Using a Design for Project Implementation (DFPI) Methodology to Accelerate Return on Investment (ROI) of an Enterprise Resource Planning (ERP) System

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ABSTRACT

Corporations continue to grapple with the dilemma of identifying, developing and managing the implementation of meaningful process improvement projects while simultaneously meeting business goals and customer needs. In this thesis we propose a methodology, dubbed *Design for Project Implementation* (DFPI) that integrates a change management model and engineering design and assessment tools to provide facts and data upon which to base decisions. We suggest that the methodology can be applied via a two-dimensional evaluation process that provides a means of balancing the needs of the business (via an impact to business perspective) and a means to accelerate return on investment (via an ease of project implementation perspective). We propose that the DFPI methodology can be applied in a bottoms-up approach to investigate the value proposition of a project, highlighting critical project elements and making specific recommendations to project leaders. We also suggest that a DFPI integrated business solution (design tools in conjunction with an interactive database) can be applied in a top-down approach, identifying high risk or high leverage areas to leadership sponsors whom can deploy project leaders to investigate the potential opportunities.

We tested our hypotheses related to the DFPI methodology and design tools at Raytheon Company. The methodology was deployed on process improvement projects targeted on leveraging the increased capability gained from a recent transition to an SAP enterprise resource planning (ERP) system integrated solution. In this thesis we define the DFPI methodology, describe how the associated design tools can be customized to target any type of business processes within a corporation (by applying it to ERP-related business processes at Raytheon), review the results of our pilot application at Raytheon and conclude with a short discussion of future areas of study.

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1.0 Introduction

Chapter 1.0 establishes the motivation for this thesis, outlines the approach used to explore the primary and secondary hypotheses, and summarizes how the thesis is organized.

1.1 Motivation for Thesis

In January 2009, Raytheon Space and Airborne Systems (SAS) and Network Centric Systems (NCS) business unit sites in California and Texas went live with the deployment of a SAP enterprise resource planning (ERP) system. The deployment, christened *"**P**rocess **R**einvention **I**ntegrating **S**ystem for **M**anufacturing"* or PRISM, is one portion of a multi-phase plan to institute a corporate-wide ERP solution[1], representing one milestone on a multiple year strategic journey within Raytheon to integrate *"one company strategy to achieve growth as a business".*(Jones, 2006)

Post-deployment, organizations within the SAS and NCS business units face two major challenges. First, they must continue to fully support business objectives, minimizing any negative impacts stemming from productivity slumps as users adapt to the new system and processes. Second, the organizations must leverage the increased capability offered by the SAP integrated solution to accelerate the return on investment (ROI) for the multi-million dollar endeavor. The convergence of these challenges generates the motivation for this thesis.

Observations during the early weeks of research on site at Raytheon SAS highlighted that core users, tasked with sustaining and leveraging benefits from the ERP deployment, struggle with multiple common challenges. Namely:

- overlapping and redundant initiatives targeting process improvements to reduce waste in the system, increase financial savings/return on investments or increase productivity;
- competing demands for limited support resources;
- fragmenting work efforts stemming from frequent resource re-deployment to different "hot" assignments;
- diminishing gains as end users revert to former behaviors; and
- increasing frustrations from performance metrics that are perceived to provide inaccurate status indicators.

Ultimately, end users and leadership grapple with the same difficult dilemma – how does a corporation identify, develop and manage the implementation of meaningful projects or initiatives while recognizing and meeting competing goals and customer needs? We hypothesize that a methodology and tools can be developed that will facilitate optimized project implementation. The methodology, and any associated tools, can enable project leaders and leadership sponsors to more effectively identify, plan

[1] PRISM is one portion of a full ERP solution at Raytheon representing operations. Other portions include financials (APEX), PDM and engineering (PTC Windchill), human resources (Peoplesoft), etc. [Gaston, G. (2010, January 21). Email Coorespondance.]

and manage projects for long-term sustained benefits and accelerated ROI. We propose that the ideal "design for project implementation", or DFPI, methodology and assessment tools integrate a change management model and engineering design and assessment tools to provide facts and data information upon which to base decisions. This thesis seeks, at a high level, to explore this hypothesis by

- documenting the development of the DFPI methodology and assessment tools and
- testing the hypothesis in a pilot application at Raytheon SAS and NCS.

