic/infrastructural facilities conditions of the neighbourhood

Access to water: The results (Table 4) indicated that limited access to essential services such as access to clean water, as (69%) of the residents walk to fetch water in about 200 meters away from their homes. While around (30%) of Bere community only have access to water in the well.Toilet facilities and waste disposal: Also, the majority of households' surveyed (85%) only have access to a pit latrine. Poor drainage systems/garbage collections (72%) and indiscriminate open dumping of refuse, leading to blockage of drainage channels and causing houses to be flooded, as well as jeopardizing environmental landscape and public health.

Table 4: Basic/infrastructural facilities conditions of the neighbourhood

Parameters	**Frequency (n=156)**	**Percentage (%)**
Access to water		
Borehole	12	7.7
Well	48	30.8
Outside my yard (<200m)	86	55.1
Outside my yard (>200m)	9	5.8
Through water tanker	1	0.6
Access to toilet facilities		
Water closets	9	5.8
Pit latrine	133	85.3
Public toilet	4	2.6
Bush	1	0.6
Dumping ground	3	1.9
others	6	3.8
Waste disposal		
Very inadequate	50	32.1
Inadequate	62	39.7
Fair	18	11.5
Adequate	25	16.0
Very adequate	1	0.6
Total	**156**	**100**

Source: Fieldwork (2015)

5.4 Flood risk perception and adaptation strategies

In Table 5, the results indicated that (79%) had records of flood-related damages to their properties. While (24%) were severely damaged, fifty-five percent were not, as (21%) had no history of the flood disaster. Also, regarding the root underlying causes of floods in the sampled areas, about (54%) believed it was as a result of blockage of waterways/river channels and (44%) chose prolonged rainfall as the second cause of flood disasters. Previous research by Agbola et al. (2012) corroborate the outcome of this study. Coping and adaptation strategies adopted by respondents are the maintenance of buildings (25%), use of quality construction materials (17%) and (4%) for support from family and friends. More than half (54%) of the heads of household believed that seeking for spiritual interventions from Almighty God as their first coping measure. In the research on the cyclone occurrence in coastal Bangladesh by Haque and Blair (1992), more than (70%) of inhabitants relied on prayer as an important adaptation strategy.

Table 5: Flood risk perception and adaptation strategies

Parameters	**Frequency (n=156)**	**Percentage (%)**
Flood-related damage before		
No	33	21.0
Yes, but not severely	86	55.0
Yes, severely	37	24.0
Causes of floods		
Heavy rainfall	68	43.6

Blockage of waterways	84	53.8
Building on flood liable plains	4	2.6
Improper planning and poor land use	1	0.6
Adaptation strategies		
Maintenance of building	39	25
Use of quality construction materials	27	17.2
Support from family/friends	6	3.8
Prayers	84	54
Insurance	0	0
Total	**156**	**100**

Source: Fieldwork (2015)

6.0 Discussions

This study has evaluated the housing and urban vulnerability of Bere, one of the pre-colonial communities in the core centre of Ibadan metropolitan city. This was achieved through households' survey of the exposure and susceptibility of human settlements, basic physical and neighbourhood infrastructure to disaster risks such as floods and weather storms. The assessment of socioeconomic profiles of heads of household in the selected society revealed that the majority of respondents involved in the only informal sector of the economy for survival. Most of the households sampled also had very low level of educational qualifications.

According to the outcome of this research, the residents of Bere community are slum dwellers by the housing quality and their neighbourhood characteristics. The households share the same features of slums as defined by United Nations; lack of essential services, substandard housing and poor building structures (UN-Habitat, 2004). Previous researchers have also affirmed that those who live in poverty housing in low-income communities without adequate infrastructure services are most vulnerable to environmental hazards and climate (Peduzzi, 2011; UN-Habitat, 2011).

Based on the results of the vulnerability assessment, Bere community fits into the categories of inner city slums such as in Cairo, Dhaka as described by Baker (2012). Situated in the historic core of Ibadan city, facing series of disaster risks range from the life-threating condition of the structures, inadequate basic services to records of the high density of inhabitants and challenging of vehicular access to narrow roads in case of emergency. It is evident that most of the urban residents in the study area are facing a great deal of variety of disaster risks such as physical vulnerabilities; flood hazards, weather storms and social vulnerabilities; informal economy, low education, lack of skills and social exclusion from local institutions (UN-habitat, 2011).

7.0 Policy recommendations: Local institutions as a focal point

Local authorities have significant roles to play in reducing disaster risks and vulnerabilities of human settlements, as a result of local governments' constitutional responsibility of providing basic infrastructure services, development of urban planning and strict adherence to building codes (Johnson, 2011). In the case of Ibadan city and most of the urban areas in African cities, the efforts are counterproductive due to limited resources and power (Satterthwaite, 2011), ineffective urban planning, bad governance, and lack of tools/skills to monitor urban development (Myers, 2011; UN-Habitat, 2009). Also, for instance in Nigeria, the only public sector for risk management is National Emergency Management Agency (NEMA). NEMA approach to risk management is more reactive than proactive because of inadequate funding, equipment and skills (I. O. Adelekan, 2012; Olorunfemi & Adebimpe, 2008). Therefore, for local institutions and disaster risk management agency in cities of developing countries to be effective in reducing vulnerability, a continuous, collective collaboration by the international community, civil organisations and NGOs to develop initiatives to assist cities and urban residents build resilience to mitigate the impacts of natural and human-induced hazards.

8.0 Conclusion

Globally, in African cities, urban residents and their assets are most vulnerable to disaster risk due to the exposure to various hazards (I. Adelekan et al., 2015). According to Hanson et al. (2011), there are three distinctive characteristics of their vulnerability; inadequate planning, low quality of housing with poor disaster resistance, and informal economy and insufficient resources. Bere, a traditional urban community in the core area of Ibadan metropolis is vulnerable to hazards such as floods, weather storms and other environmental risks that are health related with the low adaptive capacity to any future disaster. This inner city slum is characterised by tenure insecurity, very low quality, structurally weak and inadequately maintained dwellings, lacking essential services and occupied by low-income residents. The residents' physical and socioeconomic characteristics coupled with inadequate urban planning and bad governance contribute to the limited community resilience. It is crucial to integrate disaster risk management into urban planning/development, and strengthening institutional capacity so as to achieve sustainable risk reduction.

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Project Management Challenges in Road Infrastructure Development in Poland

Introduction.

Large investments in Poland's road transportation infrastructure began in 2007 and they are planned to continue till 2023. The scale of hitherto and forthcoming investments is presented in Figure 1.

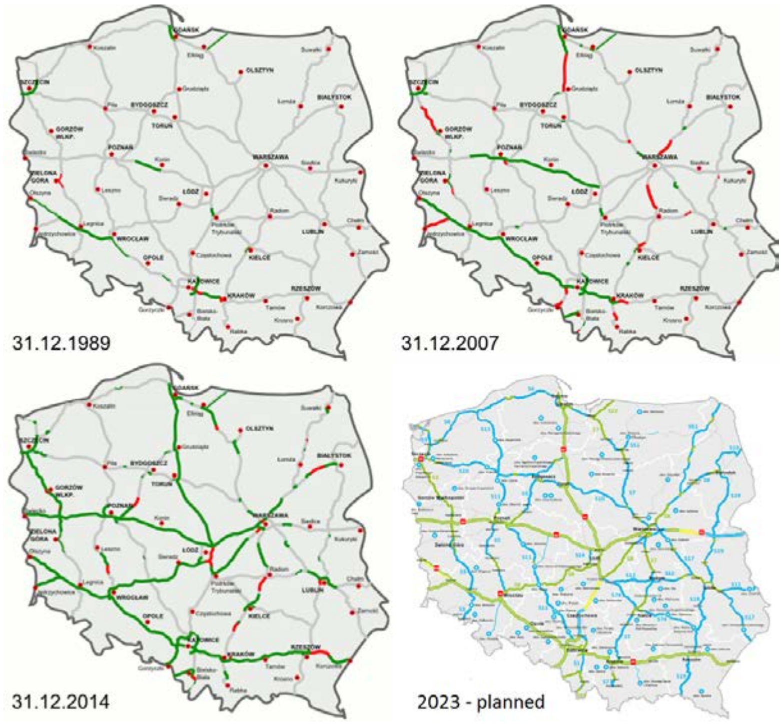

Figure 1: Motorways and highways in Poland in 1989, 2007, 2014 and 2023 (planned)[1]

Due to the scale and importance of road infrastructure investments in Poland, the decision support process in the field of road infrastructure management turns out to be very significant. This process may be supported by numerous tools and solutions. The most popular are economic models, financial analyses, multi-criteria evaluation methods, decision diagrams, risk sharing by cooperation in public-private partnership etc. They are described by numerous authors in numerous publications. For instance, the economic aspects of public investments planning and modeling were considered by D. Felstenstein, R. McQuaid, P. McCann and D. Cheltenham (2001)[2]. T. Zhao S. Sundararajan and C. Tseng (2004)[3] presented a model for decision making in highway development, operation, expansion, and

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[1] Source: Based on Resolution No. 156/2015 of the Council of Ministers of Republic of Poland, 8 September 2015 - Establishing a multiannual program under the name "National Road Construction Programme for the years 2014 to 2023 (with the prospect of 2025)" and https://upload.wikimedia.org/wikipedia/commons/a/af/Historia_budowy_autostrad_i_dr%C3%B3g_ekspresowych.gif

[2] D. Felstenstein, R. McQuaid, P. McCann and D. Cheltenham (ed.), Public Investment and Regional Economic Development (2001), Edward Elgar Hardback, 271

[3] T. Zhao, S. Sundararajan, C. Tseng, Highway Development Decision-Making under Uncertainty: A Real Options Approach., J. Infrastruct. Syst., 10.1061/(ASCE)1076-0342(2004)10:1(23), 23-32.

rehabilitation. This model bases on Monte Carlo simulation method. E. Mongo (2008)[4] in his study about the decision-making process in road infrastructure development examined the problem that policy and planning decisions have led to limited navigable roads in Cameroon. W. Brauers, E. Zavadskas, F. Peldschus and Z. Turskis (2008)[5] presented a methodology for multi-objective optimization of multi-alternative decisions in road construction. This methodology bases on Multi-Objective Optimization on the basis of the Ratio Analysis (MOORA) method. A review of multi-criteria decision-making methods for infrastructure management was presented by D. Jato-Espinoa, E. Castillo-Lopezb, J. Rodriguez-Hernandeza and J. C. Canteras-Jordana (2013)[6]. The problems of decision support in road infrastructure are still up-to-date and are explored by numerous authors such as R. Haigh (2014)[7], L. Chen, T. Henning, A. Raith and A. Shamseldin (2015)[8] and others.

One of the areas where the decision-making tools and solutions should be implemented concerns the cooperation between central and local governments. The process of building the new road infrastructure led to numerous expectations from Poland's local governments. On one hand, the communities crossed by motorways claimed negative impact of these roads on local businesses, on unemployment rates and on other economic performance factors. On the other, jurisdictions which have no direct access to the motorways need funds in order to ensure sustainable development. In Poland a significant amount of local government funds are derived not from property taxes or income tax from local residents, but from redistribution of central government tax revenues.

As a result, if the demands of local governments were met, the costs of economic development would have been charged to the central government budget and - in consequence - to the budgets of projects undertaken by the central government.

Due to the fact the expectations of local governments are not cohesive, it is necessary to determine objective criteria for funding allocation. To do this, it is essential to find the answers to the following questions:

- What is the nature (and spatial range) of impact of motorways on local municipalities?
- How to predict this impact in order to allocate the development funds?

Determining the impact

Preparing data

[4] E. Mongo, The Decision-Making Process in Road Infrastructure Development in Cameroon Since 1980, Walden University, 2008

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As an illustration of the premise of this study, Świecko - Nowy-Tomyśl section of A2 motorway was selected. This selection was made due to the following reasons:

- This section is relatively long (107 km), so it is easier to detect the spatial distribution of economic impact.
- The section was build in 2011, so in spite of being relatively new it is possible to obtain data necessary to assess its economic impact.
- The section is not in a close proximity to big cities. The proximity to a large economic center could skew the results.

The next step was to measure the distances from the motorway to all municipalities. The distances were measured to the centroids of municipalities, using QGIS software. The distances to the motorway and distances to the closest motorway intersection were both measured. The distances were put into MS Access database in order to combine them with data from the Polish Statistical Office. The database comprised the following data:

- change in the population of municipalities;
- change in the number of microenterprises (0-9 employees);
- change in the number of small enterprises (10-49 employees);
- change in the number of medium and big enterprises (50 employees and more);
- change in the unemployment level;
- change in the proceeds of individual income tax to local budgets;
- change in the proceeds of corporate tax to local budgets;
- distances to the motorway.

Each of the tested indicators is described as a change. The changes were calculated in "year on year" mode according to the formula:

$$\frac{v_y - v_{y-1}}{v_{y-1}}$$

Equation 1

where v_y is a value of an indicator in a year "y".

Data analysis

The next stage was to determine whether the dependence between the selected factors and the distances to motorway exists. To determine this dependence, the Pearson correlation coefficient was used. The data were sorted out by distance to the motorway. Then, for each municipality, Pearson correlation coefficient was calculated, including the calculations for all the municipalities, which are at least as close to the motorway as the selected municipality. For instance, if municipality of Buk is situated 29.5 kilometers away from the motorway, to calculate the Pearson correlation coefficient one included all the communes, which are no more distant from motorway than the municipality of Buk. It was done in order to assess the character and spatial range of the impact on the tested factor. The example charts which present correlations between the distances from motorway and changes of various parameters are presented in Figure 2.

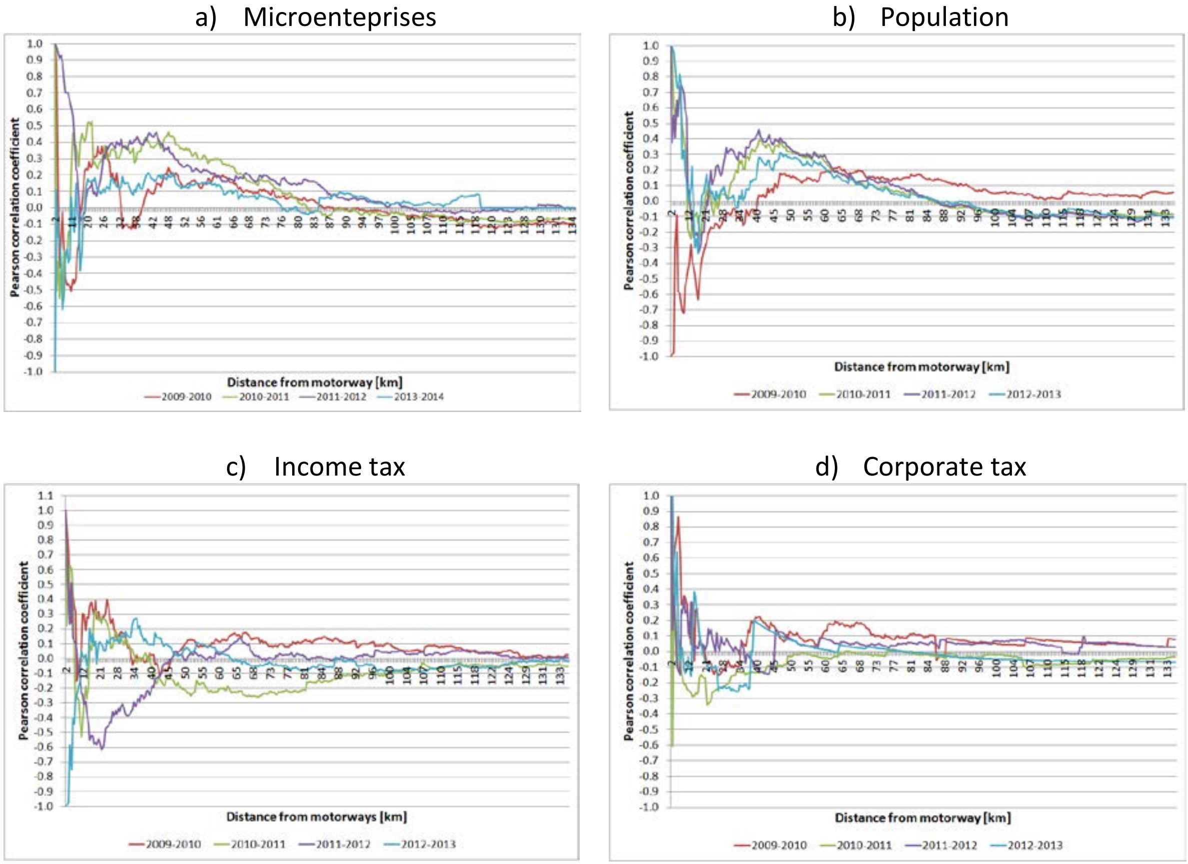

Figure 2: Correlations between distances from motorway and changes in number of microenterprises, population and proceeds of income and corporate tax

As one can see from Figure 2a, example on the chart with microenterprises, the correlations were quite high in close proximity from the motorways and then they started to decrease. In the beginning the charts are serrated. This variety is caused by a small amount of data (there are not many municipalities in such proximity of the motorway). Analysis of all the charts and previous research[9] shows that if impact of the motorways on the examined factors exists, it has a range of about 40 kilometers. However, one can notice the vast variety of correlations calculated for particular municipalities. That means that it is necessary to introduce additional conditions in order to ensure that the calculated correlations are statistically significant. For each factor all the correlations for communes which are between 30 and 35 kilometers from motorway were taken, and then the average, median and standard deviation of these data were calculated. The average value of correlation coefficients allows to flatten the serrated charts. The median value of correlation coefficients helps to eliminate the cases, when a few large values significantly overstate the average. Standard deviation, if it is too large, testifies that the chart is excessively serrated, and the correlations are changing too fast to become a creditable source of information. These three measurers were used to determine the existence and character of

[9] Results of previous research presented in report "Wpływ projektów infrastrukturalnych na rozwój lokalnej tkanki gospodarczej" (the Impact of Infrastructure Projects on Development of Local Economies), University of Economics, Katowice, 2014, unpublished

impact of motorways on the examined factors. To recognize an impact as being of significance the following conditions should be fulfilled:

- average correlation ≥ 0.2
- median of correlations ≥ 0.2
- standard deviation < 0.1

The same procedure was repeated for correlations between selected factors and distances from motorway intersections, and for the data taken from all communes between 25 and 40 km. The results are presented in Tables 1 and 2.

Table 1: Results of calculations for frame 30-35 km

	For range 30 - 35 km									
	For distances from motorways					For distances from intersections				
Dates	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**
	Microenterprises					**Microenterprises**				
Average	-0.09	**0.37**	**0.29**	-0.04	0.14	-0.01	**0.35**	**0.38**	0.10	0.14
Median	-0.12	**0.38**	**0.29**	-0.06	0.15	-0.10	**0.36**	**0.38**	0.08	0.15
Std. dev.	0.08	**0.03**	**0.04**	0.06	0.04	0.13	**0.03**	**0.02**	0.04	0.02
	Small enterprises					**Small enterprises**				
Average	-0.10	0.14	0.13	0.16	-0.16	-0.13	0.14	0.12	0.22	-0.16
Median	-0.09	0.14	0.13	0.16	-0.16	-0.15	0.13	0.13	0.24	-0.15
Std. dev.	0.10	0.03	0.04	0.02	0.02	0.03	0.03	0.05	0.03	0.03
	Medium and large enterprises					**Medium and large enterprises**				
Average	-0.08	0.04	0.17	-0.14	-0.02	-0.09	0.04	0.08	-0.11	-0.12
Median	-0.09	0.03	0.16	-0.13	-0.02	-0.08	0.04	0.07	-0.13	-0.14
Std. dev.	0.06	0.02	0.05	0.02	0.08	0.06	0.02	0.04	0.03	0.07
	Unemployment					**Unemployment**				
Average	0.15	0.08	0.11	-0.18	No data	0.15	0.00	0.05	-0.14	No data
Median	0.14	0.09	0.10	-0.18	No data	0.15	-0.01	0.05	-0.14	No data
Std. dev.	0.06	0.02	0.03	0.04	No data	0.02	0.03	0.02	0.05	No data
	Corporate tax					**Corporate tax**				
Average	-0.10	-0.12	-0.02	**-0.23**	No data	-0.06	-0.14	0.02	**-0.24**	No data
Median	-0.09	-0.13	0.00	**-0.23**	No data	-0.09	-0.13	0.01	**-0.25**	No data
Std. dev.	0.01	0.02	0.04	**0.02**	No data	0.07	0.01	0.02	**0.02**	No data
	Income tax					**Income tax**				
Average	-0.01	0.01	**-0.27**	0.23	No data	0.04	0.06	**-0.35**	0.20	No data
Median	0.00	0.01	**-0.27**	0.25	No data	0.02	0.07	**-0.36**	0.18	No data
Std. dev.	0.04	0.04	**0.05**	0.05	No data	0.06	0.06	**0.04**	0.06	No data
	Population					**Population**				
Average	-0.10	0.15	**0.24**	-0.06	No data	-0.09	0.19	**0.31**	0.01	No data
Median	-0.09	0.13	**0.23**	-0.06	No data	-0.09	0.18	**0.31**	0.02	No data
Std. dev.	0.02	0.07	**0.05**	0.07	No data	0.03	0.06	**0.02**	0.04	No data

Table 2: Results of calculations for frame 25-40 km

	For range 25 - 40 km									
	For distances from motorways					For distances from intersections				
Data	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**	**2009-2010**	**2010-2011**	**2011-2012**	**2012-2013**	**2013-2014**
	Microenterprises					**Microenterprises**				
Average	0.06	**0.32**	**0.30**	0.03	0.12	0.06	**0.34**	**0.38**	0.09	0.13
Median	-0.03	**0.33**	**0.30**	0.04	0.14	0.00	**0.34**	**0.38**	0.09	0.13
Std. dev.	0.19	**0.05**	**0.06**	0.07	0.05	0.18	**0.03**	**0.04**	0.04	0.03
	Small enterprises					**Small enterprises**				
Average	-0.08	0.13	0.10	0.11	-0.17	-0.08	0.11	0.12	0.19	-0.17
Median	-0.09	0.14	0.12	0.14	-0.16	-0.10	0.13	0.13	0.23	-0.16
Std. dev.	0.13	0.09	0.08	0.08	0.04	0.09	0.10	0.07	0.08	0.04
	Medium and large enterprises					**Medium and large enterprises**				
Average	-0.11	0.05	0.15	-0.11	-0.04	-0.13	0.06	0.15	-0.08	-0.07
Median	-0.14	0.03	0.15	-0.13	-0.02	-0.16	0.04	0.16	-0.07	-0.05
Std. dev.	0.08	0.04	0.06	0.04	0.07	0.08	0.05	0.07	0.03	0.09
	Unemployment					**Unemployment**				
Average	0.16	0.12	0.08	-0.12	No data	0.15	0.05	0.02	-0.14	No data
Median	0.14	0.12	0.08	-0.13	No data	0.15	0.03	0.04	-0.14	No data
Std. dev.	0.06	0.05	0.06	0.06	No data	0.05	0.06	0.05	0.05	No data
	Corporate tax					**Corporate tax**				
Average	-0.05	-0.14	-0.01	-0.16	No data	-0.01	-0.17	0.01	-0.17	No data
Median	-0.09	-0.13	0.00	-0.23	No data	-0.08	-0.15	0.01	-0.23	No data
Std. dev.	0.10	0.04	0.07	0.16	No data	0.13	0.04	0.06	0.14	No data
	Income tax					**Income tax**				
Average	0.05	0.02	**-0.27**	0.20	No data	0.08	0.06	**-0.32**	0.16	No data
Median	0.00	0.03	**-0.28**	0.20	No data	0.03	0.07	**-0.32**	0.14	No data
Std. dev.	0.10	0.09	**0.06**	0.06	No data	0.09	0.06	**0.06**	0.05	No data
	Population					**Population**				
Average	-0.11	0.12	**0.26**	-0.02	No data	-0.10	0.17	**0.30**	0.05	No data
Median	-0.12	0.13	**0.27**	-0.04	No data	-0.09	0.18	**0.31**	0.04	No data
Std. dev.	0.05	0.15	**0.08**	0.09	No data	0.04	0.12	**0.07**	0.05	No data

For both, the distances from motorways and distances for intersections the results were similar. For both frames (30-35 and 23-40 km) the requirements necessary to recognize the impact as significant were fulfilled for the following factors:

- change of number of microenterprises in 2010-2011 (just after the opening the motorway to use);
- change of number of microenterprises in 2011-2012 (a year after opening the motorway to use);
- change of population of communes in 2011-2012;
- change of proceeds of income tax for individuals to local budgets in 2011-2012.

In the case of 'Change of corporate tax in 2011-2012' the requirements where fulfilled while calculated in the frame of 30-35 km, but not in the frame of 25-40 km.

The positive sign of standard deviation means that the examined values are growing with the distance from the motorway. So the impact on motorway on the number of microenterprises and population is negative. These factors are decreasing (or the rate of increase is diminishing) when the distance from motorway decreases. The negative value of correlation coefficient in case of income tax indicates the positive impact of the motorway. This also means that the motorway has a positive impact on the income tax in general and, in consequence on the income level of citizens. In summary, both positive and negative impact of the highway has been detected.

Predictions

The next question formulated in the goal of research was "how to predict the economic impact in order to allocate the development funds?". The first attempt to arrive at an answer based on computing linear regression using the least-square method. As the dependent variables, the distances to motorways, the distances to intersections and both (multiple regression) consecutively were taken. To assess the results the coefficient of residual variation V_e was used.

$$V_e = \frac{S_e}{Y_{av}} * 100\%$$

Equation 2

where:

$$S_e = \left[\frac{1}{n-m-1}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2\right]^{0.5}$$

Equation 3

Y_{av} – average independent value

n – number of observations (communes)

m – number of dependent values

y_i – real independent value

$\hat{y}_i$ – estimated value

The values of coefficient of residual variation are presented in Table 3.

Table 3: Linear regression - coefficients of residual variation of values predicted by linear regression.

Dependant variables (distances from)	Microenterprises 2010-2011	Microenterprises 2011-2012	Income tax 2011-2012	Population 2011-2012
Motorway	-557.91%	82.20%	109.52%	333.09%
Intersection	-560.69%	82.42%	110.06%	333.31%
Both	-557.14%	80.79%	110.02%	331.02%

The value of the coefficient of residual variation indicates how strong is the impact of factors omitted in the model (including random error) on the independent value. In every case, even in analyses of changes of number of microenterprises in 2011-2012, this coefficient is relatively high. This means that the proposed models are insufficient to predict the real outputs. The possible reasons of poor fit of models to reality may be as follows:

- *Phenomena are not linear*. To increase the fit, non-linear models should be used.
- *Initial conditions should be taken into account*. For instance it is possible that the communes with strong economic base are getting stronger while the weak communes are getting weaker. It is also possible that for the weak communes the positive impacts are large while for the stronger ones they are weaker.
- *Some spatial information should be taken into account*. The results may be disfigured by big factories, economic centers etc. The results may be also distorted by the road infrastructure, which is not included in this research. If this problem occurs, it may be partially solved by including information about mutual proximity of communes into model.
- Lack of data or lack of data accuracy. It is also possible that the data are insufficient or to general to obtain better results. The data about communes are focused in points (centroids) and all the information about the spatial deployment of this data inside the communes are not taken into account. Moreover it is possible that the data such as traffic information should be included in model too.

If the first three reasons occurs it is possible to improve the quality of the model by using machine learning computations and a locally weighted linear regression method.

Locally weighted linear regression.

Locally weighted linear regression algorithm is a modification of Least Mean Squares (LMS) rule. Let us assume that we have values x_1, x_2, …, x_n included in a model. If the model is linear, it can be represented as in Equation 4:

$$h(x) = \theta_0 + \theta_1 x_1 + \theta_2 x_2 + \ldots + \theta_n x_n$$

Equation 4

The θ's are the parameters (or weights) of model. Function $h(x)$ is called hypothesis. To simplify the notation the value x_0 = 1 is introduced, so the hypothesis may be written as in Equation 5.

$$h(x) = \theta_0 x_0 + \theta_1 x_1 + \theta_2 x_2 + \ldots + \theta_n x_n = \sum_{i=0}^{n} \theta_i x_i = \vec{\theta}^T \vec{x}$$

Equation 5

The training set which X and Y is given. The goal is to pick (learn) the parameters θ in order to minimize the errors of hypothesis. To formalize it the cost function J(θ) is defined:

$$J(\theta) = \frac{1}{2} \sum_{i=1}^{m} \left(h_\theta(x^{(i)}) - y^{(i)} \right)^2$$

Equation 6

Where:

m	– number of training examples
$x^{(i)}$	– the dependent values in row i
$y^{(i)}$	– the independent value in row i
$h_\theta\left(x^{(i)}\right)$	– hypothesis (now $\vec{x}$'s are known and $\vec{\theta}$ is searched).

To minimize the cost function it is possible to use gradient descent algorithm. In this algorithm the subsequent values of θ are computed using the formula:

$$\theta_j := \theta_j - \alpha \frac{\partial}{\partial \theta_j} J(\theta)$$

Equation 7

$$\theta_j := \theta_j + \alpha \sum_{i=1}^{m} \left(y^{(i)} - h_\theta(x^{(i)}) \right) x_j^{(i)}$$

Equation 8

where:

α – learning rate: relatively small value responsible for speed and accuracy of algorithm.

Using this formula each θ is calculated repeatedly until obtaining convergence (the changes of θ are negligible).

In the locally weighted linear regression (LLWR) algorithm the entire calculations are made not to find the general function, but to find the predicted independent value for one particular x. The intuition is to reduce non-linear effects by paying attention mostly to these data examples, which are in the proximity of x. This is presented in Figure 3.

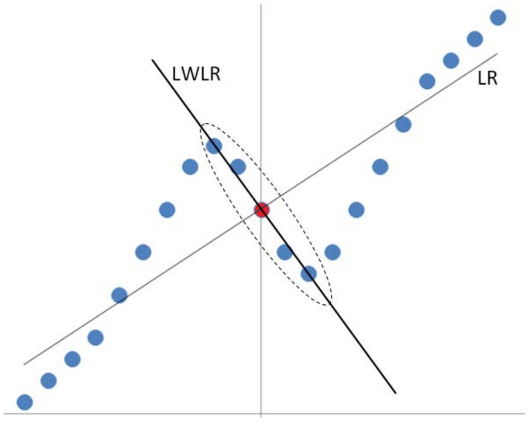

Figure 3: Locally weighted linear regression

LLWR adds weights to the cost function.

$$J(\theta) = \frac{1}{2}\sum_{i=1}^{m} w^{(i)}\left(h_\theta(x^{(i)}) - y^{(i)}\right)^2$$

Equation 9

A standard choice of “w” is:

$$w^{(i)} = \exp\left(-\frac{\left(x^{(i)} - x\right)^2}{2\tau^2}\right)$$

Equation 10

And if x is a vector:

$$w^{(i)} = \exp\left(-\frac{\left(x^{(i)} - x\right)^T\left(x^{(i)} - x\right)}{2\tau^2}\right)$$

Equation 11

τ is the parameter responsible for the behavior of algorithm. For a small values of τ the algorithm pays attention mostly on the data in proximity of searched value. For a big τ the algorithm tends to behave like Linear Regression.

The entire algorithm to find predicted value for a single data example is presented as follows:

Repeat until convergence { For each j { $\theta_j := \theta_j + \alpha \sum_{i=1}^{m} w^{(i)}\left(y^{(i)} - h_\theta(x^{(i)})\right)x_j^{(i)}$ } }

Calculations and results

Originally, the LWLR algorithm was supposed to deal with the nonlinearity of analyzed functions. However, the possibilities delivered by this algorithm are wider. The weights do not have to base on the distances of dependent values, but they may be selected due to other reasons. For instance - if we assume that the results should depend on the initial income of commune per capita, the weights could represent this income. Predicting the results, algorithm will take account mostly on this communes, which have similar level of income per capita.

During the research three different types of weights were taken into account. In the first type the "classical" weights, based on the dependent values (distances from motorway and closest intersection), were calculated. By using these weights it was possible to check, whether the searched function is significantly non-linear. The second type of weights were based on the initial values of searched variables. The data used to calculate the weights were as follows:

- population
- number of microenterprises per 1000 inhabitants
- communes budgets revenues from the income tax per capita

The third type of weights comprises spatial information - the data about mutual distances of communes. The distances were calculated using QGIS. This time, weights were used to check whether the spatial information about mutual position of commune can influence the accuracy of predictions.

Before calculating the weights, data were normalized in columns to scale [0..1]. For the second type of weights the normalization was necessary in order to make the different types of data comparable. The first and third type of data may be used to calculate weights without normalization, but normalization facilitated adjusting the proper value of τ.

The entire algorithm used to calculate the predicted values looked as follows:

```
For each type of weights and for each independent value {

        For each data example {

                Remove data example from data set;

                Normalize the data_for_weights set;

                calcualate the weights;

                Predict independent value using LWLR;

        }

}
```

The calculations were implemented in c++[10]. Due to the fact that the real values of the independent variables were known, it was possible to calculate the coefficient of residual variation in order to assess the improvement of employing LWLR algorithm with various sets of weights. The values of coefficient of residual variation are presented in Table 4.

[10] Source code on http://przemeksekula.eu/motorways2015/, (access: 2016/03/15)

Table 4: Locally weighted linear regression - coefficients of residual variation

Type of weights	Tau	Dependant variables (distances from)	Microenterprises 2010-2011	Microenterprises 2011-2012	Income tax 2011-2012	Population 2011-2012
Based on independent values	0.5	**Motorway**	-575.82%	84.33%	111.66%	339.70%
		Intersection	-582.08%	84.57%	113.03%	336.95%
		Both	-607.77%	90.01%	119.54%	341.07%
	1	**Motorway**	-573.60%	83.99%	112.98%	340.18%
		Intersection	-579.45%	84.43%	113.60%	339.09%
		Both	-594.44%	90.35%	117.59%	347.06%
Based on initial conditions	0.5	**Motorway**	-577.06%	83.45%	113.98%	340.90%
		Intersection	-583.24%	83.83%	114.21%	339.60%
		Both	-593.46%	90.78%	119.00%	351.35%
	1	**Motorway**	-574.24%	83.70%	113.82%	340.65%
		Intersection	-580.10%	84.16%	114.09%	339.98%
		Both	-589.81%	90.62%	117.95%	351.87%
Based on distances between communes	0.5	**Motorway**	-591.57%	84.61%	126.27%	345.86%
		Intersection	-598.25%	85.20%	126.33%	342.01%
		Both	-593.50%	90.28%	119.49%	347.47%
	1	**Motorway**	-590.86%	85.26%	125.20%	346.42%
		Intersection	-597.28%	85.73%	125.38%	343.59%
		Both	-590.10%	90.44%	117.67%	351.89%

None of the coefficients has a satisfactory value. Moreover, in any case the value of coefficient of residual variation has not improved (decreased). This leads to the following conclusions:

- Simple non-linear models cannot predict the searched values better than linear ones.
- Inclusion of information about the initial values of searched variables does not improve the accuracy of the model.
- Inclusion of information about the relative position of communes does not improve the accuracy of the model.

Taking into account the conclusions from the subsection "predictions" the biggest obstacle in acquiring the accurate predictions is insufficiency of data. The most obvious, and probably the only possible, way to ensure the satisfactory level of predictions is inclusion into the model more data, especially data connected with particular geographic locations, instead of data aggregated to centroids of municipalities.

Conclusions

The presented approach allowed the research undertaken herein to find answers to some of the questions formulated in the goal of the research.

1. The impact of motorways has not only a national character, but also a local one. For the examined section of the motorway the following phenomena were found:

a. The motorway had negative impact on a change of number of microenterprises. This impact took place both in the year of finishing the motorway construction (2011) and in the subsequent year.
b. The motorway had negative impact on the change of population in municipalities. This impact took place one year after the completion of the motorway construction project (2012).
c. The motorway had positive impact on a change of incomes of society (measured by change of income taxes). This impact took place one year after completion the motorway construction project (2012).

2. The local impact of motorway projects after lasted no longer than 2 years. After this time the local character of impact on local economic was not possible to detect.
3. The local scale impact is discernible at a distance of about 40 km from the motorway.
4. The simple linear regression is insufficient to predict the impact in particular communes.
5. The usage of LWLR algorithm in order to include non-linearity in a model did not improve the results.
6. The local-scale impact does not depend on the initial level of independent values.
7. Inclusion of distances among communities into model did not improve the accuracy of predictions.
8. It is most likely that to make the predictions sufficiently accurate one has to use more detailed data. The assignment of data to the centroids of communes turned out to be sufficient to estimate the nature of impact, but it did not allow to make accurate predictions.

According to presented conclusions the next step of research should be focused on including the detailed data (associated with particular places) in the prediction process.

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A Graduate-Level, Competency-Based Curriculum for Project Management

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ABSTRACT

The new economy that is emerging from the most recent recession demands graduates who are ready to add value to organizations' business strategy as soon as they graduate. This demand has spawned interest in creating educational programs that emphasize a student's competency, rather than knowledge alone. These programs are competency-based education programs, which differ from the traditional style of education. This paper presents a brief discussion of traditional versus competency-based educational programs and the design process and suggested program contents for a graduate-level, competency-based curriculum for a master's degree in project management. Issues related to migrating from the current knowledge-based curriculum to a competency-based curriculum and the new role of faculty in a competency-based program are also discussed.

A GRADUATE-LEVEL, COMPETENCY-BASED CURRICULUM FOR PROJECT MANAGEMENT

The new economy that is emerging from the most recent recession demands graduates who are ready to add value to organizations' business strategy as soon as they graduate. Ahsan, Ho, and Khan (2013), list the following as the top five skills for project managers, across industries and countries, which can add value to an organization's strategy:

- Communication
- Technical skills
- Stakeholder management
- Cost management
- Time management

This market demand has given impetus to the competency-based style of education in which the emphasis is on skills, as compared with the traditional style in which the emphasis is on knowledge.

The major difference between the two styles of education is that, in the traditional style of education, program mission motivates course design, which is primarily focused on the subject matter knowledge. In the competency-based style of education, program mission first drives the design of required competencies. To ensure learners meet program competencies, each competency is assessed through multiple assessments. As a final design phase, assessments are then packaged into program courses. In the competency-based style of education, subject matter knowledge has a supporting role, which is introduced in support of competency assessment.

This paper presents the design process and suggested program contents for a graduate-level, competency-based curriculum for a master's degree in project management. Issues in migrating from the current knowledge-based curriculum to the revised competency-based curriculum are also discussed.

BACKGROUND

The basic framework for competency-based education (CBE) has been around more than a decade, and is currently offered by many colleges. In addition, according to the US Department of Education (n.d.), several states have initiatives, plans, or legislation that support CBE:

- "New Hampshire - The state is initiating high school redesign that replaces the time-based system (Carnegie unit) with a competency-based system focused on personalized learning, strong teacher-student relationships, flexible supports, and development of 21st century skills.
- Michigan Seat Time Waiver - Michigan passed legislation in 2010 providing a seat time waiver to districts that want to offer pupils access to online learning options and the opportunity to continue working on a high school diploma or grade progression without actually attending a school facility.
- Ohio's Credit Flexibility Plan – This plan, adopted by the State Board of Education in 2009, allows students to earn high school credit by demonstrating subject area competency, completing classroom instruction, or a combination of the two. Under this plan, subject area competency can be demonstrated by participation in alternative experiences including internships, community service, online learning, educational travel, and independent study."

Accordingly, Inside Higher Ed (2013) reports a number of colleges have been offering CBE programs, including:

- Western Governors University
- Kentucky Community and Technical College System
- Capella University
- College for America

Competency-based education contrasts with time-based education (TBE); in the TBE model the student acquires credit hours by spending a certain amount of time in each course of study. In the CBE model, the focus is on acquiring specific competencies. In its purest form, the CBE model does not have credit hour requirements, grades, or deadlines. The student acquires credit by demonstrating mastery of competencies at his or her own pace, which makes CBE very suitable for online learning and the online style of teaching. Overall, a CBE program will "allow for accelerated learning, boast a lower cost because the learning is accelerated, and employ an innovative approach to curriculum and pedagogy that is typically more flexible than what is offered at a traditional college" (Franklin & Lytle, 2015, p. 8). As an example of reducing costs to the student, a CBE program of study may not require hard-copy textbooks when online educational resources are used instead.

Proponents of CBE claim that seat time, expressed in terms of credit hour, is not a proper measure of learning. Grades are supposed to measure learning, but there is evidence that even this measure is less effective, because of grade inflation (Rojstaczer & Healy, 2012). Another weakness of TBE is that it does not accommodate students who learn faster than others. Furthermore, seat time cannot be easily applied to the online method of education.

The above factors have prompted colleges, such as Capella and College for America, to adopt a variation of CBE, *direct assessment*, in which there is no linkage between competencies and the credit hour standard.

MOTIVATION FOR COMPETENCY-BASED EDUCATION

The economy that emerged from the Great Recession of 2008 demands graduates who are not only knowledgeable, but are skilled to immediately contribute to business value of the organizations where they are employed (O'Halloran & Gordon, 2014). Additional pressure on these new recruits is reflected in Federal student loan default rates (US Department of Education, 2016). The default rates are calculated for both public and private colleges. The average rate through 2012 for all colleges is presented in Table 1.

With the total cost of US student debt exceeding one trillion dollars, and with mounting default rates, colleges are trying to make it easier for their graduates to find jobs, and also to reduce the cost of education. Although CBE does not necessarily decrease the cost of education for all students, it has the promise of reducing the cost for those who can acquire the necessary competencies in a shorter time. Another cost-reducing initiative has been migration to online educational resources (OER) to reduce or eliminate the cost of textbooks for students.

Table 1

US Department of Education reported student loan default rates through 2012.

Year	Rate
2007	6.7%
2008	7.0%
2009	8.9%
2010	9.1%
2011	10.0%
2012	11.8%

An impediment to CBE has been Federal student financial aid, which is based on credit hours, not competencies. In March 2013, the US Department of Education issued a letter, providing guidance for institutions that seek financial aid based Direct Assessment CBE Programs. Following issuance of the letter, the Department authorized Southern New Hampshire's College for America to implement the Direct Assessment method of CBE. Similarly, Capella University received U.S. Department of Education approval to "offer and provide federal student financial aid support to students in competency-based direct assessment programs at the bachelor's and master's level" (Gilligen, 2014, p. 2). As the cost of education continues to increase more colleges and universities, private and public, will likely explore competency-based education as an alternative to their traditional, credit based programs (Ordenez, 2014).

ADULT STUDENT PROFILE IN PROJECT MANAGEMENT

This paper is based on our experience in designing a new master's degree program in project management at University of Maryland University College (UMUC), a component university of the University System of Maryland. Since this is a new degree program, there are no existing students in the program to assess their profile. However, a specialization in project management (PMAN) has been offered by The Graduate School since 2004 in two degree programs: Master of Science in Management and Master of Science in Information Technology. The profile of these students, as shown in Figure 1 through Figure 5, is a good proxy for the profile of future incoming students.