The results of pilot applications at Raytheon SAS and NCS establish no evidence to reject our hypotheses related to DFPI methodology and design tools, as discussed in further detail in Chapter 7.1. Based on user feedback we believe that the DFPI methodology, as applied via two unique design tools, effectively stimulates project discussion and guides users in documenting salient project information. Subsequently, the design tools successfully quantify documented information and generate scores that evaluate projects on two complementary perspectives. The first perspective focuses on the potential project's impact to the business, and the second perspective focuses on the ease of implementing the potential project. Combined, the scores efficiently and consistently measure the value proposition offered by the project and provide a means of reliably comparing and prioritizing multiple projects.

1.2 Thesis Approach and Organization

In this chapter we will discuss the approach utilized in investigating the hypothesized design for project implementation methodology. It will also outline how the remainder of the thesis will be organized.

1.2.1 Thesis Approach

As stated in Chapter 1.1, the primary dilemma considered in this thesis is how a corporation identifies, develops and manages the implementation of meaningful projects or initiatives while recognizing and meeting competing goals and customer needs. In this section we describe the analytical approach used to identify and test the methodology for solving the described dilemma.

Firstly, we identify an environment within the host company, Raytheon Space and Airborne Systems, which represents a situation similar to that found in many corporations that are challenged by the project implementation dilemma. At Raytheon SAS the implementation of the SAP ERP system is an opportunity-rich environment. Post-deployment, SAS is leveraging numerous projects to implement strategic and tactical process changes to accelerate the return of investment from the new ERP related capabilities. SAS is simultaneously working to maintain full support of sustaining business objectives and laboring to recover from the expected productivity slump resulting from significant changes associated with the ERP deployment. Hence, the SAP ERP environment and its associated business processes were selected for as the scope for testing the proposed hypothesis.

Secondly, we investigate the ERP deployment environment. In order to develop a methodology that will enable implementation of meaningful projects, we must be able to identify the challenges the projects must overcome to achieve return on investment. For our research, as stated above, we have chosen to apply the methodology to projects targeting ERP-related business processes. Therefore, we must understand the unique challenges of an ERP environment. To do this we completed a literature review to identify critical success factors for ERP deployment; this enables us to document a baseline environment any company may experience transitioning to an ERP integrated solution. With this literature review baseline we are able to focus on finding ways to customize the application of the DFPI methodology to highlight critical areas, which a project leader can leverage to strengthen the project's value proposition.

Thirdly, we develop an assessment methodology that integrates change management models and engineering design tools to evaluate quantitatively a project on the two complementary perspectives identified in Chapter 1.1—impact to the business and ease of implementation. To do this we complete a second literature review to identify related critical behavioral, process or business elements to include in the evaluation. Areas of focus include change management literature, engineering design and assembly literature (*Design for…)* and project management literature. Then we develop algorithms to quantify individual evaluation scores for each element. Finally, we utilize interpolation and weighted average calculations to derive overall scores for each evaluation perspective and demonstrate how the overall scores can be used by different prioritization strategies to generate alternative priority lists of all evaluated projects.

Fourthly, we create tools that project leaders or sponsors can use to apply the proposed project assessment methodology.

Fifthly, we document how the methodology will be tested via pilot applications of the assessment tools in different situations at the host company.

Finally, the feedback collected after each application is analyzed to determine the validity of the hypothesis. It is also fed back into the original methodology as improvements to the model.

1.2.2 Thesis Organization

In this subchapter a brief overview will be provided identifying what will be presented in each of the chapters of this thesis (Reference Table 1).

Table 1: Overview of Thesis Organization

Chapter	Chapter Title	Chapter Description
	Abstract	Presents an executive summary of this thesis including an overview of the dilemma, the hypothesis, the approach for proving the hypothesis, and the thesis findings.
	Acknowledgements	Imparts personal and professional acknowledgements of the individuals and teams that enabled the author to successfully complete this thesis and the MIT LGO Program.
1	Introduction	Presents the motivation for the thesis by introducing in detail the dilemma that will be investigated and explored. Also provides a summary of the thesis approach and organization.