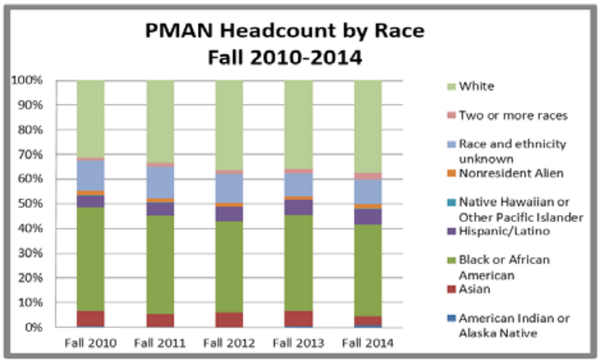

Figure 1. PMAN Headcount by Race Fall 2010 - 2014

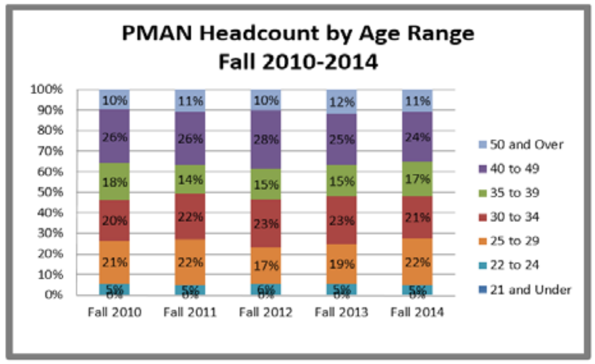

Figure 2. PMAN Headcount by Age Fall 2010 - 2014

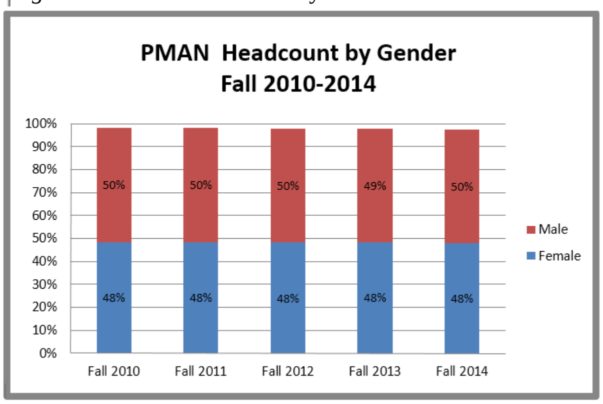

Figure 3. PMAN Headcount by Gender Fall 2010 - 2014

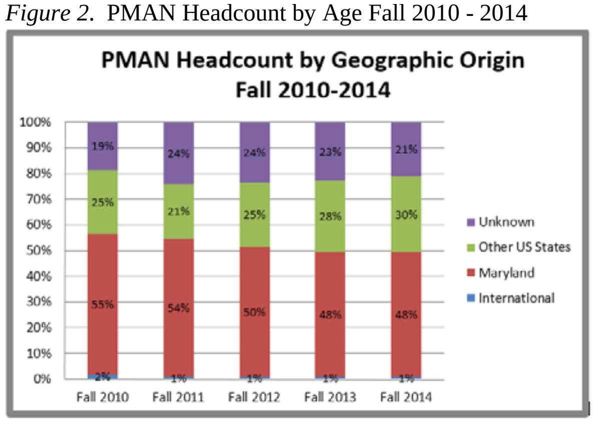

Figure 4. PMAN Headcount by Geographic Origin Fall 2010 - 2014

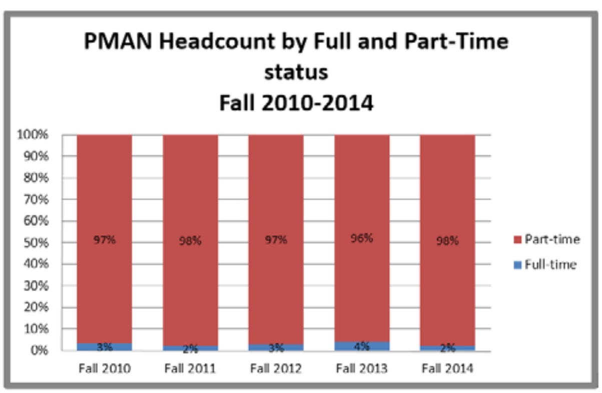

Figure 5. PMAN Headcount by Full or Part-Time Status Fall 2010 - 2014

These figures illustrate that the PMAN Program attracts an exceptionally diverse student body in age, ethnic background, and socio-economic circumstances. About 98 percent of the students attend the Program on a part-time basis, as a substantial number of students are employed. Adult students who are already working are suitable candidates for the CBE model. Competencies that they acquire through the CBE model will help them transition to new careers or enhance their existing careers.

Since the students have a diverse background, it is critical to place all students on the same footing when they start their program of study. This consideration is reflected in the design of the CBE curriculum; the first course of the curriculum is focused on essentials of their graduate study, such as communication, critical thinking, quantitative reasoning, and leadership. Once the students have a common foundation, they will proceed to specific subject areas, i.e., project management.

INSTITUTIONAL CURRICULUM REQUIREMENTS

In 2014 UMUC decided to migrate its graduate programs to the CBE model. Later in 2015, the decision was extended to all undergraduate programs. In The Graduate School, a common structure was put into place for all master's degree programs, in that each program curriculum consisted of 36 credits, distributed over six courses. The academic year would consist of 4 semesters, each 11-weeks long, with a first course common across all master's degree programs, which focuses on the essentials of a graduate-level program.

Furthermore, a common process was put into place for designing all master's degree programs. In traditional program design, program curriculum is first distributed among several courses. The content for each course is then designed. In the CBE model, the competencies are designed first. Competency design is followed by the design of assessments, which are mapped to competencies in a matrix fashion. The purpose of mapping is to ensure that students exercise each competency multiple times during the course of their study. Assessing student competency multiple times during the course of their program ensures the student is proficient in that competency.

Once competencies are finalized, they are then allocated to program courses. This process ensures that:

- The student masters a set of cohesive competencies.
- Mastery is achieved by repeating the exercise of competencies.
- The collection of all competencies are in support of overall program goals.

The next step in the process is to identify a list of topics for each competency. The student has to learn these topics in order to be ready to perform the assessments mapped to that competency. Once the learning topics are identified, reading resources, software tools, and other material which cover the topic can be identified.

As a final step, model classes for each course is designed. These model classes eventually map to individual semester classes to be used by the faculty for each course.

PROJECT MANAGEMENT CURRICULUM REQUIREMENTS

A project management curriculum must meet current and future requirements of the project management profession. Professional project managers must be proficient in the managerial aspects of project management, the industry in which they manage projects, and the policies and procedures of the specific organization where they are employed. The managerial aspects of project management include performance, knowledge, and behavioral competencies, as described in detail in the Project Manager Competency Development Framework (PMCDF) (PMI, 2007).

Performance competencies include the ability to initiate, organize, track, and bring projects to completion in a manner that satisfies the business needs of the client.

Knowledge competencies cover the underlying information, in support of performance competencies. They include managing project scope, cost, schedule, quality, risk, as well as managing stakeholders, vendors, and human resources who support the project.

Behavioral competencies include ability to lead, manage, communicate, and operate with professional integrity.

A careful study of the competencies described in PMI's PMCDF revealed that the competencies have a substantial overlap with examination requirements for the following PMI credentials:

- Certified Associate in Project Management (CAPM)®
- Project Management Professional (PMP)®
- PMI Risk Management Professional (PMI-RMP)®
- PMI Scheduling Professional (PMI-SP)®

In total, the competencies provide a foundation for the student to prepare for the professional credentialing examinations in the field of project management, and also to grow in a variety of roles. The competencies support the following program goals, which have a broad range of application:

- Lead and work in teams
- Persuade and influence others
- Delegate tasks
- Communicate clearly
- Perform quantitative analysis
- Solve problems and make decisions
- Learn how to apply technology to solve problems
- Plan, organize, and prioritize

Although the curriculum cannot provide the foundation for every industry and enterprise, the curriculum, through a capstone course, can meet the needs of specific students. This capstone course can also address specializations in project management, such as program management, portfolio management, agile project management, etc.

PROJECT MANAGEMENT CURRICULUM

The PMCDF (PMI, 2007) defines competency as "a cluster of related knowledge, attitudes, skills, and other personal characteristics that affects a major part of one's job… correlates with performance on the job, can be measured against well-accepted standards, and can be improved by means of training and development" (p. 73). In other words, competencies are characteristics that graduating students should demonstrate to indicate that they are prepared to perform and function independently in professional practice. This section outlines the process and steps used for developing a framework for a competency-based PMAN program.

As noted by Marrelli, Tondora, and Hoge (2005), the competencies could be organized in many ways depending on the needs of the organization/institute. In case of designing CBE, (i) one approach could be to identify core competencies that are critical to master a specialized course or (ii) to organize the competencies based on their types, such as leadership, personal effectiveness, communication, critical thinking or technical capacity or (iii) to develop a framework based on specific job level. The PMAN Program CBE development team used a combination of the approaches and identified the following five steps for developing the CBE framework.

1. Identifying the Learning Goals
2. Creating Competencies
3. Identifying Descriptors
4. Designing Performance-Based Assessments
5. Creating the Rubric

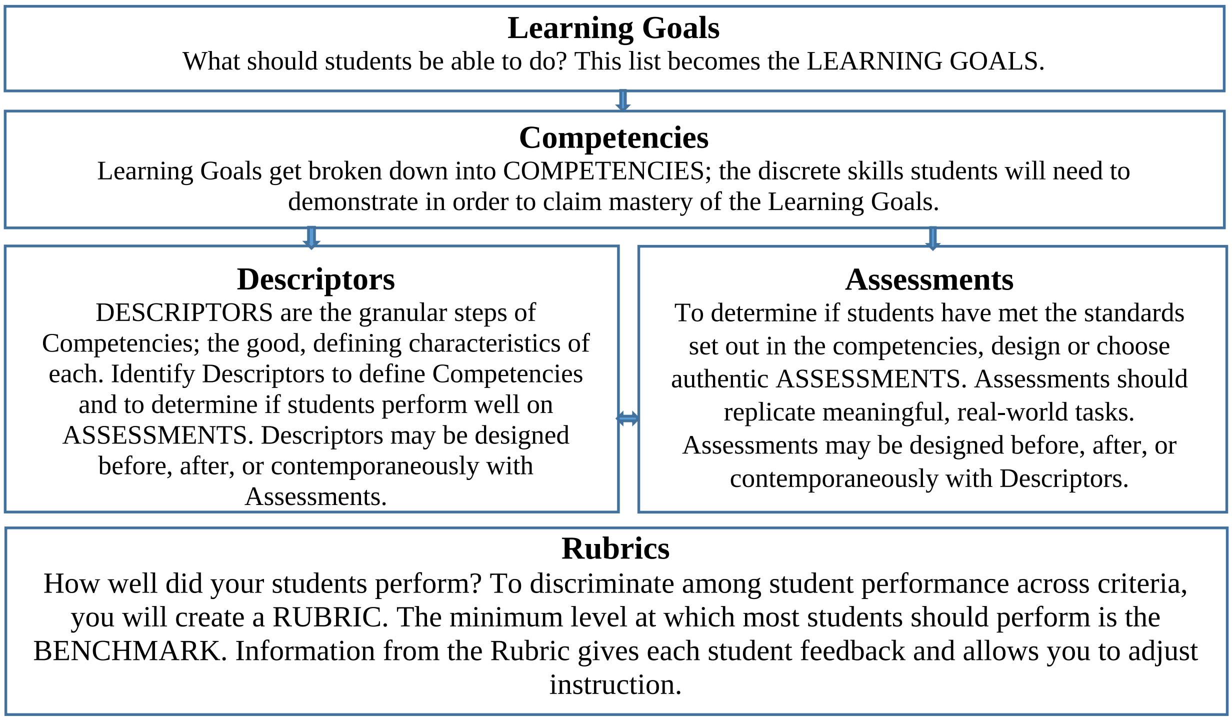

Figure 6. PMAN Competency Model (Adapted from Mueller, J. (2013) *Authentic Assessment Toolbox*. Retrieved from http://jfmueller.faculty.noctrl.edu/toolbox/index.htm)

Identifying the learning goals. A Learning Goal is a very broad statement of what students should know or be able to do. The purpose for crafting a set of goals is to give a brief and broad picture of what the program expects its students will know and be able to do upon graduation. In identifying the Learning Goals related to project management, the PMAN program also includes university-wide goals, such as Communication, Critical Thinking, Quantitative Literacy and Leadership. An example of a PMAN program Learning Goal would be:

- *Project Risk Management: Students demonstrate competency in identifying, assessing, and mitigating project risks, while taking advantage of opportunities.*

Creating competencies. A competency is a measurable human capability that is required for effective performance. A competency may be comprised of knowledge, a single skill or ability, a personal characteristic, or a cluster of two or more of these attributes. Competencies are the building blocks of work performance (Marrelli, Tondora, & Hoge, 2005). In developing competencies for the PMAN program, the team considered the following questions:

- Why do we think this knowledge or skill is important?
- Realistically, are students ever going to have to know this/do this/use this?

• Can we really assess this? Should we assess it?
• Is this knowledge or skill essential for becoming a professional? How? Why?
• Is this knowledge or skill essential for program mastery?

For a competency to be amenable to assessment, it must be observable and measurable. For example, "Students will correctly add two-digit numbers" IS observable and measurable; however, "Students will understand how to add two-digit numbers" is NOT observable and measurable. While a student's understanding cannot be observed directly, it can be observed through performance. Related competencies are rolled up to a learning goal. The team made sure that a competency does not mention any specific task by which students will demonstrate what they know or are able to do. For example, asking to "Identify cultural differences between two cultures using a Venn diagram" is too specific; specifying "Venn diagram" in the competency requires the teacher create exactly that assessment, even though others certainly could work.

Examples of competencies related to the Learning Goal of *Project Risk Management: Students demonstrate competency in identifying, assessing, and mitigating project risks, while taking advantage of opportunities* would be:

- Plan Risk Strategy.
- Engage Stakeholders.
- Facilitate Risk Management Process.
- Monitor and Report Risks.
- Analyze Specialized Risks.

Identifying the descriptors. A descriptor further defines a competency. A competency can have more than one descriptor. The team kept the number of descriptors to the essential elements of the task. The assessments (or Learning Demonstrations) are mapped to particular competencies and descriptors. Taking the same Learning Goal and list of Competencies for *Project Risk Management*, the following are examples of descriptors that were developed:

Plan Risk Strategy

- Develop risk assessment processes and tools that quantify stakeholder risk tolerances in order to assess and determine risk thresholds for the project and set criteria for risk levels.
- Update risk policies and procedures using information such as lessons learned from projects and outputs of risk audits in order to improve risk management effectiveness.
- Develop and recommend project risk strategy based on project objectives in order to establish the outline for the risk management plan.
- Produce risk management plan for the project on the basis of inputs such as project information, external factors, stakeholder inputs, and industry policies and procedures in order to define, fund, and staff effective risk management.
- Establish evaluation criteria for risk management processes based on project baselines and objectives in order to measure effectiveness of the project risk.

Selecting performance-based assessments. Performance-Based Assessments (Learning Demonstrations) give students the opportunity to demonstrate that they are capable of meeting the competency. We will consider the same example from above: Competency: *Plan Risk Strategy*. A risk management strategy provides a structured and coherent approach to identifying, assessing and managing risk. It builds a process for regularly updating and reviewing project risks based on new developments or actions taken. Risk management is both a quantitative and qualitative approach to determine impact, probable likelihood and overall project impact of risks to scope, schedule and costs in any project.

Students will play the role of project risk managers to demonstrate competencies in project risk management for a given project context. Students will be expected to first identify the stakeholders, and then evaluate and identify project risks in order to create a preliminary risk breakdown structure (RBS) for the project. Using the risks identified, students will then move on to developing a risk assessment (with inputs such as stakeholder tolerances, lessons learned from past similar projects, benchmarking data), developing risk response management and finally risk control development as described below:

- Risk Identification. In this step, students will:
    - Identify project primary risk sources and risk events
    - Determine project stakeholder tolerances on project risks
    - Develop Risk Register
- Quantitative Risk Analysis. Students will assess risks in terms of:
    - Investigating the likelihood that each specific risk will occur and its potential impact on the project objectives such as schedule, cost, quality or performance
- Qualitative Risk Analysis. Students will numerically assess the risks on the overall project. Some tools and techniques include:
    - Risks' Expected Monetary Value
    - Risk Analysis using simulation
- Risk Response Planning: Students will:
    - Develop a strategy to reduce possible damage and enhance opportunities to project objectives
    - Develop a Risk Management contingency plan
- Monitor and Control Risks. Students will:
    - Implement the risk response plan via Risk Register documentation
    - Track the risks identified and monitor any new risks
    - Evaluate the effectiveness of the risk management process

Students will be introduced to essential project risk management concepts, tools, and techniques as they apply them to the given project context. All performance based assessments are developed as a set of scripted activities involving real life scenarios with built in feedback checkpoints (Figure 7).

Learning Goal: Project Risk Management: Students demonstrate competency in identifying, assessing, and mitigating project risks, while taking advantage of opportunities.

Related competencies “roll up” to create a learning goal.

Learning Goal: Leadership, Facilitation and Collaboration. Leaders lead, facilitate, and collaborate with a variety of individuals and diverse teams to achieve organizational objectives.

Related competencies “roll up” to create a learning goal.

Competencies:

- Plan Risk Strategy.
- Engage Stakeholders.
- Facilitate Risk Management Process.
- Monitor and Report Risks.
- Analyze Specialized Risks.

Authentic Assessments enable learners to demonstrate the competencies specified.

The City of Baltimore, Department of Recreation and Park, and Department of Planning have over the past few years begun a beautification project that will clean up the city and bring new life to areas that were once deteriorating. For fiscal year 2016, the city has proposed tearing down an old industrial area and transforming it into a thriving, 150-acre community park, that is within a 3-mile radius of Bayview community. A major design requirement is that it meets the environmental standards set by the Building and Environmental Research Assessment Method (BERSM). The local council has proposed a factory site; a car build industrial estate. Although the site is now derelict and requires cleaning before any construction can take place, it is just 2 miles from the community providing ease of access between sites. The site is close to a recently extended main road connecting the city town center with the Bayview community, which has a reliable and frequent public transport service. The business community sees the increase in civilian population as very positive while residents of Bayview community are concerned that the increased traffic will cause excessive congestion. However, a local environmental group has raised the problem of site clearance saying that the car parts manufacturing plant had been used for the disposal of undocumented hazardous material.

You are the new risk manager for the project and have been asked to implement a realistic risk management process with the stakeholder consensus. Since this community park project is in its early planning stage, estimates of cost and time are considered unreliable, a complete project risk assessment is needed, and guidance on more reliable cost estimates are needed from stakeholder(s).

Figure 7. Learning Demonstrations to assess students’ proficiency in the specific competencies.

Creating a rubric. In the first step, we identified what the program wants the students to know and perform: This is the Learning Goals. Next, we created observable, measurable competencies that support the Learning Goals. By defining Descriptors, we then ask the students how they could demonstrate that they had met the Competencies. In devising these activities, we created the Performance Based Assessments and identified the characteristics of good performance on the Performance Based Assessment. Finally, for creating the rubrics, we translate our Descriptors into the means by which the students will be evaluated. A good analytic rubric needs at least two criteria and at least two levels of performance. We used the Descriptors as basis for the rubric criteria; in that way, the goals, the assessments and the rubrics will be aligned. As an example (Figure 8), this is how the PMAN *Project Risk Management* Goal's first competency *Plan Risk Strategy* looks in a 3-level rubric:

Risk Mgt. Outcomes	Low/No Proficiency	Proficient	Highly Proficient
After reviewing the given project context, comprehensively identifies and assesses all risks associated with the event or activity	Addresses only some of the categories of risks; Addresses only obvious risks.	Identifies some basic risks in each category	Provides a comprehensive list of all risks; Not only identifies the primary risks, but clearly understands the various kinds of associated risks
Clearly identifies stakeholders and develops techniques to gather stakeholder tolerances.	Stakeholder list and the techniques are not comprehensive.	Identifies complete list of stakeholder, but lacks in defining the techniques for gathering stakeholder tolerances. (or) Identifies incomplete list of stakeholder list, but defines clear techniques for gathering stakeholder tolerances.	Provides complete list of stakeholders and clear techniques for stakeholder tolerances.
For the given context, realistically assesses all risks, considering the probability of occurrence and severity of consequences.	Over or under estimates the probability and/or severity of the risks identified.	Gives some logical consideration to the probability and severity of the risks identified.	Realistically estimates the probability and severity of all risks identified.
Comprehensively explores and examines actions that can be taken to mitigate each risk.	Minimally explores options to mitigate risks; Only explores options for the most basic risks.	Brainstorms options to mitigate most of the risks.	Thoroughly considers various options to mitigate all risks identified.
Selects the most appropriate mitigating actions for each risk.	Selects some inappropriate mitigating actions; may select actions solely based on cost or ease of implementation.	Selects mostly appropriate mitigating actions; Somewhat considers the prior risk identification and assessment.	Selects appropriate mitigating actions for each risk based on the prior risk identification and assessment.
Develops thorough contingency plans.	Minimally plans for emergency response.	Establishes basic plans for managing emergencies.	Develops clear and thorough contingency plans.

Figure 8. Sample rubric. Adapted from Student Leader Learning Outcomes Project at Texas A&M University.

In developing a competency-based curriculum for the PMAN program, a thorough modelling process was considered. The PMAN CBE team determined what the model should be and decided the student learning experience would be centered on project-based learning in a sequenced set of performance based assessments. As described above, the first step in the program redesign was to define Learning Goals or Objectives. Then the team worked on determining all the competencies students would need to demonstrate project management skills, starting with general competencies such as written communication, critical thinking, and quantitative reasoning. The competencies were rolled up into the Learning Goal.

Finally, the team ensured that the competencies are not discrete skills, but are embedded in several assessments so they build on, and reinforce, each other.

THE ROLE OF FACULTY IN COMPTENCY-BASED EDUCATION

Pace and Worthen (2014) stated simply that "a highly trained and engaged educator workforce will be the single most important driver of a successful competency education system" (p. 5). The role of the educator in a CBE environment will transition from one of simply instilling a body of knowledge in a student to one of helping the student use that knowledge to master critical competencies. This will require that educators "work individually and collectively to design customized pathways to graduation for every student". Additionally, educators will have to acquire new classroom skills to help students with varying levels of skill, knowledge, and ability to succeed.

Competency-based education programs typically contain two common elements: (1) a framework of competencies that are mapped to and aligned with learning demonstrations or assessments, and (2) methods to assess progress toward mastering the competencies (McClarty & Gaertner, 2015). Inherent in each of these common elements are activities associated with developing and maintaining the course materials and activities associated with using the materials in a classroom setting.

Developing and maintaining course materials. Educators play a primary role in defining required competencies and mapping those competencies to one or more assessments. Competencies must be explicit, measurable, and relevant to the skills and knowledge needed in the chosen career path (McClarty & Gaertner, 2015). Assessments typically identify learning objectives, the learning activities that must be completed, study and reference materials, and assessment methods and rubrics.

Where alignment with national professional organizations, such as the Project Management Institute (PMI), is required or desired, competencies may be derived from professional certification standards published by such organizations. Where national guidelines are not prescribed, competencies may be derived from consultation with external stakeholders, such as employers, unions, or other subject matter experts. Additional competencies may be derived from internal standards required by the learning institution (Ott, Baca, Cisneros, & Bates, 2015).

Another challenge for educators is developing competency mastery assessment methods that are valid and reliable (Schuwirth & Ash, 2013; Ott, Baca, Cisneros, & Bates, 2015). Schuwirth and Ash (2013, p.555) suggest assessment methods should:

- "Support development of an integrated competence.
- Be organized around content domains rather than test formats.
- Value all forms of information, quantitative and qualitative.
- Combine summative and formative functions to inform and guide student learning.
- Be equitable through a balance of assessments that are standardized and tailored to the individual and by focus on improvement of competence rather than solely on detecting incompetence."

Finally, educators must be sensitive to changes in the internal and external environments that affect the relevance and usefulness of identified competencies and assessments and proactively propose updates to learning materials to keep pace (Ott, Baca, Cisneros, & Bates, 2015). For example, project management educators must ensure that course materials keep pace with changes to PMI certification standards and industry demands on project managers as well as changes to university graduation standards. One way this can be done is through continuous interaction with practicing project managers and participation in PMI symposiums and chapter meetings.

Using the material in the classroom setting. Educators, successfully transitioning from time-based education to competency-based education, report increased opportunities for authentic learning as power is transferred to the student and educators assume more of a facilitator, coach, or guide role than a traditional teaching role (Sullivan & Downey, 2015).

In line with this shift from a traditional teaching role to a facilitator, coach, or guide role, Pace and Worthen (2014) suggest educators will need new skills to maximize competency-based education outcomes. In summary, these skills include:

- Providing timely and personalized instruction, aligned to explicit, and measurable learning objectives and based on individual learning needs, so students can progress to mastery along individual trajectories at a sufficient pace to achieve career readiness in time for graduation.
- Using performance-based formative and summative assessments with high validity and reliability to evaluate individual student progress to mastery.
- Supporting student development of lifelong learning skills and social and emotional competencies.

The last skill listed – supporting development of lifelong learning skills and social and emotional competencies – may be more germane to early-stage (e.g., K-12) competency-based education than graduate-level competency-based education.

CONCLUSION

The new economy demands project managers that can successfully manage projects immediately upon entering the workforce as a project practitioner. These project managers must have skill in communicating and managing stakeholder expectations, along with technical skills, and competency in managing project cost and duration.

This paper has outlined a methodology for developing a curriculum that meets the above requirements. The methodology is based on the development of learning goals, competencies, descriptors, assessments and rubrics to ensure graduates of the program have the knowledge, skills, and abilities required to successfully manage projects in a wide range of organizations and industries.

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Would Joint Ventures affect Market Competition?

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Abstract

Purpose

The construction activities in Hong Kong are at un-precedent high level as the Hong Kong Government is rolling out major infrastructure projects. The tender values of these projects exceed budget substantially. With the rocketing tender value, major concerns have been raised over the market competitiveness. Contract packaging approach such as forming joint ventures may have effect on market concentration. This study aims to investigate the effects of using joint ventures on competition intensity with reference to the Ten Mega Projects programme in Hong Kong.

Methodology

At the time of the study, there were 81 contractors involved in the Ten Mega Projects programme. Among them, 33 are in the form of Joint Venture. Based on the respective contract values, both four-firm concentration ratio (CR_4) and Herfindahl-Hirschman Indice (HHI) are used to analyze. The effect of forming joint ventures is also analyzed in terms of the frequency of different contractors' winning contracts. The characteristics of "active contractors" and "inactive contractors" are compared.

Findings

The study offers the following key findings. For the active contractors, due to the network of joint venturing among them, forming joint ventures did not reduce the number of competitors. In fact, when joint ventures are considered as separate and independent entities, the concentration level is lowered as a result. For contractors that have only one contract, forming joint venture increases the concentration level. For contracts that are less technically demanding or of lower value, segmenting sized projects into smaller separate contracts would enhance competition and lower concentration level.

Introduction

After the 2008 global market tsunami that hit on many economies around the world, the Government of the Hong Kong Special Administrative Region (HKSAR) adopted a series of measures including rolling out Ten Mega Infrastructure Projects, to boost the local economy. Hong Kong's construction market has thereby been energized by this series of infrastructure projects. The gross value of construction works in 2014 has reached HK$199.7 billion, increasing by year-on-year 13% compared with 2013 (HKTDC 2015). However, budget overrun has become a notable problem for many of these projects. The statistics from Civil Engineering and Development Department of HKSAR revealed that the construction cost index is rising markedly less than the tender price is, indicating that the cost increase cannot fully account for the surge of tender prices obtained for the construction mega projects. Insufficient competition in the market can be one of the key determinants for the soaring construction prices. A number of research studying the market competitiveness in the construction industry focus on the collusion behavior and bid rigging problems (Gupta, 2001, Dorée, 2004). Aside from these practices, joint ventures are also frequently practiced in the construction industry. However, there is relatively few research conducted on the impacts of contract packaging approaches such as joint venture bidding on the market competitiveness (Tong and Reuer, 2010). Researches studying construction joint ventures have been focused on risk assessment, managerial practices and economic efficiencies of joint ventures (Walker and Joannes 2003; Hong and Chan, 2014). The primary aim of this research is to investigate the effects on the use of horizontal joint ventures on market competitiveness with reference to the Ten Mega Projects programme in Hong Kong.

Literature Review

Definition of joint venture

Since a joint venture can be used to include all situations where more than one company unite their resources to achieve a common goal or shared interest (Pitofsky, 1969), the difficulty in defining joint ventures lies in the "lack of sharp definition that would distinguish joint ventures from other interfirm contractual agreements" (Brodley, 1982). To define the distinctive features of a joint venture, Kitch (1985) suggested that compared with a merger, a joint venture involves fewer restraints on competition but offers more efficiency gains than a cartel or a price fix. Bernstein (1965) suggests that the difference between mergers and joint ventures is that participants in mergers combine all of their assets while in joint ventures, participants only combine parts of their assets. However, Mead (1967) believed that the distinction between joint ventures and mergers proposed by Bernstein (1965) overemphasizes the form at the expense of substance, because joint ventures and mergers can share very similar characteristics. Another difference identified by Mead (1967) and Brodley (1982) is that a joint venture creates a business entity separate from its parents. Meanwhile, Werden (1998) distinguished a joint venture from a mere cartel by suggesting that true joint ventures should achieve efficiency-enhancing economic integration. Brodley (1982) provides that a joint venture is "an integration of operations between two or more separate firms and is characterized by : a) Parent firms jointly control the enterprise; b) A substantial contribution must be made by every parent firm; c) The venture firm is established as a new entity; and d) The joint venture creates significant new capability in terms of output capacity, technology and product advancement, or market expansion.

Effects on Competition

Joint ventures can be pro-competition by creating a new competitive force especially where a joint venture is formed by two smaller firms to enter the market without precluding the potential entry of the parent firms. Large amounts of capital can be accumulated through joint ventures so as to enable small firms to undertake projects that are too extensive for them to complete alone (Kitch, 1985, Pate, 1969, Mead, 1967, Pfeffer and Nowak, 1976). In addition, a joint venture can intensify competition because economies of scale can be achieved and transaction costs can be reduced thereby, e.g. information costs (Kitch, 1985, Pfeffer and Nowak, 1976, Werden, 1998, Pitofsky, 1969, Mead, 1967). Notwithstanding, Mead (1967) reminded that even though a joint venture may cause potential anticompetitive hazards, such interfirm link may still be preferred where the parents are too small to finance entry or undertake risks.

The anticompetitive hazards of horizontal joint ventures including potency of collusions and increasing entry barriers are widely recognized in many studies (Pfeffer and Nowak, 1976, Pitofsky, 1969). There have been great concerns over whether joint ventures are de facto mergers because joint ventures can have similar anticompetitive effects as mergers but can enjoy much relaxed regulations (Pfeffer and Nowak, 1976, Pate, 1969). Competition can be lessened or eliminated by horizontal joint ventures in the following three directions:

a) Actual competition between parents (Bernstein, 1965, Pfeffer and Nowak, 1976).
b) Actual or potential competition between either one of the parent firms and the joint venture enterprise (Bernstein, 1965, Pitofsky, 1969, Brodley, 1982, Pfeffer and Nowak, 1976).
c) Potential competition by the entrances of the parent firms but for the existence of the joint venture (Pfeffer and Nowak, 1976, Mead, 1967, Pitofsky, 1969).

For a) and b), horizontal competition can be restrained due to the change of competitive incentives and/or collusions.

<u>The change of competitive incentive</u>
Kitch (1985), Werden (1998), Pfeffer and Nowak (1976), Mead (1967), and Bresnahan and Salop (1986) have observed that joint venture partners are unlikely to compete at arm’s length. Joint ventures connect the interests of actual or potential competitors, which inevitably affect the independent decision making and the competitive incentives of all the relevant parties (Werden, 1998, Mead, 1967, Bresnahan and Salop, 1986). In addition, it is found that firms bid significantly less against their former partners than against non-partners over a two-year interval and the impacts can even extend to matters outside of the joint venture (Mead, 1967, Pfeffer and Nowak, 1976), meaning that the change of competitive incentive that makes parent firms unwilling to compete vigorously with each other can last beyond the actual period of joint venture.

<u>Collusion</u>
A joint venture may encourage or facilitate implicit or explicit collusion (Kitch, 1985, Pfeffer and Nowak, 1976, Mead, 1967, Werden, 1998, Brodley, 1982, Pitofsky, 1969). Information exchange and continuous cooperation are almost inevitable in every joint venture no matter how

small it is, and may lead to information spillover or provide great convenience to cartelization (Werden, 1998, Kitch, 1985, Brodley, 1982, Pfeffer and Nowak, 1976). Especially in the case where a joint venture is formed all by fully capable parent companies, the anticompetitive effects of eliminating potential bidders can be apparent and indifferent to explicit collusion (Mead, 1967).

For c), Potential competition can be lessened because it is possible that the establishment of a joint venture precludes the parent firms from being involved in the same competition (Pfeffer and Nowak, 1976, Mead, 1967, Pitofsky, 1969). The number of independent firms competing in the market can be reduced or left unchanged if one or more parent firms could have entered the market (Pitofsky, 1969). Such a preclusion of entry can be the desired or intended objective of forming a joint venture (Mead, 1967). Furthermore, a joint venture may even raise the entry threshold in terms of the financial and technical resources offered by the joint ventures (Pfeffer and Nowak, 1976, Pitofsky, 1969).

Joint ventures and market structure

In general, the potential of having anticompetitive behaviors is found to be positively related to the market concentration level (Berg and Friedman, 1981, Pfeffer and Nowak, 1976, Bresnahan and Salop, 1986, Mead, 1967, Tong and Reuer, 2010). Nonetheless, Pfeffer and Nowak (1976) found a negative correlation between the proportions of horizontal joint ventures over all types of joint ventures and the difference between the particular concentration level and the cross-industry median value, which means that the closer the market concentration level is to the cross-industry median concentration level, the higher the anticompetitive risks of joint ventures can be The rationale behind is that with numerous competitors in the market, horizontal joint ventures only have very limited impacts on reducing the uncertainty associated with competitive interdependence, while with very few competitors in the market, other forms of interfirm links can be more efficient (Pfeffer and Nowak, 1976). Therefore the argument that the higher the market concentration level is, the more likely that joint ventures can lead to anticompetitive behaviors is true provided that the concentration level is still within the intermediate range of cross-industry concentration level.

Market Competitiveness

There is limited reported research that investigates the market competitiveness of the construction industry. The most commonly recognized and widely observed anticompetitive behavior in the construction industry is collusion (Gupta 2001, Doree 2004). However, there is relatively few studies done to assess the competitive consequences of joint bidding in the construction contracting market. Drew and Skitmore (1997) argued that the competitiveness of every bidder is dependent on both the size and type of the contracts. In the construction contracting market, it is possible that the variation of contract size can change the competitiveness of firms of varying sizes and hence alter the overall competition level by the market.

Methodology

Concentration measures can be used to indirectly gauge competition level. Dimensions of market structure can be captured to indicate the competitiveness in an industry (Perloff et al., 2007). One of the most commonly used concentration measures adopted by the U.S. Bureau of Census and the U.S. Government Accountability Office is the four-firm concentration ratio (CR_4). Another measure that has been widely used is Herfindahl-Hirschman Index ("HHI"). Both the U.S. Department of Justice (DOJ) and Federal Trade Commission (FTC) use HHI as a quantitative indicator of market structure.

Four-firm concentration Ratio (CR_4) is the sum of the market shares accounted for by the top four firms in the market (Perloff et al., 2007) and can be expressed as below:

$$CR_4 = S_1 + S_2 + S_3 + S_4 \quad (1)$$

This index approaches zero where there is infinite number of firms in the market and equals one where four firms' market shares have made up the entire industry (Bikker and Haaf, 2002).

Herfindahl-Hirschman Index ("HHI") is the sum of the squared market shares of all the firms in the market. (Perloff et al., 2007)

$$HHI = \sum_{i=1}^{n} S_i^2 \quad (2)$$

Where S_i is the market share of the i^{th} firm. HHI value ranges from 0 to 1, when HHI equals 1, the market structure will be considered a monopoly (Hirschman, 1964).

In this study, the results obtained from CR_4 and HHI need to be compared with the standards used by the Department of Justice (DOJ) and the Government Accountability Office (GAO) in the United States. Where HHI is below 0.15 or CR_4 is below 40%, the market is considered as un-concentrated. Where HHI is between 0.15 and 0.25 or CR_4 is between 40% and 60%, the market is considered loosely concentrated. Where HHI is higher than 0.25 or CR_4 is higher than 60%, the market is considered highly concentrated. In order to reflect the market structure in a more comprehensive way, the presence of major firms, the number of firms, and the inequality of market share distribution shall all be taken into account besides HHI in assessing market structure (Rhoades, 1995).

Data Analysis and Findings

In this study, the contract value each firm obtained in the ten mega projects market in Hong Kong from 2010 to 2015 are used to represent their market shares. As the most important infrastructure development projects in Hong Kong, Ten Mega Projects have involved almost all the active contractors in Hong Kong. At the time of study, six of the Ten Mega Projects that have commenced were analyzed in this study. The contract values obtained by the firms may not be final, as all the projects are still in progress and many works haven't been awarded. In total, there are 81 contractors involved, and 35 contracts have been awarded to construction joint ventures. There is only one joint venture which has repeatedly bid in three different projects while each of the remaining joint venture entities only obtained one contract. In addition, one third of the joint venture parent firms formed more than one joint ventures with different partners.

Two tests were conducted to analyze the effects of joint venture bidding. In Test I, joint venture entities are counted as contractors independent of their parents. There are in total 81 firms with the largest one having 14.76% market share. In Test II, each contract awarded to a joint venture entity is viewed as being split into several smaller contracts, of which each was awarded to one parent firm. There are altogether 86 firms with the largest two companies having market shares of 13.28% and 11.07% respectively. It is suggested in both tests that instead of being dominated by one monopoly firm, the mega project market in Hong Kong is composed of several sized firms and a number of fringe firms. (see Table 1)

TEST I		**TEST II**	
Market Share	*No. of Firms*	*Market Share*	*No. of Firms*
10%-15%	1	0%-1%	2
5%-10%	5	5%-10%	4
1%-5%	14	1%-5%	12
0%-1%	61	0%-1%	68

Table 1: Firm Size Distribution

Prior studies suggest that joint venture can be an effective device to facilitate fringe firms to enter the market while greater convenience is provided to fully capable firms to reduce competition (Mead, 1967, Kitch, 1985, Pfeffer and Nowak, 1976). In this study, the effects of joint ventures will be analyzed separately for inactive firms and for active firms.

There are altogether 7 contractors which obtained 6 or more contracts and 9 contractors which obtained at least 5 contracts. Among the total 81 firms, they represent the first ten percent of the most active players in the market. Meanwhile, there are in total 50 firms only getting one contract, representing the most inactive players in the market. Therefore Test I and Test II will be conducted again for most actively bidding firms and the fringe firms which can barely get awarded. Table 2 and Table 3 give the details of the market share distributions among 7 contractor market.

Contractor	**Contract Value**	**%**	**%^2**
Firm A	12,534,750,236	14.79%	218.6904335
Firm B	2,053,440,949	2.42%	5.868983012
Firm C	9,428,533,146	11.12%	123.733324
Firm D	4,249,549,964	5.01%	25.13531287
Firm E	13,500,369,140	15.93%	253.6820292
Firm F	4,904,890,611	5.79%	33.4855216
Firm G	2,887,054,080	3.41%	11.60134265
Firm A – Firm E Joint Venture	5,869,282,300	6.92%	47.94776998
Firm A – Firm B Joint Venture	8,400,000,000	9.91%	98.21028877
Firm A – Firm C Joint Venture	11,793,608,604	13.91%	193.5939751
Firm C – Firm D Joint Venture	3,368,442,219	3.97%	15.79270852
Firm D – Firm B Joint Venture	1,422,000,000	1.68%	2.814476383
Firm F – Firm E Joint Venture	4,350,000,000	5.13%	26.33764441
SUM	**84,761,921,249**		
CR4	**55.75%**		
HHI	**1056.89381**		

Table 2: Test I for 7 most active contractors

Contractor	Contract Value	%	%^2
Firm A	25,566,195,688	30.16%	909.7679507
Firm B	6,964,440,949	8.22%	67.51043971
Firm C	17,009,558,558	20.07%	402.7026628
Firm D	6,644,771,073	7.84%	61.45517535
Firm E	18,610,010,290	21.96%	482.0495063
Firm F	7,079,890,611	8.35%	69.76723494
Firm G	2,887,054,080	3.41%	11.60134265
SUM	**84,761,921,249**		
CR4	**80.54%**		
HHI	**2004.854312**		

Table 3: Test II for 7 most active contractors

For the market of 7 most active contractors and the market of 9 most active contractors, the numbers of market participants in Test I are higher than those in Test II, because the joint venture enterprises formed between each other are counted as new entrants.

	Test I (7 firm)	Test II (7 firm)	Test I (9 firm)	Test II (9 firm)
CR_4	55.75%	80.54%	55.70%	75.72%
HHI	1056.89381	2004.854312	1116.355113	1616.725451

Table 4: Concentration Level Change for most active contractors

Comparing the results for both 7-firm and 9-firm market in Table 4 , the market concentration levels increase in both Test II, suggesting that with joint venture, the market appears to be more competitive than without joint ventures.

For the market of 50 most inactive contractors, contrary to the active player market, the number of competitors increases in Test II. Among 50 inactive market competitors, 24 of them get awarded with contracts in the form of joint ventures, but only six of the joint ventures are formed exclusively by the 50 inactive contractors. The remaining 18 joint ventures are formed by at least one sizable company and one inactive firm. Since the six joint ventures are all formed by small contractors, in Test II where the parent firms are counted as individual participants, the number of participants increases. Table 5 shows that the HHI decreases slightly in Test II while CR_4 remains the same, suggesting that the market appears to be less concentrated where the contract package is split into smaller parts for small firms.

	Test I	Test II
CR_4	42.45%	42.45%
HHI	740.6297	684.4039

Table 5: Concentration Level Change for 50 most inactive contractors

Discussions and Limitations

The findings suggest that the use of joint ventures in the ten Mega Projects has lowered the concentration level for active large firms. However, for inactive fringe firms, joint ventures are found to have the effect of lowering competition.

The following explanations are offered. First, instead of operating as independent firms entering the market, most joint ventures in the construction contracting market are only formed to bid for one particular contract and such joint ventures usually exit the market as the project ends. In this study, only one joint venture enterprise among the 33 joint ventures in total bidding for multiple contracts and it is found that contractors are used to forming joint ventures with various firms at the same time, meaning that such joint ventures are unlikely to lead to extremely close relationship or collusion. Walker and Johannes (2003, pp.41) suggested that forming joint ventures becomes "a means to temporarily merge strategic assets" so as to meet the requirements of the client, and such characteristic can influence the relationship between joint venture partners. Since these joint ventures are only project based, it is less likely that the parent firms can develop such a "close and continuous relationship", as previous literature described. (Brodley, 1982, Werden, 1998, Kitch, 1985, Pfeffer and Nowak, 1976).

In the active contractor market, with only 7 contractors, there are already 6 joint ventures formed among them. In other words, the additional six joint ventures are only formed to overcome their "competitive interdependence" and reduce the competition among them rather than to create new competitive force. Meanwhile in Test I, due to the presence of the additional six joint ventures, the market is comprised of 13 firms while in Test II, there are only seven companies, which contributes to the higher HHI and CR_4 value in Test II. However, this finding cannot be interpreted as proving that contract fragmentation increases market concentration for active contractors because these joint ventures are not in fact competitors in the market. It is suggested that construction joint venture is unlikely to have pro-competition effects by introducing new competitive force to the market. On the other hand, construction joint venture can hardly have significant anti-competition effects as well when there is no dominant firm in the market. Because where the large contracts are split into smaller ones Instead, sizable contractors which choose to form joint ventures to bid for larger contracts can always bid solo.

As for inactive contractor market, 24 out of 50 contractors obtained contracts by forming joint ventures, suggesting that it is an effective approach for many smaller firms to enter the market. Meanwhile, 18 of the joint ventures are formed by at least one sizable company and one fringe firm. Hendricks and Porter (1992) reported similar observations in the oil leasing auction market that fringe firms participate, through joint bidding with large firms rather than with each other. Mohanram and Nanda (1996) explained that a joint venture with a large firm signals the invisible value of the small firm. Another reason could be that the prior experience large contractors acquired in previous sizable projects seem to increase the barriers to entry to such a height that prevent small firms to bid alone or exclusively with each other (Hendricks and Porter, 1992). Since the sizable firms that many fringe firms form joint ventures with are not in the inactive contractor market, data from these 18 joint ventures are not included in this study. For the remaining contracts awarded to joint venture entities formed exclusively by small contractors, it is found that contract fragmentation has pro-competition effects, demonstrated by the decline in HHI value in Test II. Because when these contracts are divided into smaller packages so as to allow small contractors to bid solo, the number of bidders inherently increases and the market competitiveness can be enhanced. Moreover, it can be inferred that contract fragmentation has the same pro-competition effects for joint ventures formed by fringe firms and sizable firms, because where the contracts are so extensive that small firms have to form joint ventures with larger companies, their entrances are contingent on the needs of sizable firms. In contrast, when contracts are sized down to smaller ones which can be bid by joint ventures formed by small firms or even by solo effort, much more bidders are then available.

In order to understand different features of active and inactive contractor market, the work natures of the contracts in both markets are studied. It is found that most jobs bid by larger and more active contractors are more technically demanding, such as tunneling and construction of bridges, roads and buildings. As for inactive contractor market, only nine contracts are for tunneling and among them, 8 are undertaken by joint venture enterprises, which mostly involve at least one sizable contractor. Generally speaking, the technical requirements of the jobs bid in the inactive contractor market are lower.