2	Company Background	Introduces the US-based corporation that hosted the research upon which the thesis hypothesis was tested. Describes the company history as well as an overview of the company's journey to implement an SAP Enterprise Recourse Planning (ERP) System.
3	Setting the Stage – The Challenges & Opportunities of an ERP Deployment	Provides a detailed discussion of what is involved, or at stake, when a corporation chooses to deploy an ERP system. Includes an overview of why corporations make the investment, the critical success factors of an ERP system, whether the Raytheon deployment is considered "successful", and why a DFPI methodology is vital to accelerating the ROI of an ERP investment.
4	Project Overview	Introduces the details of the thesis research, including the goals and objectives (as generally applied to any industry and specifically applied to the host company), the detailed approach to investigating the hypotheses and a summary of the project deliverables (again at a general level and specific to the host company).
5	Design for Project Implementation (DFPI) Methodology	Communicates a detailed discussion of the hypothesized "Design for Project Implementation" solution. This chapter will delve into the critical elements of the methodology, expand upon their application and quantitative evaluation and introduce the specific tools that the different target stakeholders can use to apply the methodology.
6	Utilizing Design for Project Implementation (DFPI)	Explores the application of the DFPI methodology at any type of company or organization. This chapter introduces the potential global applications, drawing on the host company application to provide supporting evidence. It provides an overview of the how the DFPI methodology can be utilized from three different perspectives—the organization perspective, the project leader's perspective and the project sponsor's perspective.
7	Conclusions and Next Steps	Summarizes the findings: the supporting evidence for the acceptance of the thesis hypothesis and the benefits or derived value from the project. This chapter also documents future recommendations specific to the host company and areas of future study including a discussion about how the proposed solution can be transported to other applications in any industry.
8	Bibliography	Exhibits the source information referenced throughout the thesis.
9	Appendix	Presents supporting detailed figures and tables referenced throughout the thesis.

2.0 Company Background

This chapter introduces the research sponsor company, Raytheon Company. It will also summarize the history of ERP deployment activities completed at Raytheon. The background establishes the environment for the pilot application of the proposed Design for Project Implementation Methodology.

2.1 Raytheon Corporate History

Raytheon Company has a long and distinguished history as a Defense and Aerospace Systems supplier. It was founded in 1922 in Cambridge, MA by Laurence K. Marshall, Vannevar Bush and Charles G. Smith.(Raytheon: History) Over its 87 year history Raytheon has established itself as an industry leader, successfully integrating the products, capabilities and talents of multiple legacy corporations. Some of the most notable legacy corporations include Beechcraft; E-Systems; Texas Instruments' Defense Systems and Electronics business; and Hughes Aircraft's Defense Electronics businesses. (Raytheon: Milestones)

Raytheon is comprised of six integrated business units, each focused on meeting and exceeding the needs of customers in multiple segments of the Defense and Aerospace Industry. Figure 1 shows headquarter locations of each of the Raytheon business units as well as the corporate headquarters. The following is a short description of each business unit and its specific mission. (Raytheon: Businesses)

- Integrated Defense Systems (IDS) – IDS is tasked with providing *"affordable, integrated solutions to customers in the U.S. and abroad."* Its 13,500-plus employees are based in Tewksbury, Massachusetts. In 2008 IDS accounted for $5.2 billion in revenue, or 21% of all revenue. (Raytheon: IDS)
- Intelligence and Information Systems (IIS) – IIS is tasked with providing the solutions that supply the *"right knowledge at the right time"* to enable global customers to make the decisions necessary to meet their goals. Its 9,200-plus employees are based in Garland, Texas. In 2008 IIS accounted for $3.1 billion in revenue, or 12% of all revenue. (Raytheon: IIS)
- Missile Systems (MS or RMS[2]) – RMS is tasked with designing, developing and producing *"missile systems for U.S. and allied forces"*. Its 12,500-plus employees are based in Tucson, Arizona. In 2008 RMS accounted for $5.4 billion in revenue, or 22% of all revenue. (Raytheon: RMS)
- Network Centric Systems (NCS) – NCS is tasked with developing and producing solutions *"for networking, command and control, battlespace awareness, and air traffic management"*. Its 12,400-plus employees are based in McKinney, Texas. In 2008 NCS accounted for $4.5 billion in revenue, or 18% of all revenue. (Raytheon: NCS)