The HHI of the inactive contractor market is only 684 and hence, the inactive contractor market is considered highly competitive while the HHI value of the active contractor market reaches 2004 and the market is considered moderately concentrated. In total there are 50 contracts awarded to inactive contractors while there are 52 contracts awarded to 7 most active contractors, which means that the active contractors get awarded 7 to 8 times as many as the inactive contractors do. The average contract value in the active contractor market reaches 1.6 billion while the average value in the inactive contractor market is only 451 million. Nonetheless, the technical requirements of the contracts bid in the active contractor market are more demanding than in the inactive contractor market.

Concluding Remarks

This study uses the data of the Hong Kong Ten Mega Projects to illustrate the effect of forming joint ventures on market competition. Concentration Ratios (CR_4) and Herfindahl-Hershamann indice (HHI) are used to assess concentration. It is found that a joint venture in construction is more like a temporary agent synergizing the resources from multiple parties rather than creating a new entity or new entrant. Projects of high value and sophisticated technical requirements are usually bid by joint ventures formed by two or more large contractors already active in the market, and thus sizing down these contracts into smaller ones may not have significant impact on the market competitiveness. Moreover, the joint venture activities by the inactive contractors raise the market concentration. It is therefore suggested that sizable contracts of smaller contract value and less technically complex can be further split into smaller contracts so as to allow more fringe contractors to bid solo.

Acknowledgements

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Designing and Evaluating Simulation Games For Professional Project Management Education

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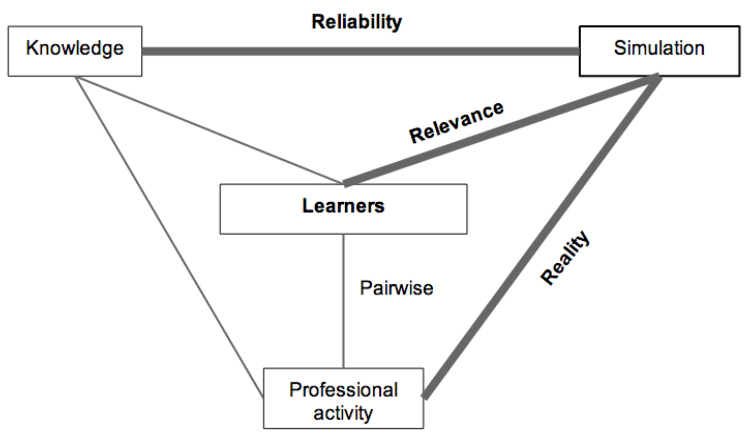
Abstract

Simulations and serious games are often considered to be efficient for professionals training. Experiential learning makes simulation a good pedagogical tool for educating working professionals. But the success of game based delivery depends on various factors such as the right blend of simulation and traditional theoretical lessons, concept and content of the simulation, link between the simulation and professional activities etc.

Paper proposes a simple model representing links of the simulation with other relevant elements of professional training. The model has been tested in the specific case of project management education where the authors offered training to professionals having experience of 5 to 25 years. The qualitative responses of participants were processed using Analytic Hierarchy Process (AHP) and the findings are presented in the paper. The study reveals that concept based learning need to be complemented with application based simulation software and identified three significant characteristics of simulation game, which are referred as 3R's (i.e. Reality, Relevance & Reliability) of simulation based pedagogical practice that trainers have to focus on while designing and delivering serious games.



Key words: Project management Body of Knowledge (PMBOK), professional training, experiential learning, Synthetic learning environment, Simulation, PM Game, 3R's, Analytic Hierarchy process (AHP).

Designing and Evaluating Simulation Games For Professional Project Management Education

1. Introduction

Two factors that can significantly influence simulation based project management training are the design of the game & its effective administration. Experts in the industry across various businesses who were interviewed by the authors are of the opinion that an effective training can enhance project management capabilities of practicing professionals and such trainings need a good combination of class room delivery and activity based learning.

Early in the 20th century *Case studies* based approach was accepted as effective practice in project management pedagogy. Modern projects being complex require more robust techniques to meet the project challenges. This led to a wide range of project tools and techniques to plan control and schedule our projects. Bowers (2012) in their research observed that "Applied correctly, technology can be a great tool in improving education and training at all levels." A number of techniques such as case studies, serious games, role plays & simulation games are in practice to create a better learning environment for the learners.

Though the techniques have matured, the projects are not benefited fully and timely project delivery within the budgeted cost remains an area of concern. Present research attempts to identify the extent to which simulation based trainings can help in enhancing effectiveness of such trainings.

Organizations investing in large projects prefer to have project managers who have undergone a formal training in project management and are able to develop a holistic approach in managing projects. Training is generally challenging and more so in an environment where it has to match with the requirement and expectation of practicing professionals. Traditional teaching-and-learning environments are often too predictable and do not impress the participants as they fail to bring in "real-world" environments (Ruben B. D, 1999).

Authors of this paper being trainers themselves have tested simulation based software as a training tool for practicing project managers and realized that the observations are worth sharing with academic community.

The paper in the subsequent sections attempts to answer following questions.

- What could be the best project management pedagogy for practicing professionals?
- To what extent simulations are effective in training professionals?
- How to choose the right simulation?
- How to design the right simulation for professional project management training?
- Is there a simple framework that can link simulation with other elements of learning?

The paper addresses issues related to Project Management pedagogy and will be of interest to those professionals who design PM simulation games and those who teach Project management for practicing professionals.

2. **Objective**

The objective of present research is to evaluate the effectiveness of simulation-based training for practicing project professionals and to present findings. Paper also suggests a simple framework that can be of use to both designers & trainers of simulation games.

3. Literature Review

This section presents a detailed literature review highlighting various techniques adopted in in the past. Several key factors were recorded by researchers in the literature. Case study, role play, simulations are widely referred by various researchers as effective training techniques that create scenarios similar to real time projects. This motivates the learner to participate actively in the class room. Motivation, interest and role-play are found to enhance learning process and have been reported by many of the researchers in the past. One way to create better motivation is to provide scope for the learner a role playing opportunity in a real project environment (Drappa, A., Ludewig, 2000, Dantas, A.R., et al 2004). Problems can be structured with different alternatives and presented to the learner who will then be allowed to make decisions. Learner can evaluate the quality of decisions under a specific scenario and in the process will have a better learning experience. This is similar to case study approach introduced in 1950s. (Forrester J.W 2004, Dantas, A.R., et al 2004). Many researchers have attempted to identify unique characteristics of various experiential learning techniques. Henry Ellington recorded significant observations related to games, simulations, case studies and role-plays. “Learning is at its best when it is goal-oriented, contextual, interesting, challenging, and interactive” (Clark N.Q 2005).

Few definitions are available in the literature. Early use of Game as educational tool can be referred to “Serious Games”, a book written by Clark Abt (1970). Abt explored methods to use games for training and education. Abt also gave a clear definition of “Serious Games”. Serious games are those that have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement. However this should not be construed as serious games are not, or should not be, entertaining (Djaouti D. et.al 2011). Abt, (1968) also explained the need for two basic characteristics, namely overt competition and rules in an exercise for it to qualify the context of “Game”. For the exercise to fit into the definition of simulation it also needs to have a real situation and it must be on-going (Henry Ellington). A detailed examination of real –life or simulated situation can be seen as a case study. (Percival and Ellington, 1980) A role-play requires a design that allows participants to act out the parts of other persons (Ellington, Addinall and Percival, 1982). Kolb (1984) stated that “Learning is a process whereby knowledge is created through the transformation of experience” (Collin, 2013). Experiential learning refers to the process of human cognition as stated by Fenwick (2000). Experiential education refers to learning activities that engage the learner directly in the phenomena being studied (Cantor, 1997). Adult experiential learning broadly speaking is a process of reconstruction performed by individual learner (Malinen, 2000).

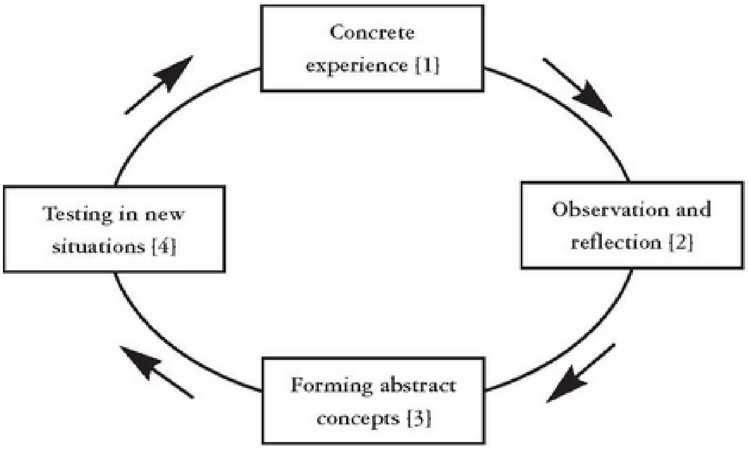


Fig.1 Kolb's learning cycle.

Experiential learning is the preferred design and it suits the adults learning as it is a learning process implying reflection on doing and thus "learning from experience". Experiential learning is the current way of learning for professional in their all day practice, following the Kolb's learning cycle model (Kolb 1984). ***Figure1*** shows Kolb's learning cycle. Six main perspectives on learning i.e. behaviorism, cognitivism, constructivism, social learning, humanism and cognitive neuroscience were identified by Wilson.

The first reported functional simulation game is the GREMEX game (Rowe, Gruendeman et al. 1968, Hussein B.A 2007) aimed to provide a synthetic experience illustrating the types of problems that can come up in an R&D project and possible control strategies. He classified the simulation games into two main categories namely functional & leadership Simulation. While functional simulation targets problems such as balancing cost, time and scope etc, leadership simulation deals with softer issues such as developing project strategy, negotiation and decision making in pursuit of several objectives. These findings also helped the authors in evaluating team performance.

Pioneers in Simulations & Games such as Bradford, Gibb, & Benne, 1964, Schein & Bennis, 1965; Rogers, 1967; Boocock & Schild, 1968; Gamson, 1969; Tansey & Unwin, 1969, Coleman, 1969; Abt, Egan,1970; Budd, 1972; Pfeiffer & Jones, 1969-1977; Greenblat & Duke, 1975; all recognized effectiveness of simulation tools (Ruben B. D, 1999).

Veshosky D and Johannes H. E (1991) used a simulation game to teach project management to civil engineering students at Lehigh University and found that the game was successful in teaching project management functions and the importance of a systems approach to project management. However they observed that simulations were less successful in teaching those concepts that are associated with financial and technology management. Authors of this paper also identified that areas such as financial and technology management, contract negotiations are still not explored fully. Only in very few cases we could see simulation games in contract related areas during our literature survey. In 1998, Dudziak. W and Chris H of Carnegie Mellon University applied simulation games based techniques as training tools for contract negotiations.

Adults develop resistance to pure theoretical concepts over a period of time and are not generally motivated to participate in a training that focuses only on concept without creating a connection with what they do in practice in real world or project scenario. Dantas A.R (2004) identified two vital attributes namely adult training and complexity as significant aspects that are to be covered by a simulation game based training for project professionals of software projects (Knowles M, 1984). Doyle identified two key challenges. i.e Replicating complexity of adequate nature & creating scope for the learner to connect the past experience to make future decisions are critical to the success of simulation based training. Conventional class room training is found not sufficient to meet such challenges (Dantas; Doyle, J.K et.al 2003).

Simulation-based games are well suited to be introduced for practicing professionals as these games enable the learner to experiment the consequences of executing or neglecting project management actions. These games also enable learners to adopt different approaches and experience the consequence (Dantas A.R 2004). Hence, professionals' trainings may require specific design. Hussein B.A (2007) presented the evolution of simulation games. Simulations are found to create a better learning environment (Boocock & Schild, 1968; Farran, 1968; Stembler, 1975) (Woodward J et.al.1988). Hemmasi, M and Lee A. G (1991) found simulation based training more effective for practicing professionals in enhancing specific skills such as teamwork, planning, and problem solving/decision making etc. Seidner (1978), Bredemeier & Greenblat (1981) and Dorn (1989) claim that there is a significant improvement in learner’s interest level with the introduction of simulation based games. Use of games in education is recognized as a factor for increasing motivation (Dorn 1989), this may be right both for children, pre-graduate or postgraduate learners. Many other researchers like Boocock, & Schild (1968), Wentworth & Lewis (1973), Coleman (1973), Seidner (1978), and Bredemeier & Greenblat (1981). Dorn (1989), Clegg (1991) and Randel et al. (1992) agree that simulation games when presented correctly can increase the learner’s motivation.

While some experts favour case study based training many others consider simulation as a better option. (Egenfeldt N S 2004). Some researchers also opine that the team size, group cohesion, game environment also can significantly influence the motivation of learning groups. (Clegg, 1991; Bredemeier & Greenblat, 1981; Wellington & Faria, 1996; Egenfeldt N S 2004).

4. Overview of the research problem

Training of practicing project engineers involves few challenges that differentiate it from pre-graduated education. Those characteristics include motivational aspects, strong link between training and prevailing professional problems. This leads to the requirement of specific design & delivery. Experiential learning is one kind of training design that is suitable for adult learning. It is a learning process implying reflection on doing and thus "learning from experience". Consequently, simulation games may be a good way of supporting experiential learning, as they provide an experience that is derived and analyzed during the training session.

4.1 Professional training- A combination of soft and hard skills.

Project management is a good example of adult training. Project management courses are mostly offered to post-graduate students or professional. These are sometimes included in bachelor or master programs, but nearly never to younger students. Project management in practice requires a combination of a multitude of different skills, which are generally divided between *soft skills* (leadership, negotiation, conflict management, stakeholder integration, communication, motivation, etc.) and *hard skills* (planning, risk management, financial analysis, control, etc). One of the difficulties with traditional education is that it mostly focuses on hard skills, as it is more difficult to teach soft skills. The other difficulty is about integration. Traditional education is mostly divided in chapters, and different aspects of project management are not integrated in a whole concept. Simulation-based training can be a way to include both soft and hard skills (for example by integrating role plays during the simulation) and be an effective tool to develop the systemic view needed for project management.

4.2 Challenges associated with simulation-Games design

Simulation-based training for professionals is often considered to be efficient. But efficiency may depend on various factors like the right blend of simulation and traditional theoretical lessons, concept and content of the simulation, link between the simulation and professional activities etc. There are a number of research papers about serious games and simulation games as tools for education, but only few about simulation design, and even less about simulation design for professional education. Designing the right simulation game requires a good analysis of learners' knowledge, environment and background. In order to continually improve simulation games design, it is mandatory to evaluate their effectiveness and rely on a standard assessment model.

Though it is widely agreed by researchers that concept based learning need to be supplemented with application based simulation software there is no precise information available in the literature describing the design requirements for a good simulation based learning that can serve as the right blend and a perfect fit for project management training. Earlier researchers like Egenfeldt have also cautioned that one may run a risk of not realizing the full potential of games if we try to put them into a procrustean bed. Teachers need to be specific about the learning outcome and find ways in which they can measure learning. This is very important failing which there is a risk of learning being repetitive, undocumented, confusing and pointing in different directions (Elder, 1973, Egenfeldt N S 2004).

Simulation games combine both theory and games aspects and provide the concrete experience to reflect on. Consequently, simulation games may be a good way of supporting experiential learning training sessions, as they provide an experience that may be derived and analyzed during the training session. Even if effectiveness of simulation games is still unclear, Chuda (1996) argue that well-conducted simulation games can provide excellent atmosphere for students. The above aspects of simulation game design is discussed by Cano and Sanez (2003) who argue that simulation games are widely used in project management education, but conditions needed to obtain optimal learning through simulation are still unclear. Hussein (2007) presented that simulation games are about solving well defined problems such as network calculation or cost estimation.

A closer look at the simulation games leads to a belief that these games shall be used for more than just solving well defined problems and the extent of application shall then depend on how the simulation is designed. The success of a training results in not imparting knowledge but to create scope for translating this knowledge into behavior (Ruben B. D, 1999). The pedagogical objectives have to be at the basics of the definition of the simulation with scope to include integration aspects where the focus is on solving global problems in a systemic perspective. All the above strategies were considered by the authors while carrying out the research and were built into the training sessions.

5. Project Management Pedagogical Practice-Present scenario

This section focuses on present practices adopted in training project managers. Authors of this paper are engaged in project management training to practicing managers and have tested effectiveness of simulation based games by including them as part of the training program. At present it is observed that most of the professional training programs are designed with lecture sessions and a case study approach. A number of concepts are introduced in the classroom and these are taught as standalone concepts while the trainee is expected to perform his role as project director/manager/team member in a holistic project environment. For example when a series of scheduling concepts such as Barchart, PERT, CPM etc are introduced on one day and a series of monitoring and control techniques such as progress charts, EMV are introduced on the other day, there are challenges to the trainee in integrating the concepts of project management.

Trainers also face a similar challenge when it comes to evaluation of performance of teams. Conventional evaluation methods reveal the understanding of the knowledge areas by the trainee but not the application capability. Project managers learn this concept of integration while they are actually executing projects with risk of time and cost over-run in projects. Project management training in a conventional classroom environment involves imparting knowledge on relevant tools and techniques of a specific knowledge area and has limited scope for integration of concepts within the training duration. Simulation based training focuses on specific scenarios. Activities are in the form of games played in a virtual environment and helps improving the overall learning experience to a reasonable extent.

Authors evaluated few games before finalizing the specific game. While some of the simulation tools are based on animation the others allow interactive environment. The game used for the purpose of this study (Name of the game not disclosed in this paper) is based on a pluri-annual experience in project management education in various environments (undergraduate and master levels, technical and managerial syllabus of academic and professional institutions). The specific game is chosen for this study as it allows much of user participation and reflects participant's performance on various scales. This is not scheduling software like MSP or Primavera but a simulation based game, which creates a virtual project environment and allows participants to evaluate their ability in converting their learning into actions in managing projects in a dynamic environment. The structure of the game helps participants to evaluate quality of their actions in meeting stakeholder's expectations and managing time, cost and quality of decisions during the course of project planning and execution.

The game displays various project phases and performance measurement scales and updates the same as participants play. Game consists of four phases (Initiation, planning, Execution and Closing) of project and five scales of evaluation (Management, User, Schedule, Cost and Quality of performance). The participant is expected to perform actions based on the project scenario with some constraint on efforts and resources. The paper restricts its scope only to evaluating effectiveness of the simulation game as a training tool and does not elaborate the various aspects or features of the game.

The game was introduced to participants as part of their formal training course in project management. The training was conducted for three different groups. Each group comprised of 18 participants who had experience in the range of 5 to 20 years. The game was introduced to the participants in a structured way and the participants were allowed to play in teams of two. Participants were reasonably familiar with the basics of project management as they were put through conventional classroom training before start of the game. At the end of the game participants were asked to fill a questionnaire and the responses were further analyzed for arriving at suitable simulation game design.

5.1 Test Measures

When it comes to evaluation of a simulation design it was observed that direct measures are not possible as it becomes difficult to directly measure link between knowledge and simulation, simulation and reality or simulation and participants. It was therefore decided to get the indirect measures. Indirect measures are those that derive conclusions based on the perception of participants. A questionnaire has been developed in order to have questions linked with the criteria that covers 3R's of simulation based training i.e relevancy, reality and reliability.

5.2 Development of questionnaire

In order to understand the requirement of good design of simulation based training it was decided to capture the participant's perception on effectiveness of training and other related features through a carefully structured questionnaire. Accordingly, a questionnaire was prepared and was circulated to the participants and the consolidated response is presented in ***Annexure B***. Out of 56 participants who were given the questionnaire 23 responded leading to a response rate of 41%. The present research involves a questionnaire survey, which covers most of these concerns presented by the previous researchers. The concepts presented by early researchers were further reduced to three critical criteria namely Reality (closeness to reality), Relevance (Educational relevance) and Reliability (reliability of the results) and presented in the following section.

5.3 The 3R's of Simulation Game

Based on the study of various elements in ***Annexure A,*** Authors derived three dimensions that can sufficiently reflect the success of the simulation-based training. This resulted in identification of three significant characteristics of simulation game, which shall be referred as 3Rs of Simulation based pedagogical practice. These three core features 3R's i.e. ***Annexure A*** shows core features of Simulation Game & their grouping under 3R Model.

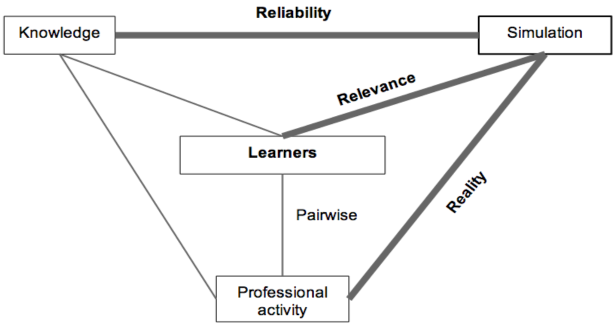


Figure 2: Link of the simulation with other components of the training session.

This specific model for simulation-based training session highlights the links of the Simulation with Learners, Knowledge and Professional activity. ***Figure 2*** presents the link of the simulation with other components of the training session.

This model referred as the “3Rs model”, relates Reliability, Relevance and Reality.

Reliability is about the simulation behavior and its dependability in terms of changing variables and associated decisions in a dynamic environment.

Relevance is for “education relevance”, how the simulation help the participant to better understand the subject and acquire the knowledge.

Reality is about the reflection of scenarios that can closely resemble challenges that the professionals face in their projects. As link between simulation and reality is difficult to measure in a multi-criteria scenario, we undertake a pair-wise analysis

The teacher is not included in the model. Of course, the teacher is present during the traditional acquisition of knowledge (training, teaching or supporting learning). For this part, the traditional pedagogical triangle may be used and very much has already been written about it. During the simulation part of the training session, the teacher acts more as a facilitator or an actor of the simulation than as a teacher. The 3R model focuses on the simulation part of the training session and on its articulation with the others parts of the course.

5.4 Simulation link with others training aspects

For choosing how to organize the acquisition of content centric knowledge, the traditional pedagogical triangle offers a good reference. This triangle focuses on the link between teacher, learners and knowledge. The pedagogical triangle does not include simulation. In other words, simulation-based activities are on the “learning” side, with learner acquiring knowledge through the simulation, in an experiential learning mode. But this triangle does not help to design simulation-based training session.

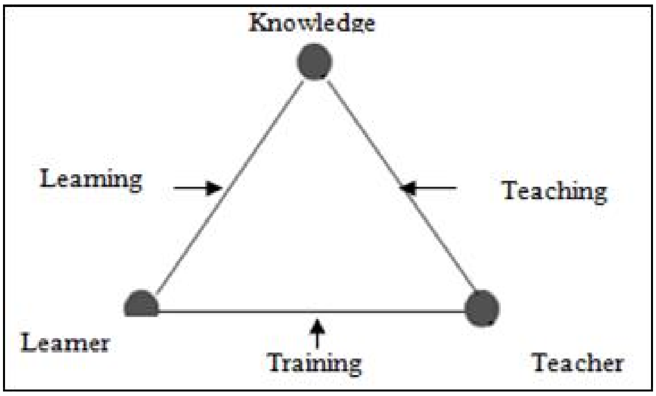


Figure 3 Pedagogical Triangle

For designing simulation-based training session one requires a specific model. This model should include simulation, its characteristics, the link between simulation and knowledge. As for adult training, link between knowledge and current professional activities is a main factor for learning motivation and knowledge integration and the model includes this aspect. ***Figure 3*** presents the link of pedagogical triangle. The research in the following section attempts to identify the extent to which this link is established in the present simulation game

6. AHP analysis of PM knowledge areas

Pair-wise comparison method was introduced by Fechner in 1860 and developed by Thurstone in 1927. Based on pair-wise comparison, Saaty proposed the Analytic Hierarchy Process (AHP) as a method for multi-criteria decision-making. Many researchers have later picked up the AHP method as a tool to solve multi criteria decision making problems as it provides a way of breaking down the general method into a hierarchy of sub problems, which are easier to evaluate. Hence authors adopted a similar strategy to evaluate participant's perception on various factors listed in PMBOK. Participant's qualitative responses were scaled and converted into quantitative values. (A.J. Antonio, and M. T.Lamata 2006). The evaluation process involves one to one comparison of each of the knowledge area under discussion. The factor weights were decided on a scale of 1 to 9. Knowledge areas that were more prominent as perceived by learners were given higher weights on a scale of 1 to 9 with 1 referring to low level of significance and 9 referring to very high level of significance.

All the knowledge areas of PMBOK were presented to the participants in the questionnaire. i.e. Scope, Time, Cost, Quality, HR, Communication, Risk, Procurement, Meeting stakeholder's expectation and Integration. Participant's responses to the questionnaire were analyzed. The questionnaire and consolidated response are shown in ***Annexure B***. Filled in responses were then consolidated before evaluation. The responses being qualitative it was found necessary to have an evaluation strategy that can be useful in managing a multi criteria assessment. Saaty's Analytic Hierarchy Process is found suitable in evaluating responses on PM knowledge areas and their reflection in the simulation games as perceived by the participants. Pair- wise comparison of these values resulted in the following PMBOK matrix. ***Figure 4*** shows the AHP Matrix for PMBOK with weights derived for various knowledge areas

	Scope	Time	Cost	Quality	HRM	Comm	Risk	Proc	Deliver	Stk Exp	Integ	G Mean	N Value
Scope	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
Time	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229
Cost	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229
Quality	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
HRM	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
Comm	2	0.5	0.5	2	2	1	2	4	2	1	4	1.6245	0.113
Risk	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053
Procurement	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026
Deliverables	1.00	0.25	0.25	1.00	1.00	0.50	1.00	2.00	1.00	0.50	2	0.7579	0.053
Stake Exp	2.00	0.50	0.50	2.00	2.00	1.00	2.00	4.00	2.00	1.00	4	1.6245	0.113
Integration	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026

Figure 4: AHP Matrix with weight factors

6.1 Consistency check

The response matrix was also put to consistency check for evaluating reliability of the results while converting qualitative assessment into quantitative dimensions.

RI $_{(n=11)}$ is taken as 1.5 as RI $_{(n=10)}$ is 1.49 and the earlier research has shown that RI is an increasing and convergent function with increasing values of n. (A.J. Antonio, and M. T.Lamata 2006).

λ_{max} = 11.066; CI= $(\lambda_{max} - n)/(n-1)$ Where n=11 & RI= 1.5

CR= CI/RI = 0.004 < 0.1 Hence, accepted

	Scope	Time	Cost	Quality	HRM	Comm	Risk	Proc	Deliver	Stk Exp	Integ	G Mean	N Value		
Scope	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
Time	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229	2.2785	9.954
Cost	4	1	1	4	4	2	4	6	4	2	6	3.2875	0.229	2.2785	9.954
Quality	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
HRM	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
Comm	2	0.5	0.5	2	2	1	2	4	2	1	4	1.6245	0.113	1.1914	10.533
Risk	1	0.25	0.25	1	1	0.5	1	2	1	0.5	2	0.7579	0.053	0.5957	11.289
Procurement	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026	0.3169	12.154
Deliverables	1.00	0.25	0.25	1.00	1.00	0.50	1.00	2.00	1.00	0.50	2	0.7579	0.053	0.5957	11.289
Stake Exp	2.00	0.50	0.50	2.00	2.00	1.00	2.00	4.00	2.00	1.00	4	1.6245	0.113	1.1914	10.533
Integration	0.50	0.17	0.17	0.50	0.50	0.25	0.50	1.00	0.50	0.25	1	0.3745	0.026	0.3169	12.154
												14.3623	1.000	10.552	11.066

Figure 5: Consistency check

The consistency in the analysis results as shown in ***Figure 5*** reveals the participant's perception on various knowledge areas and the same is consistent with their performance scores. Performance score here refers to their performance scale that gets updated based on participant's decisions and actions while playing in the virtual environment.

6.2 Results of AHP & Findings

On evaluating the matrix by AHP method, following results were achieved.

a. Few PM areas were found to be more prominent and often reflected in the game.
b. Many of the participants opined that they were able to appreciate the concept of time and cost to a greater extent followed by communication and stakeholder's expectation.
c. It is interesting to note that many of the project managers were not able to appreciate the reflection of attributes such as HR, scope and risk etc.

The instructors are of the opinion that the participant's inability to appreciate the above factors during the planning phase had actually resulted in challenges in meeting schedule and cost requirements during execution phase in the project. The results of AHP analysis reveal that all knowledge areas of PMBOK are not reflected equally in the present simulation game that is used as case study. This difference can be attributed to the game structure, participant's perception and the way they played the game. While time & cost attributes are reflected at 30% level communication & meeting stake holder expectation was seen at 13%. Many of the other knowledge areas such as scope, quality, HR, Risk, Procurement and Integration were much below 5% as can be seen in ***Figure 6.***

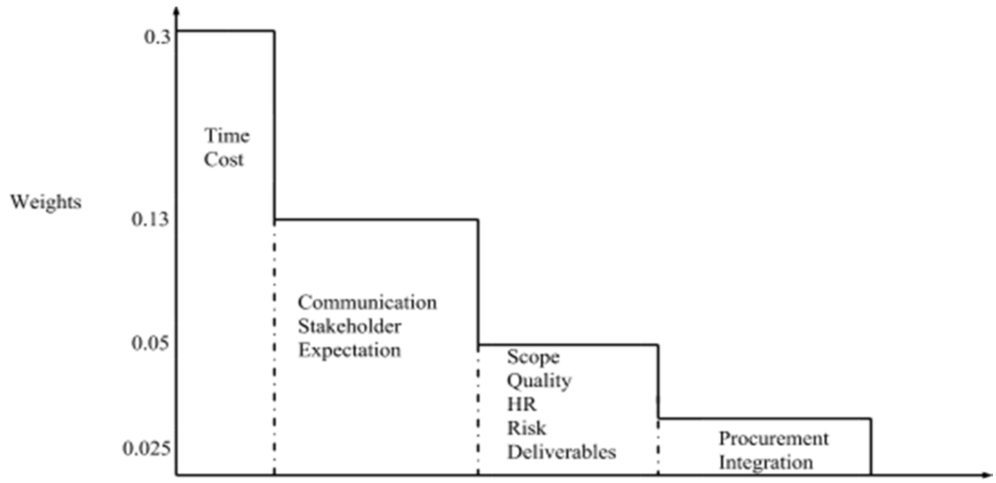


Figure 6: Level of reflection of PM Knowledge area

AHP analysis results reveal that project managers need more training in the area of functional and leadership roles before being presented with simulation based training. Participants found many challenges during execution and the same was attributed to lack of integration of behavioural and functional based inputs in managing the projects.

6.3 Observations on game features & team performance

Participants were given literature sheet that briefed project related information as reference material at the starting of the game. It is found that the participant's motivation level increased with the introduction of simulation game. The trainer's role reduced gradually during the training. However the trainers were focusing on various aspects of the play and behavior of team members during the training and few interesting observations are discussed in the following section.

- Each team tried to interpret the scope with the help of literature provided to them followed by a discussion with the team members.
- While scheduling the task, some of the teams used paper pencil, others resorted to tools such as Excel or MS Project.
- Activities were scheduled as per the technical requirement with very little scope for buffer durations.

It was interesting note that the teams focused more on schedule, cost, communication and stakeholder's expectation and in the process ignored other aspects such as employee training, motivation and their personal requirements (HR functions). Teams also did not consider factors such as engaging all team members, identifying standby requirements etc in the planning stage (HR functions). It was also observed that the inadequate planning lead to risk of losing control over factors such as scope, time and cost in the execution phase.

Participants found the way in which the project schedule and cost scale were reflecting their project scenarios is close to reality and are able to better appreciate knowledge areas concerning time and cost more compared to other knowledge areas. The learners were able to better connect 3Rs when it comes to cost and time. However communications and stake holder management were not clearly coming out through the games. Participants were not able to appreciate the link "Reliability" the way they appreciated time and cost factors. Scope, Quality, HR, Risk, deliverables were found to be even less reflected.

Annexure B shows consolidated response of participants indicating the need for a content centric training coupled with simulation game. While content centric training shall create interest in the game as the participants know what they are expected to do, the simulation game can create motivation by allowing them to transform their learnings. It is therefore clear that *theoretical sessions are effective but incomplete if not complemented with experiential learning techniques such as simulation game*.

The game made participants to appreciate the role of HR functions, leadership capability, and motivation, risk of inadequate planning, ability to convince management in decision-making etc in a project and correlate the same with their current project environment when the game was over. A good level of motivation and participation of team was observed throughout the training. *This kind of learning environment is difficult to articulate in a typical classroom session and hence supports the proposition that experiential learning is essential and not just desirable component in professional training.*

Following section summarizes the trainer's evaluation of the teams and the ability of teams to integrate and convert their learning into actions under real time conditions.

- While the participants gave more emphasis on meeting project needs during all the phases, they showed little attention on employee need. (For example HR Role such as employee motivation, training needs, employee availability etc.)
- Teams scheduled their tasks as per the literature information on project which explains only the estimates of duration by the technical teams and as a result ended up with having no provision to accommodate time contingencies arising out of managerial decisions.
- Critical activities were identified in terms of schedule during the planning phase and the participants realized that activities became critical in terms of resources in the execution phase.
- Mechanically assigning resources based on their availability or cost criteria does not ensure project delivery. Though theoretically one is correct in assigning resources that are available during a particular point in time, productivity may not be up to the mark. This may be attributed to factors such as poor motivation of the resource.
- Allocating a poorly motivated staff in the initial activities can potentially delay the whole project. For example activity 1 in the case example is delayed due to poor motivation thereby delaying subsequent activities. There are two adverse outcomes that are possible
- The project can suffer as the resources were idle for the planned period of subsequent activity. Same resources may be required for some other activity that was scheduled during the delayed period.

- Project managers should also know that selecting highly motivated individual alone cannot solve the problem but there should be continuous effort in keeping them motivated and making them available for the project.
- While selecting a highly motivated resource can facilitate smooth project execution one should also appreciate the fact that highly motivated ressources may also be wanted by the management for the very same reason that they are highly motivated!
- Participants were logical in sequencing their activities and using scheduling software. However the success lies in allowing floats not as per the information available but based on brain storming possible scenarios. But none of the teams did this and it resulted in teams performing poor in those cases where no provision for buffer time was kept. Although theoretically they were correct, practically they were not able to meet the schedule targets.
- Planning should also involve provision for alternate resources. There are possibilities that resources are moved from project and the project manager has few options when it comes to the authority of retaining resources.
- It is also to be noted that the project manager has the responsibility of managing the project team by engaging each member of the team. It is the responsibility of teams who play the game to check whether all individuals are assigned some tasks and no one is idle for the whole duration of the project. However it was found that the teams never attempted to see whether all the manpower is utilized. While project can progress by allocating resources in a theoretical sense unutilized resources can become a potential threat to the project environment. It also reflects poor capability of project manager in engaging human resource available to him and can adversely affect the progress.
- Functional & Leadership classification of resources were clearly reflected in the team's performance. While most of the teams performed well on the functional aspect a similar level of performance was clearly missing on the leadership capabilities.
- The learner's knowledge about learning (meta-cognition) and self-regulation skills also reflected through the games and thereby making them more effective in an adult learning environment.

7. Recommended frame work of a professional training session

The study makes it evident that concept based learning need to be complemented with application based simulation software. In project management pedagogy of planning, while the content centric conventional scheduling techniques answer the question of "How" the simulation when introduced can answer "How effectively" there by adding completeness to the training. This confirms the idea that "*Theoretical sessions are effective but incomplete if not complemented with experiential learning techniques such as simulation games*". For example, conventional training emphasizes on resource allocation with resource availability while the simulation-based games allow participants to look at other dimensions such as resource motivation, resource optimization and other issues concerned with project interface thereby enhancing the understanding of learner.

Design and evaluation are complementary in developing a simulation game and there should be sufficient scope for both the academicians and designers to continually evaluate the game for its relevance, reality and reliability. This shall be enabled by a strong delivery and feedback mechanism between those who design and those who take it forward in a class room environment.

A good simulation game training shall have the following features

- Sound theoretical concept orientation and discussion prior to simulation training
- Game should focus on covering all knowledge areas to the extent possible.
- Motivate and help project managers in understanding the knowledge and application requirements in a project and thereby connecting hard and soft skills.
- Both academic relevance and professional practice in terms of reliability embedded in a game shall allow the learner to connect the concepts well to their projects and make the game more motivating for the learners. *(Relevance and Reliability)*
- Games must have a provision to create more scenarios that suit their specific business environment of those undergoing training (*Reality*).
- Simulation game design therefore must reflect *3Rs of a project scenario. (Reality, Relevance and Reliability)*

Figure.7 explains the recommended framework for professional training program.

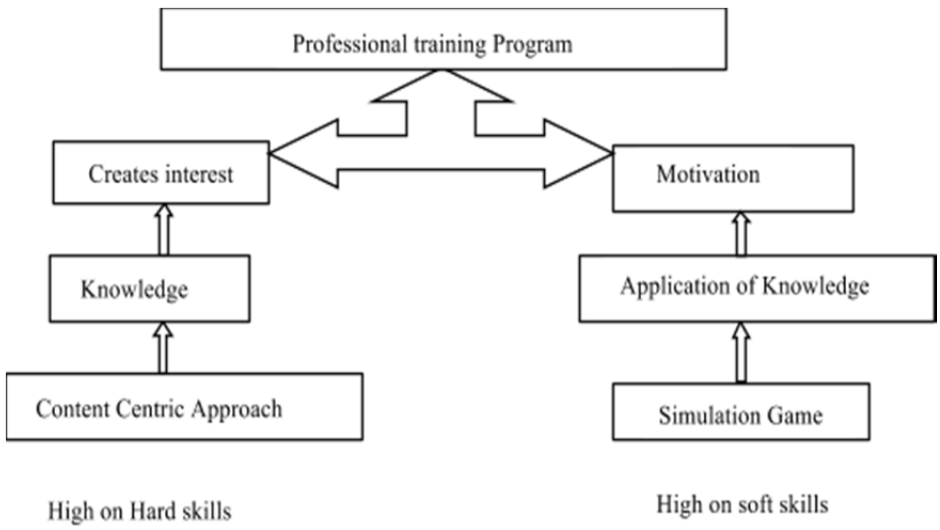


Fig.7: Recommended framework for professional training program.

8. Conclusion

Findings of the research lead to the development of simple framework that shall be referred while designing a simulation based training. The design of such framework should link the simulation with others elements of training. While the participants agree that the game can contribute in improving the interest levels and motivation to participate they also look for provisions to create more scenarios that suit their specific business environment. This confirms the discussion put forward by the authors that 3R's of simulation based pedagogical practice. i.e. Reality, Relevance and Reliability are equally significant in success of a simulation based project management training.

A simulation is not good or bad in itself, but its effectiveness depends on the learning environment and how it is linked with the training context. The paper presents the learner's and instructor's perspective on effectiveness of the game as a training tool and suggests a framework that may be of interest to both trainers and professionals who are engaged in designing and developing the simulation games. Based on the study it is concluded that professional training in project management requires theoretical inputs supported with simulation based learning. Structure of the game should cover all knowledge areas of PMBOK to the extent possible. *Designers of simulation games shall note that there is good scope for simulation based pedagogy in the developing soft skills, negotiation, contract administration and leadership competencies.*

With the introduction of more simulation games created to the requirement of specific scenarios, there is a good scope to integrate various aspects of project management that can strengthen the learning process and improve the effectiveness of project management pedagogical process in the years to come.

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Annexure A: Core Features of Simulation Game & their grouping under 3R Model

Concept	Definition	Reference	Core Feature (As reflected through concepts)	Response
Accuracy	Does a simulation game accurately mirror the reality it is supposed to represent?	Dukes and Waller, 1976	Closeness to Reality	As per 81% of respondents the Game reflects 50 to 80% of real time project scenario. Participants also suggested that the game requires some modification to suit the specific scenario.
Conceptual Validity	Does the model adequately represent the real-world system?	Pegden, Shannon and Sadowski,1995		
Criterion (predictive) Validity	Does the model effectively predict real-world situations?	Babbie, 1992, Carmines and Zeller, 1979		
Event Validity	The degree to which a simulation's predicted responses correspond to actual data from the organization being simulated	Mihram, 1972		
Empirical Validity	Does a simulation game exhibit a closeness of fit to other measures of the phenomena it is designed to simulate?	Boocock, 1972		
External	Does the simulation model represent actual external phenomena?	Cook and Campbell,1979		
Plausibility	Does the simulation model appear to represent real-life Phenomena?	Boocock, 1972		
Realism	Does the simulation represent the business environment it is designed to simulate?	Norris, 1986		

Verisimilitude (face validity)	Does the simulation model appear to represent real-life phenomena?	Kibbee, 1961		
Educational	Does the simulation provide a valid learning experience?	Feinstein, Andrew Hale, and Hugh M. Cannon,2002	Educational Relevance	57% participants say that simulation based learning can replace classroom theory sessions to a certain extent (ranging from 20 to 50%) 100% of participants felt that the simulation game can be useful as a training tool subject to due modification to suit their business needs.
Algorithmic Validity	Does the model return appropriate values? Representational validity.	Wolfe and Jackson, 1989	Reliability of Simulation Game	While some respondents agree that the evaluation scales are closer others think that the actual scales are better than what is reflected.
Believability	Does the simulation model's ultimate user have confidence in the model's results?	Pegden, Shannon and Sadowski, 1995		
Construct Validity	How correctly are the variables in the model related to each other to form strategic and environmental constructs?	Babbie, 1992, Carmines and Zeller, 1979		
Content Validity	How complete is the simulation model, relative to the demands imposed by the purpose for which the model was developed?	Babbie, 1992, Carmines and Zeller, 1979		

Convergent Validity	How well do simulation performances results compare with other measures of comparable competencies?	Cannon and Burns, 1999		
Operational Validity	Are the model-generated behavioural data characteristics of the real-world system's behavioural data?	Pegden, Shannon and Sadowski,1995		
Internal Validity	Do a model's relationships represent true causality?	Cook and Campbell,1979		
Representational Validity	Does the simulation provide a valid representation of a desired phenomenon?	Pegden, Shannon and Sadowski, 1995		
Verification	Does the model do what it intends to do?	Pegden, Shannon and Sadowski, 1995		

Annexure B: Details of Questionnaire response

Summary of Participants response
Qn: Have you played a simulation game for project management in the past? If yes, then please specify name of the game? Ans: *Out of 23 participants only one had played a PM Game Earlier. Transversal Project – Global remote assistance system from Transversal Project team*
Qn: Was the duration (one day) sufficient for you to complete the PM- game? Ans: *74% of respondents say that the duration of one day was sufficient. However they responded more time could have improved their performance*.
Qn: What was the tool that you used for planning while playing the game? Ans: *60% of participants used MSP as tool for their scheduling. It was noted that the team that used MSP planned their resources better compared to those who used Excel or paper pencil.*
Qn: Do you think some project management conceptual inputs are required to be briefed to participants before they start the game? If yes then specify few. Ans: *60% of respondents say that some Project management conceptual inputs need to be briefed before starting the Game*
Qn: Do you think a game of similar nature can substitute theory lectures completely or partially? If yes then please specify to what percentage? Ans: *57% participants say that simulation based learning can replace classroom theory sessions to a certain extent. (ranging from 20 to 50%)*
Qn: Does the game depict the actual project scenario? If yes, then to what extent? Ans: 81% participants say that simulation game depicts the real time scenario. While 81% participants agree that it is close to 50 to 80% of real time scenario, 19% are of the view that it only captures 20 to 50% of real time scenario
Qn: Which of the PM knowledge area relevant to real time application you think is more emphasized during the game? Ans: *Schedule, Cost etc are covered as per all the participants. Procurement Management is one area, which the participants say is not covered.*
Qn: Do you think the scales of performance that you got in the end are reflecting your team's actual ability? If no then what are your self-assessment scales for all five-performance measurements. Ans: *There are contradicting views. While some respondents agree that scales are closer others think that the actual scales are better than what is reflected.*
Qn: Did you focus on all parameters during all the phases of project management? (Parameter refers to schedule, cost, Management, User & quality of decisions) Ans: *While 50% of respondents said that they focused on all scales, 90% of respondents focused more on schedule and cost scales*

Qn: How many members should be in a team typically to play the game more effectively? Ans: *81% participants say that a 2 member team should be fine.*
Qn: Do you think your team's scale is same as your scale or how do you compare your performance with your team's performance? Ans: *While 70% of respondents agree that the individual scale is same as team scale, 30% of respondents said their scales can be different from team scales.*
Qn: During which phase of the game you were more interactive with other member of the team? Ans: *Planning & Execution*
Qn: Which of the Five scales was more realistic in projecting your actual PM capability? Ans: *More varied response*
Qn: Do you think this simulation game can be effective if taken further to suit your business scenario through new scenario development? Ans: *100% of participants felt that the simulation game can be useful as a training tool subject to due modification to suit their business needs.*

Facilitative Leader and Leadership development during a mega project implementation phase: A case study

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ABSTRACT

Organisations are turning to project managers to deliver one-of-a-kind or complex initiatives required to remain competitive. Despite the formalisation of the project management profession up to 65% of industrial capital projects fail to meet business objectives. Research literature suggests that project managers require leader and leadership skills to contribute to the successful completion of projects, meeting business objectives and ensuring customer satisfaction throughout the project life cycle. Fortunately, leader and leadership skills can be developed, but due to the uniqueness and temporary nature of projects different methodologies are required to develop these skills.

This study utilised a case study research approach and evaluated the benefits of facilitative leader and leadership development of the project management team on a mega project over a two-year period. Facilitative development combined the benefits of on-the-job training linked to a strategic business goal, action learning, coaching and the development of the emotional intelligence of the project management team.

This research shows that the development of the emotional intelligence of the project management team during the project contributed to both the personal development of each team member and enhanced the efficacy of the management team. The two-year development process entrenched the learning and development of the leader and leadership skills of the project team members. This development contributed to the successful completion and ramp up of the project. The model developed from this research can contribute to the continuous development of project managers and project teams to enhance the success rate of capital projects.

INTRODUCTION

As organizations are required to change and adapt in the new millennium project management is seen as the "new" form of general management used to scope, plan and deliver one-of-a-kind or complex initiatives (Pant and Baroudi, 2008). Despite the formalization of project management as a profession and the development of systems and tools to assist projects and project managers, 65% of industrial projects with budgets larger than $1 billion[1] failed to meet business objectives (Merrow, 2011).

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[1] In 2010 real terms.

The current mostly used standard approach to project management is the Project Management Body of Knowledge (PMBOK®) (2013a) guide, developed by the Project Management Institute (PMI). Although the PMBOK® guide states that "effective project managers require a balance of technical, interpersonal, and conceptual skills that will help them analyze situations and interact appropriately…" they offer little in how to acquire or use interpersonal and leadership skills effectively on projects. Project leadership is required to influence management, peers and stakeholders to buy-in to the vision of the project and ensure alignment in defining the project objectives (Cleland, 1995). The uniqueness and temporary nature of projects and project teams imply that traditional leader and leadership development will not be as effective as what is used for operational organizations. The question is therefore not "is leadership development required?" but rather "how must project leadership development be approached in project organizations?" A balanced approach to teaching the technical (hard) and interpersonal (soft) skills of leadership will contribute to more successful project outcomes (Cleland, 1995; Pant and Baroudi, 2008; Day, 2000; Thompson, 2010). Leaders learn and develop through challenging work, solving complex problems and leading teams (Hirst et al., 2004).

RESEARCH OBJECTIVES

The research objectives are: (1) to investigate and determine the benefit of leader and leadership development of the project management team during the implementation phase of a mega mining project as a case in South Africa, and (2) to determine if the leader and leadership development approach had a sustainable impact on the leader and leadership skills of the project management team.

THEORY AND CONCEPTUAL MODEL

Project leadership and project management

Project managers are required by their organizations to acquire a professional accreditation through training and learning activities to ensure the successful delivery of projects. The Project Management Institute (PMI) reports that they have over 500,000 PMI certification holders in over 180 countries (PMI, 2013b). Despite these numbers, more and more projects fail to deliver on their objectives mainly as a result of the lack in human or soft skills of project managers (Cooke-Davies, 2002). Project management is about leading and managing people and not controlling them, which makes their human interpersonal skills more important than just their technical skills (El-Sabaa, 2001; Pant and Baroudi, 2008; Thompson, 2010).

Leadership, unlike management, is an informal position without authority or an occasional activity from where the leader uses his ability to influence others to action (Du Plessis, 2014). Although project managers are appointed by organizations to lead and manage a project to ensure organizational objectives are met, they need leadership skills to lead a team and have the ability to influence others. Turning technical project managers into effective project managers is a multidimensional and complex process that requires the development of technical and interpersonal skills in context, moving beyond traditional learning, to learning and development that can adapt to project environments (Ramazani and Jergeas, 2014; Thomas and Mengel, 2008; Turner and Lloyd-Walker, 2008).

Development of leader and leadership skills

Leader development is defined as the human capital, “the individual leadership model of the organization” and leadership development as social capital, “the relational leadership model of the organization” (Day, 2000). Leader and leadership development focusses on the development of soft skills like self-awareness, self-regulation, self-motivation and how you see others in terms of social awareness and social skills. Leadership development enhances the collective capacity of the organization developing leaders at all levels (Osborn et al., 2002; Dalakoura, 2010). Effective leader and leadership development occurs in the context of the employees’ work, especially when tied to strategic organizational objectives or business goals (Dalakoura, 2010; Dotlich and Noel, 1998; Hirst et al., 2004). Practices used for leader and leadership development include 360-degree feedback, coaching and mentoring, networking, action learning, specific job assignments, experiential learning and classroom-type leadership training (Cacioppe, 1998; Day, 2000).

Project leadership competencies

Projects are temporary endeavors with temporary teams, therefore project managers require a high level of emotional intelligence to develop interpersonal relationships in order to establish trust and commitment within the project team (Müller and Turner, 2007; Tyssen et al., 2014). The skills linked to enhancing project success are listening, trust, motivation, empathy and conflict resolution. In investigating the competency profiles of project managers it was found that emotional competencies were associated with project success as opposed to managerial or intellectual competencies (Müller and Turner, 2007). For project leaders to lead and manage mega project teams they need emotional intelligence in order to be inspiring and refreshing through the different phases of the project.

Development of emotional intelligence

Salovey and Mayer (1989) described emotional intelligence as “the ability to perceive accurately, appraise, and express emotion; to access and/or generate feelings when they facilitate thought; to understand emotion and emotional knowledge; and to regulate emotions to promote emotional and intellectual growth”. Various studies have shown that people can develop their emotional intelligence skills to increase emotional awareness and control their emotions in order to achieve better results (Dulewicz and Higgs, 2004; Druskat and Wolff, 2001; Allio, 2005; Goleman et al., 2013).

Project managers and project teams must develop their emotional competencies in order to communicate effectively, establish trust, develop interpersonal relations, improve participation and collaboration in order to deal with the complexity and changes within projects. Emotional intelligence enhances the management of conflict due to misunderstanding, miscommunicating and stress on the project, leading to better decisions, more creative solutions and higher productivity (Clarke, 2010b; Druskat and Wolff, 2001). Goleman (2004) developed the mixed model of emotional intelligence in the work place which focusses on four dimensions; self-awareness, self-management, social awareness and relationship management. The project manager and team can improve their emotional intelligence by consciously practicing these aspects.

Leader and leadership development model

Leadership is required to enable the successful completion of projects and ensuring customer satisfaction throughout the project life cycle. The uniqueness and temporary nature of projects and project teams suggest that traditional leadership development methods will not be effective in a project environment. The research proposes a conceptual model whereby facilitative leader and leadership development is used to develop the emotional intelligence of project team members through on-the-job training on a strategic project, thereby enhancing the learning experience and benefitting the organization. The conceptual model for development of leader and leadership is depicted in Figure 1.

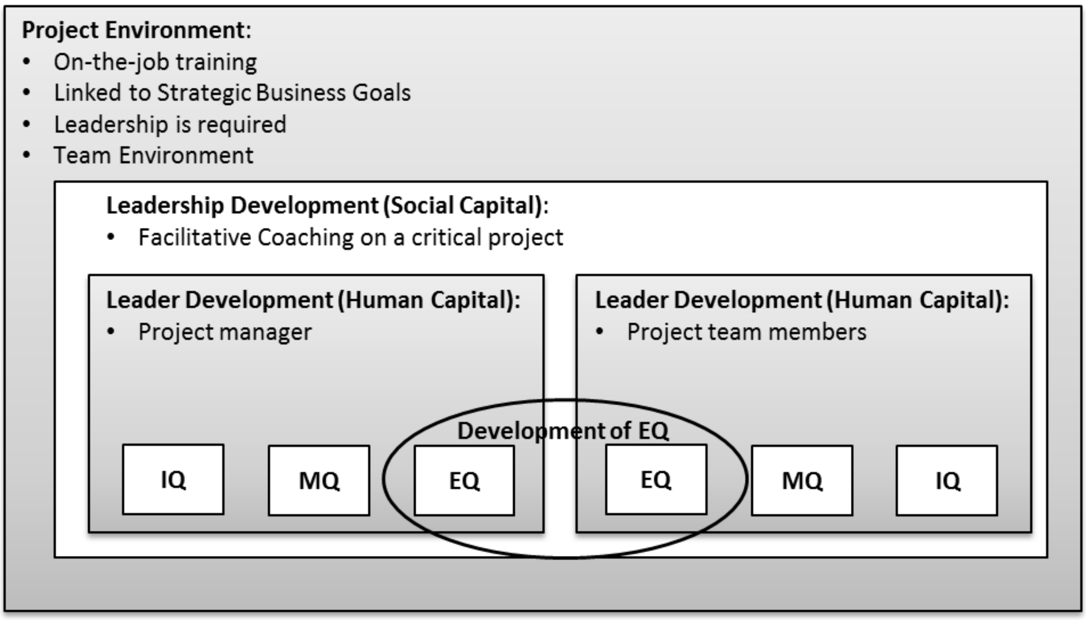

Figure 1. Conceptual model for leader and leadership development on projects

RESEARCH DESIGN AND METHOD

Qualitative research based on a case study was used to research the model and answer the research questions. The case study research answered the following questions; (1) how did the individual benefit from the leader and leadership development during the project? (2) how did the leader and leadership development during the project benefit the outcome of the project? (3) which development strategies/techniques were the most beneficial and how were they used during the project?

The propositions that support the research questions are:

- Facilitative leader and leadership development during the project implementation phase contributed to the emotional competence of the team members and the team as a whole.

- The increase in emotional competence contributed to the project being completed successfully.
- The leader and leadership development on a strategic project for the organization enhanced the training which benefitted the individuals and the organization in the long term.

The unit of analysis was a mega project, a new open cast mine, which was implemented for a mining company based in South Africa during the period 2008 – 2012. The evaluation of the leader and leadership development focused on the project management team that was responsible for the delivery of the project. The project management team consisted of a project manager, assistant project manager, engineering manager, construction manager, controls manager, financial manager, human resource manager, procurement manager and the health & safety manager.

The project management team assembled was a very competent and experienced team. The team members had more than 45 years' project experience between them. The project manager had previously completed two mega projects. The management team had 15 post graduate degrees between them of which two was at masters' level. Three members of the team completed a mega project together. The team consisted of eight males and one female.

The data gathering for the research was done through data mining and structured interviews. Data mining was done on the information that was gathered by the facilitator during the development phase of the project. Structured interviews were conducted with seven[2] of the nine project management team members and the facilitator.

RESULTS AND FINDINGS

Project Background

The project was approved for execution in July 2008. Project team mobilization started in early 2008. A strategic company decision was taken to replace the project manager of the feasibility phase with the project manager that just completed another mega project for the company. He brought with him a core group of people, to implement the lessons learnt from the previous project. The merging of two teams with different experiences, backgrounds and cultures caused disruption within the team. The high pressure and deadline driven environment resulted in conflict, unproductive tension and dysfunctional team behavior. The team culture was one of distrust and blame (Kumba, 2013; Roux, 2011). In January 2010, eighteen months into the 40-month project, the project was 3 months behind schedule and the management team was in disarray. The executive head of projects decided to appoint the facilitator to break the cycle of conflict within the team.

During the conflict resolution process, the facilitator identified the potential in the team and shifted his focus from only defusing tension and breaking the cycle of conflict to

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[2] The construction manager passed away during the project and the finance manager could not be traced after leaving the company.

the development of a group of “extreme achievers” and “brilliant individuals” into an efficient team. The facilitative development was done through (1) individual coaching, (2) inter-personal coaching and (3) team coaching. A narrative approach with a focus on leadership development through discussions and reflective thinking was utilized.

Through the various facilitation sessions, the team dynamics improved through development of interpersonal relationships, improved trust and communication between members. The team provided mutual support to reach project goals and to take responsibility and accountability for their actions, thereby developing a winning team culture (Kumba, 2013; Roux, 2011). The growth and development was achieved as a result of frequent interaction and inclusive problem solving, open and respectful communication and personal feedback within the group and, elimination of triangular relationships. This lead to an increase in self-belief and growing self-confidence within the team and understanding the “soft issues” and how that impacts on the team and individual performances.

The end result of the two-year development process was that the project was able to rail the first ore from the new mine to port in November 2011, five months ahead of the project date of April 2012. The project was completed under budget and managed to ramp up to design capacity by July 2012 and has been producing above that capacity up to 2015 when the research was conducted.

Findings

The following section provides a narrative of the feedback from the team members during the interviews conducted in 2015.

How did the project management team members benefit from the leader and leadership development during the project?

The team members had very little leadership training and development before the project. Most training was general management training and class room based, with little to no “on the job experience”. This is in-line with the research done by Allio (2005) which states that this type of training is ineffective. The development process improved the emotional intelligence of the individuals by developing their self-awareness and self-management. Through the facilitation the team members understood their own emotions and how to control that in order to build relationships and trust within the team. The development of trust within the team was not fully established due to relational distrust between members. The team did trust each other in terms of technical competence and accountability to do what was required. The emotional intelligence of the team was further enhanced through the development of social awareness and relationship management. The development of empathy was the biggest breakthrough for the team especially on a project that had ups and downs in terms of emotional impact. The development of communication (listening) improved dramatically after the initial phases.

In terms of developing others, the team commented that the relationships that were developed enabled the team to move at a faster pace and contributed to achieving milestones (teamwork & collaboration). Under pressure the team operated more effectively (service orientation) and bonded on a deeper level (building bonds). The team acknowledged that in 2010 they did not have the emotional intelligence to resolve the initial issues between team members. The facilitator managed to develop the group efficacy (teamwork and collaboration) through creating a vision of an efficient team where each other's strengths were acknowledged and developed.

How did the leader and leadership development approach during the project benefit the outcome of the project?

The project team felt the leadership style was autocratic and dictatorial, which contributed to the conflict within the team. The project had an extremely low chance of being completely successful based on the situation after 18 months. The comments from the team reflected the transactional leadership style of the project manager. In times of uncertainty and change, a transformational leadership style was seen as more effective in aligning people needs with project goals (Tyssen et al., 2014). Developing the emotional intelligence of the team improved the trust and efficacy which contributed to the cohesion and improved participation between team members. The project teams' leadership style preferences are indicated in Figure 2 (Goleman et al., 2013).

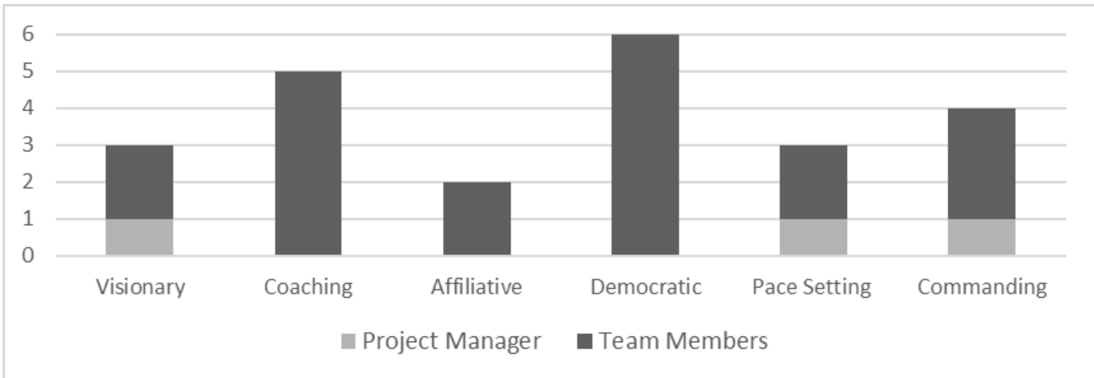

Figure 2. Project team leadership styles preferences

The combined team represented all the various styles. The team understood the power of influence whereby a leader with limited positional power could influence a team and take responsibility for specific aspects through the phases of the project. The collective leadership style of the team enhanced the leadership of the project team to complete the project five months ahead of schedule, under budget and to the specified quality.

Which development strategies/techniques were the most beneficial and how was it used during the project implementation?

None of the team had previously been exposed to this type of facilitation on a project. In fact, one member found it strange that it was required. They did, however, experience that the development was deeper, more emotional than expected. The focus on an emotional level brought the team closer by building relationships and trust between members. The involvement over a long period (2 years) in good and bad times benefitted the process. The reflection and feedback, identified blind spots and helped people understand issues and the effect it had on team members. Although the development focused on the soft issues, the facilitator held the team accountable and was robust in how he handled issues.

The benefit of having a personal coach for the team was positive as the facilitator understood the context and could give feedback on relevant issues. The focus was always on the individual contribution and individual accountability within the team. He developed the individuals' understanding of their opportunity to influence decisions and impact on team members. The project manager raised the concern of team members rather confiding in the facilitator which could undermine the authority of the project manager. The team therefore had to be mature and the facilitator impartial to make the process effective.

Emotional development

The team rated themselves in terms of emotional development on the five components of emotional intelligence at work (Goleman, 2004) on a 5 point scale. All project team members, except for two, showed an increase in self-awareness after the project. The members who experienced a decline stated that they disconnected their feelings towards some members as a coping and survival mechanism. The average score increased from 3.6 to 3.9. Five of the seven members showed an increase in self-regulation with two members remaining constant. The average score increased from 3.0 to 4.1. Three members showed an increase in motivation with four members remaining constant. The average score increased from 4.0 to 4.4, which showed high levels of motivation. Four members showed an increase in empathy, two remained constant and one showed a decline in empathy. The individual stated that the decrease in empathy was used as a coping/survival mechanism towards some people on the team. The average score increased from 3.6 to 3.7. Five members showed an increase in social skills with two remaining constant. The average score increased from 3.3 to 4.1. Overall the team confirmed that the facilitation developed their emotional intelligence.

CONCLUSIONS AND RECOMMENDATIONS

Having technical competent project managers and teams does not guarantee successful projects. Turning technical project managers and teams into great project managers and teams is a multidimensional complex process that should be done in context and address both the interpersonal and technical skills. The research showed that through facilitative development the emotional competence of the project members had increased due to the training that lasted two years, which in turn contributed to the effectiveness of the project management team (Druskat and Wolff, 2001). The increase in emotional competence contributed significantly to the successful completion of the project. This supported the research done by Du Plessis (2014) - emotionally intelligent project managers (or project teams) are more effective leaders (or have more effective leaders in their team) and deliver more successful projects. The experienced-based development assisted the team members to gain insight in what it took to lead, develop leadership skills and become an effective leader (Thomas and Cheese, 2005). The development of the project management team on the most important and critical project for the company enhanced the experience of the individuals and supported the research by Dalakoura (2010) that development should occur in the context of their work and tie to strategic organizational objectives (projects) and everyday life at work of the employees. The training must adapt to the complexities of project environments (Ramazani and Jergeas, 2014). The benefit of having a personal coach on the team enhanced the learning by tailoring the development of the individual to match their experiences, skills and learning styles on a one-on-one basis, supporting the findings by Solansky (2010).

The research supports the conceptual model that a strategic project is the ideal opportunity to develop leader and leadership skills of project managers and their teams through development of emotional intelligence. Projects provide (1) action learning linked to strategic goals, (2) finite duration whereby development can be measured and assessed, (3) job assignments that benefit the individual and company (4) high pressure environment with constant change, (5) quick feedback on decisions taken and impact on team and project, (6) efficient and effective leadership is required to be successful, and (7) opportunity to develop a new team to become efficient.

Recommendations

The research project was an extreme case in terms of the dysfunctional behavior within a management team. The full potential of the development was therefore not realized. Further research is required whereby practitioners that do emotional intelligence development can partner with industry to develop programs whereby learners can be assigned to projects and taken through a more structured developmental process based on the initial gap analysis of their emotional intelligence. More work is required to make industry and project organizations and project directors aware of the potential benefit of developing the emotional intelligence of their project managers and project team members.

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The Missing Link – Risk Identification

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Abstract. All risk management standards, guides and process descriptions note that risk identification is a key component of a robust risk management framework. Further, an effective risk identification process should identify all types of risks from all sources across the entire scope of the program/enterprise activities. However, no document or solution provides sufficient guidance for identifying a comprehensive set of risks – a risk management baseline. Further, risk identification as it is practiced today is a subjective, ad hoc, non-comprehensive and non-repeatable process resulting in continuing failures and overruns in all types of product and service development and modification programs.

A radical new approach to risk identification is presented to overcome this serious shortcoming. A large analysis of over 500 programs called the Risk Identification Analysis, its conclusions and the tool developed from those conclusions, Program Risk ID, are discussed in this paper.

The Risk Identification Analysis and Its Conclusions

A fundamental question prompted the performance of the Risk Identification Analysis. "Why is risk management the only Systems Engineering (SE) process that does not require a baseline to be developed?" All other SE processes - configuration management, requirements management, design, architecture, etc. - require that a baseline be developed for each program as one of the first steps after a program is established. This requirement does not exist for risk management. Risk management standards and guidelines [1,2,3,4,5,6,7,8,9,10,11] do indicate that risk identification is a very important step in the RM process, but do not require that a risk baseline be developed. We define risk to be potential problems that can affect program cost, schedule and/or performance. The term program also includes projects, activities and operations.

There is a widespread belief that each program has a unique set of risks. This is false, based on the results of our Risk Identification Analysis (herein known as the Analysis). It has been determined that every program inherently has the same risks as every other one. Of course, the *specifics* of the risks vary. For example, "Technology Risk" will change from program to program depending on what technology one uses or what skills personnel possess or require. These change as do the assessments and the impact(s) depending upon the specific program. But the overall baseline of technical, enterprise, operational, management, organizational and external risks that should be considered remains the same. *There are no unknown* unknowns or Black Swans[12], only *unconsidered risks.* All risk management standards and guides fail in this regard: they do not require that all risk management processes/programs use the same basic set of risks for identification, thus creating a risk baseline for each program.

The risk management process has been fairly well standardized over the past 50 years – most risk management standards, handbooks and guidebooks (references as noted above) use the same basic process steps albeit with different names. A closer examination of the definitions shows that the steps are essentially the same – Planning, Identifying, Assessing, Prioritizing, Control and Monitoring in a continuous effort. When examining each of the steps however, one finds that Identification (establishing a risk baseline) is essentially ignored except to state that it must be done. Risk Identification is defined as

"…discovering, defining, describing, documenting and communicating risks before they become problems and adversely affect a project. Accurate and complete risk identification is vital for effective risk management. In order to manage risks effectively, they must first be identified. ***The important aspect of risk identification is to capture as many risks as possible.*** (author italics) During the risk identification process, all possible risks should be submitted. Not all risks will be acted upon. Once more details are known about each risk, the decision will be made by the project members as to the handling of each risk. There are various techniques that can be used for risk identification. Useful techniques include brainstorming methods as well as systematic inspections and process analysis. ***Regardless of the technique used, it is essential to include key functional area personnel to ensure no risks go undiscovered****."*[13] (author italics)

Common Historical Risks. The process steps for risk management, with the exception of risk identification, are outlined and defined. This lack of consideration in establishing a risk baseline is because of the mistaken belief that each program is unique and therefore its risks must also be unique. The Risk Identification Analysis has shown that this belief is wrong. As programs were analyzed, it became clear that the same risks kept occurring, over and over again. A set of common risks emerged. Thus there are a set of inherent risks that are applicable to any program and should be considered in developing a program risk baseline. These common risks provide a comprehensive method that can be used to develop a risk management baseline for all programs - based on this analysis of historical data.

The Analysis was conducted over 15 years by examining over 500 programs. Information from direct experience was utilized on over 70 programs, and the rest were researched using GAO project reports on DoD projects, and anecdotal evidence gained from teaching risk management to approximately 3500 people and train the trainer sessions provided to NASA Goddard personnel. Participants from these training programs shared confidential data during subsequent discussions that was not documented in papers or GAO reports. Programs (a blanket term that covers programs, projects, activities and operations) include those in the commercial and governments sectors, as well as those from numerous domains. Aerospace programs include those from all branches of the DoD and NASA. IT programs covered both hardware and software. Energy and utility programs were covered including facility construction.

Risk Weighting. As the risks were identified, it became apparent that some risks occurred more frequently than others. Also, when the risks occurred, some risks had a more detrimental effect on programs than others. In order to accurately gauge the effect of a given risk on a program, each risk needed to be weighted relative to the others. Once the risks were identified, the analytical hierarchy approach was used to perform the risk weighting.

Risk Levels. Once the inherent risks are in hand, how would one determine the status of the risk? Consider management experience, for example. How does one determine whether this risk has been addressed properly or not? If no standard is provided, the risk status is subjective, completely up to a given individual. In order to reduce subjectivity, risk levels were defined for each risk to define its current status in the solution space for that risk. These risk level statements are based on historical data for numerous programs and incorporate areas like the maturity of the process, the level of the design, the build level of the hardware, etc., for each risk. An example of a set of risk level statements is as follows:

Generic Risk: Requirements Definition

- Level 5 – System and user requirements are not defined, forcing the developer to make assumptions. There is no potential for definition of requirements for the long term.
- Level 4 – System and user requirements are not defined, forcing the developer to make assumptions. Assumptions are informally agreed to by the stakeholders or users. There is no potential for definition of requirements for the long term.
- Level 3 – System and user requirements are not defined, forcing the developer to make assumptions. Assumptions are informally agreed to by the stakeholders or users. Potential for definition of requirements in the short term exists.
- Level 2 – System and user requirements are partially defined: the remainder are to be defined in the short term and formally agreed to by all stakeholders.
- Level 1 – System and user requirements are fully defined and formally agreed to by all stakeholders.
- N/A – This risk is not applicable to the program being analyzed.

The risk levels provide the means of establishing program status for a given risk at a given time. The risk levels also provide a path to risk mitigation, and a guide to assigning likelihood of the occurrence of a risk. The risk levels minimize the subjectivity associated with risk status and allow the assignment of weighting factors to each risk, as well as the risk levels for each risk.

Program Complexity and Its Effect on Program Risk. From long experience performing risk management on programs, we see that programs with larger budgets, more people, and longer schedules are more complex, and thus are higher risk. However, there is no consensus in the literature on how to define program complexity, much less how to incorporate complexity into the risk profile of a program. A survey of sources that discuss definitions of complexity was consulted [14, 15,16,17,18,19,20,21]. We found that certain complexity factors caused the relative weighting of the risks to change, and these five parameters became the way that we describe program complexity: program cost, personnel effort, program duration, number of technologies/disciplines involved, and influencing factors. Influencing factors include conflicting organizational objectives, significant inter-organizational planning, building trust requirements, and partner drag effects. Levels of program complexity was further defined by 5 levels that include Simple, Average, Moderate, Intermediate and High.

Table 1 illustrates the relationship between a risk, the risk weighting factors, the risk levels associated with a given risk, and the program complexity level.

Table 1. Complexity, Risk Level and Sample Risk Weighting Factors

Risk Level	Program Complexity Level				
	Simple	**Average**	**Moderate**	**Intermediate**	**High**
Level 5	16	18	20	22	23
Level 4	13	15	17	18	19
Level 3	8	11	12	14	16
Level 2	6	8	8	9	11
Level 1	4	4	5	5	7
N/A	3	3	3	3	3

Once the weighting factors for each risk and risk level were in place, they were combined to determine the overall risk level of the program (high, medium or low). By using the same risk baseline for each program, program risk levels and risks can be compared. Current risk management programs and methods do not allow a straight comparison.

The common risk set, with risk levels defined for each risk and combined with a set of complexity factors and levels, provides a comprehensive program risk baseline. The sum of these advances becomes a revolutionary approach to risk identification. The final innovation is to use this risk identification system as a diagnostic tool so that program vulnerabilities can be identified and addressed before their consequences are realized. That tool is Program Risk ID.

Risk Identification Today and Program Risk ID

Program failures, overruns (cost, schedule) and performance shortfalls are a recurring problem. This problem applies to both commercial and government programs and to small, medium and large programs. Some examples include the following.

- In March 2014, the US Government Accounting Office reported that the 72 major defense programs they reviewed that had reached the systems development stage were averaging 23 months delay in delivering initial capabilities. [22]
- A KPMG survey conducted in New Zealand in 2010 found that 70% of organizations surveyed had suffered at least one project failure in the prior 12 months. [23]
- A 2008 IBM study of over 1500 project leaders worldwide found that, on average, 41% of projects were considered successful in meeting project objectives within planned time, budget and quality constraints, compared to the remaining 59% of projects which missed at least one objective or failed entirely. [24]
- KPMG research conducted in 2013 showed that only one-third of the IT Project spend for any given organization is delivering the desired outcome. [25]

- A study covering 134 companies worldwide shows reports that 56% of firms have had to write off at least one IT project in the last year as a failure, with an average loss as a result of these failures being 12.5 Million Euros ($13.6M U.S.). [26]

Risk Identification Today. A 2012 risk management survey conducted by Sysenex, Inc. found that although 75% of companies surveyed had a risk management process in place, 51% of them had experienced a risk-related loss or failure. [27] If one has a risk management process in place and is using it, why is the loss and failure rate so high? In our experience, the primary causes are the current ad-hoc, non-repeatable, non-comprehensive approach to risk identification, the piecemeal approach to risk identification, and the 'Shoot the Messenger' syndrome.

The current ad-hoc, non-repeatable, non-comprehensive approach to risk ID. The better the risk identification process, the better the risk management process. If a risk is not identified, none of the other risk management steps are of any use. We have identified over 60 risk guides and requirements documents. Risk identification is addressed in numerous ways; a representative sample of risk identification approaches are provided in Table 2.

Table 2. A Representative Sample of Risk Identification Approaches

Risk Management Document	Brain-storming	Lessons Learned	Failure Scenarios /FMEA	WBS/ Work Plan	SMEs, Program personnel	Stake-holders	PRA
NASA SE Handbook, SP-2007-6105 [28]	X	X					
Risk Management Guide for DoD Acquisition [10]			X	X			
NASA SE Process and Reqmts. [29]			X	X	X		
NASA Risk Mgmt. Handbook [30]						X	
Engineers Australia Risk Management Guide [31]				X			
Human Rating Rqmts. NPR 8705.2 [32]			X				X
FFIEC Mgmt IT Exam. Handbook [33]			X	X			

NASA Gen'l Safety Program Rqmts [34]			X				X

When participants were asked during the Sysenex survey about how they identified risk, over 83% indicated that they relied on their personal experience, 74% consulted their subject matter experts or colleagues, 67% brainstormed with their colleagues, 55% conducted failure analyses, 50% consulted their stakeholders, and 41% performed Probabilistic Risk Assessments. The problem with these techniques is that they are unique to a given program or project: one starts over from scratch for every new effort.

Further, we have had many conversations with program personnel about risk identification. Despite the best efforts of these dedicated, experienced professionals, they are failing to resolve risks before they suffer the consequences. They know that it is better to find risks earlier rather than later. They also know that they are not uncovering all of their risks, and that they will likely have to deal with these problems later on when they are harder and more costly to fix.

In conjunction with George Mason University, Sysenex conducted a risk management tool survey. Although over 50 risk management tools are commercially available today, none of them provide a risk identification capability.

The piecemeal approach to risk ID. On programs, financial and business risk is often considered separately from technical risk. Having a partial understanding or visibility of program risks can lead to skewed decision-making. A good example of this phenomenon is the 2010 Gulf Oil Spill. The three companies involved, BP, Transocean and Haliburton, all performed risk analyses on their portion of the well system. None of the companies looked at the overall risk of the well system. The results were disastrous.

Shoot the Messenger. This occurs when program personnel that raise risks are blamed for the bad news as if they were responsible for creating the risk. The reasons for this reaction are numerous but are based on fear, denial and embarrassment. The resulting inhospitable and closed environment causes bad news to be suppressed until circumstances conspire to make the problem obvious to all.

In summary, risk identification today is an ad hoc, non-comprehensive, non-repeatable, subjective exercise. Risk guides and requirements only partially address these problems. There are no tools to assist personnel in their efforts, and personnel are mostly left to their own devices to do the best they can. Risk identification is often performed piecemeal on programs, leading to a fragmented or incomplete understanding of program risks, which can distort decision-making. Program personnel are sometimes discouraged from reporting risks.

This is why Program Risk ID was developed – www.programriskid.com .

Program Risk ID (PRID) is designed to be used by personnel (Users) who are knowledgeable about their program, allowing program personnel to perform this analysis for their programs. PRID provides risks found on a wide variety of past programs to help inform current development efforts. PRID provides the risk framework so that Users can assess their program for vulnerabilities – risks - that are addressed before they cause cost and schedule overruns and performance shortfalls. Users are typically the most knowledgeable about their specific product or service development or modification program, and so are best positioned to perform the analysis.

The Risk Identification Analysis revealed 218 risks that fall into six broad areas: Technical, Operational, Organizational, Managerial, Enterprise, and External risks. For each risk area, PRID further subdivides the areas into categories by subject, with individual risks within the categories for ease of analysis and to assist in tool navigation. Examples of risk categories and individual risks are shown in Table 3.

Table 3. Examples of Risk Categories and Individual Risks

Risk Area	**Risk Categories**	**Example Risks**
Enterprise	Enterprise Approach, Processes, Security and Risk Approach	Experience, culture, reputation, security processes
External	Customer Focus, Funding, Labor, Regulatory and Legal, Threats, Environment	Customer interaction, country stability, threats
Management	Management Approach/Experience, Personnel Approach, Funding, cost and schedule, Management Processes, Measurement and Reporting	Program scope, management experience, staffing, personnel experience, turnover
Operational	System Maintenance, Security, Processes and Personnel, Failure Detection and Protection, Readiness, Impact on Company, User Considerations	Obsolescence, personnel training/experience, contingencies, human error, profitability, user acceptance
Organizational	Organizational Approach, Processes and Procedures, Security	Organizational experience, culture, personnel motivation, processes, data protection, security
Technical	System Definition/Integration, Common Technical Risks, Design, Software and Hardware Specific Risks, Processes, Production, Test, Reuse	Requirements, dependencies, quality, training, data quality, integration maturity, reliability, root cause analysis, fabrication, testing

PRID is intended to augment and enhance current risk identification efforts. Beginning as early as possible during a development or modification program, PRID analyses are ideally performed at periodic intervals throughout the program. As a program evolves, so does its risks, and PRID helps to identify new risks as they arise. Also, PRID will show the effectiveness of risk mitigation efforts as scores of individual risks fall, remain the same, or rise, from analysis to analysis.

A User sets up an analysis by inputting basic program information including program name, start and end dates, and the like. Users choose the program type: software only, hardware only, or both. Since PRID includes both hardware and software risks, and not all programs have both, selecting the appropriate program type enables PRID to provide only those risks that are pertinent to a given program. Users answer the complexity questions, given in Table 4. Five ranges are provided for each answer: the range endpoints are given in Table 4.

Table 4. Complexity Questions and Answers

Complexity Question	Range of Answers
Program Duration – months	From 13 to 49 months+
Program Cost - dollars	From $1M to $100M+
Personnel Effort - days	From 2000 to 50,000 +
Technologies/Disciplines	From 1 to 5+
Influencing Factors	From 0 to 4

Based on the answers, PRID determines a program complexity level. The User can choose to agree with or to change the complexity level. While it is recommended that the User agree with the tool, there may be mitigating circumstances not accounted for by the tool that cause the User to adjust the complexity level. Once the setup information is input, PRID provides a screen for checking User input.

Once the analysis is set up, the User is presented with the six risk areas, and chooses one to begin the analysis. Each risk is presented the same way as shown in Figure 1. The Management Experience risk is shown with five risk levels and N/A, as described earlier.

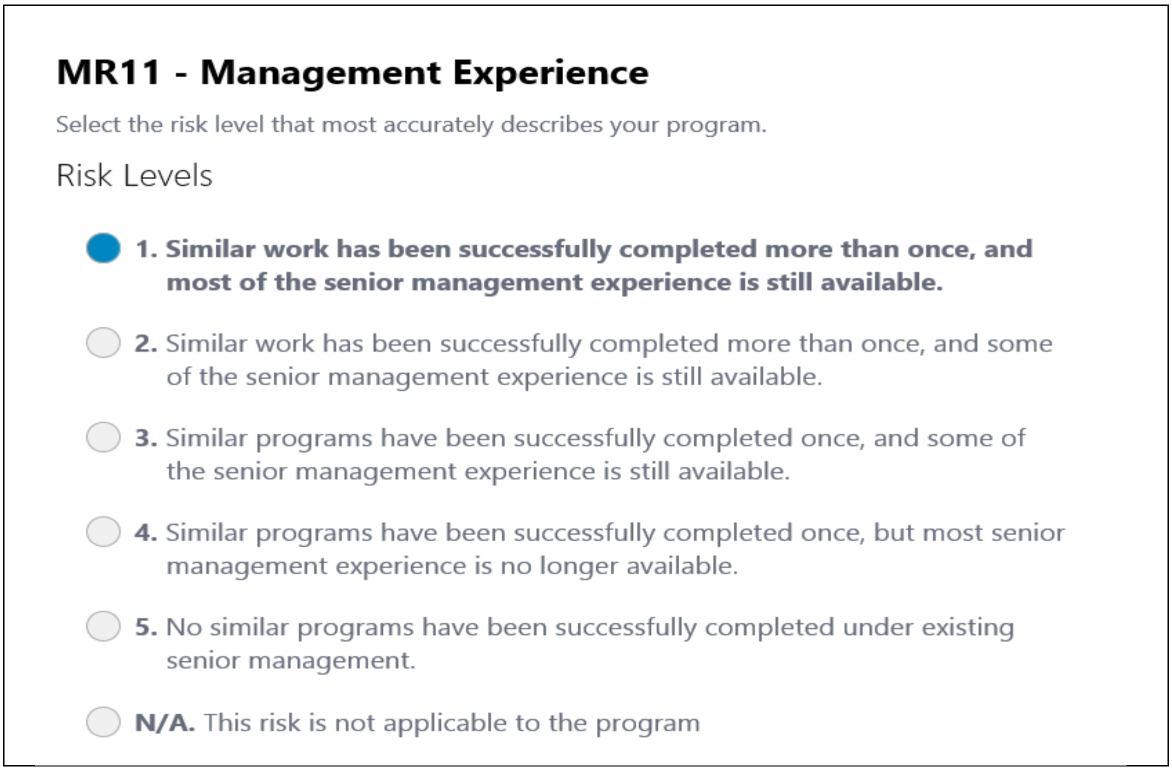

Figure 1. The Program Risk ID Management Experience Risk

If a program has experienced managers that have successfully completed a similar past program, then that program is low risk for the Management Experience item. Levels 3, 4, and 5 are more problematic, and additional effort is required to reduce the risk. It is recommended that all risks designated as Levels 3, 4 or 5 be examined further so that mitigation efforts can be undertaken, in alignment with program priorities and the availability of resources. A User chooses N/A if the judgment is made that the risk is not applicable to the program. We advise caution here as often, upon further examination, the risk is actually applicable, so N/A should be chosen rarely. PRID outputs scores at the program, risk area and individual risk area levels, facilitating progress tracking through time. Reporting capabilities include a list by risk level as well as numerical listing of risks by risk area. Reports are exported in a variety of formats to accommodate input to a wide variety of risk tools: MS Word, Excel, PDF, CSV, XML, MHTML and TIFF.

When two or more analyses for a given program are performed, PRID provides a trending capability so that previous analysis results can be compared with current analytical results so that risk mitigation efforts can be evaluated, and new identified risks can be addressed.

A summary of a case study using PRID involves a DoD Enterprise Resource Program (ERP) development program. The objective was to design, develop, prototype and install an ERP program for a DoD agency. Installation of hardware and software elements occurred at multiple sites and required continuous communication between them. User training development and implementation across the agency was included in the program. Table 5 shows the initial and final program scores overall and for each risk area. The declining scores indicate that risk mitigation efforts through time are having a positive effort, since the lower the score the better. We also chose select critical technical and operational risks to highlight in Table 6. As mitigation efforts progressed, risk levels were reduced for these risks (as well as others). A reduction in risk level corresponds to a reduction in the risk score, thus providing a means of measuring risk mitigation efforts through time.

Table 5. DoD ERP Program Risk ID Analysis Results

Risk Area/ Program	**Initial PRID Analysis**			**Final PRID Analysis**		
	Score	Analysis Level	# of High Risks	Score	Analysis Level	# of High Risks
External	180/225	Moderate	3	77/225	Low	0
Organizational	156/225	Moderate	11	90/225	Low	2
Enterprise	163/247	Moderate	14	120/247	Moderate	9
Management	433/560	High	29	329/560	Moderate	19
Operational	472/545	High	25	298/545	Moderate	18
Technical	980/1100	High	42	616/1100	Moderate	29
Program Score	2384			1530		

Table 6. DoD ERP Risk Mitigation Path Via Subsequent Program Analyses

Risk	Initial Analysis	Second Analysis	Final Analysis
Interface Definition and Control	Level 5 - System level constraints are undefined and requirements have not been decomposed to Program teams. No proven process to establish system level constraints.	Level 3 - All preliminary design documents and associated preliminary specifications for the software that will be created or implemented exist and flowed down using a consistent reporting structure.	Level 1 - Process has been repeated using a consistent reporting structure, and verified at the system level using physical items.
Common Mode/ Cascading Failures	Level 5 - No consideration given to determining if there are any potential common-mode or cascade failure mechanisms.	Level 3 - Some formal consideration has been given to determining if these mechanisms exist, but only minor analysis has been accomplished	Level 2 - Formal analysis of any common-mode or cascade failure mechanisms has been accomplished.
Operational Security	Level 5 - No consideration, direction or training for system security is ongoing.	Level 3 - Formal consideration, direction and/or training for system security is ongoing but contingencies have not been tested.	Level 2 - Formal consideration, direction and/or training for system security is ongoing and contingencies have been tested.
Obsolescence Management Process	Level 5 – No obsolescence management process being used.	Level 3 – Informal obsolescence management process based on design obsolescence management analyses being used.	Level 2 – Formal program obsolescence management process being used.

Conclusions. We have presented in this paper a radical new approach to risk identification based on an analysis of over 500 programs, their risks and outcomes, called the Risk Identification Analysis. The conclusions of the study include the emergence of 218 common program risks, risk levels for each risk, the identification of pertinent program complexity parameters and their effect upon the program risk profile. These conclusions provide an antidote to the serious problems that plague risk management today: the lack of a baseline to assist programs in identifying risks, thus addressing the short-comings associated with the ad-hoc, non-comprehensive, non-objective and non-standardized approach currently taken towards risk identification today.

A software tool based on this analysis has been shown to be useful anywhere risk identification is performed today for product and service development and modification. This approach has been used on product and service development/modification programs for numerous domains including aerospace, IT, and energy. It has been used on both commercial and government programs, including proposal efforts. It has been used on programs with various development approaches including Waterfall, Agile, Rapid Application Development, and Component-Based Development. This risk identification approach can be used on one program or on a portfolio of programs to compare risks across them directly.

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Biography

David Hall has over 40 years of systems engineering, risk management and program management experience in DOD, NASA, Department of Commerce, state and local agencies, numerous industrial and commercial companies. He has successfully completed all types of programs and activities, conducting both comprehensive analytical studies and implementing solutions to problems and risks. He is an INCOSE Expert Systems Engineering Professional (ESEP) and a Certified Information Systems Security Professional (CISSP). He has accomplished numerous risk management/systems engineering articles published in both report formats and peer-reviewed journals. The latest article was in the Journal of Systems Engineering.

Laurie Wiggins has 28 years of experience in systems engineering and business. She is a member of the INCOSE Risk Management and Critical Infrastructure Protection & Recovery Working Groups. Formerly with The Boeing Company, Ms. Wiggins gained experience on numerous successful development programs. As a consultant, Ms. Wiggins worked with firms in the aerospace, IT and energy industries. The resulting broad experience base culminated in the vision for Program Risk ID. Ms. Wiggins led her company in the development of Program Risk ID.