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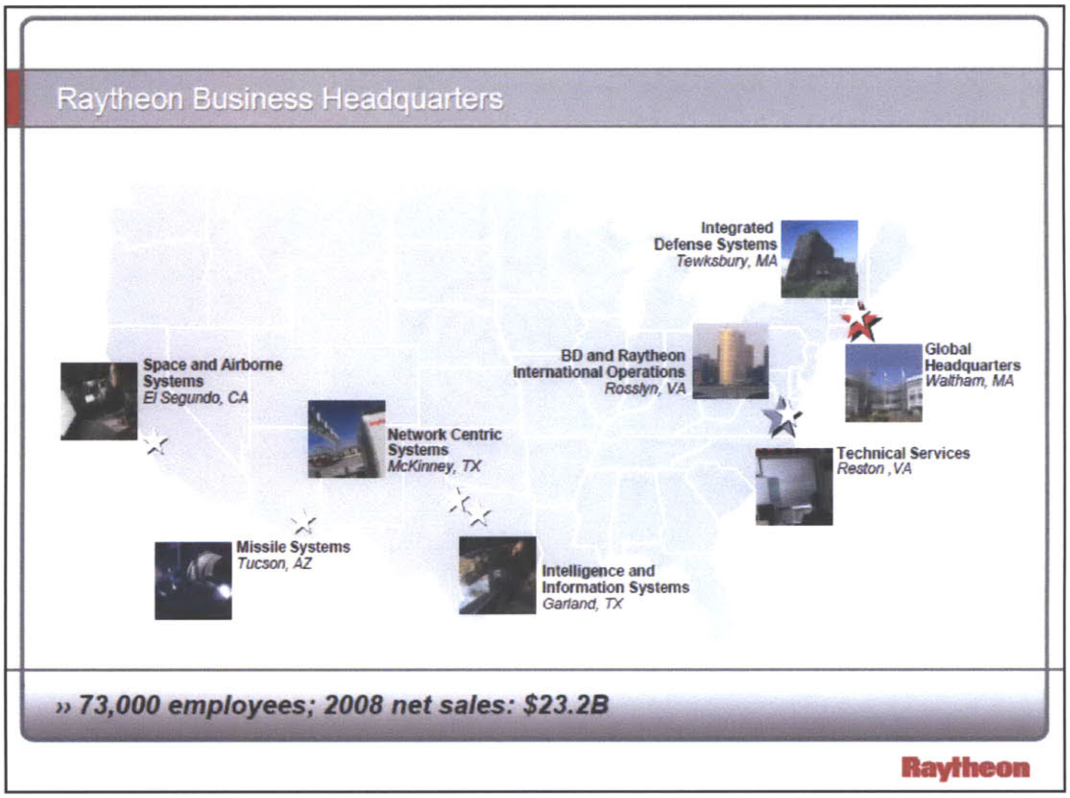
[2] In this thesis we will use "RMS" as the abbreviation for Missile Systems in order to clearly differentiate between references to the Raytheon Business Unit and the state of Mississippi (MS).

- Space and Airborne Systems (SAS) – SAS is tasked with *"designing and developing advanced, integrated systems for crucial missions."* Its 12,000-plus employees are based in El Segundo, California. In 2008 SAS accounted for $4.4 billion in revenue or 17% of all revenue. (Raytheon: SAS)
- Technical Services (TS) – TS is tasked with providing *"technical, scientific and professional services for defense, federal and commercial customers worldwide."* Its 9,000-plus employees are based in Reston, Virginia. In 2008 TS accounted for $2.6 billion in revenue, or 10% of all revenue. (Raytheon: TS)



Raytheon's guiding principle for the future is a corporation that has *"come together to form one company with one vision."* (Raytheon: Milestones) This principle is one of the drivers that led to the 2009 deployment of a SAP ERP system across two of the business units, SAS and NCS.

2.2 Raytheon ERP Implementation History Overview

Raytheon's journey to implement an SAP ERP system has been over a decade in the making (Gaston, Interview, 2010). The decision to move forward with an SAP solution aligned with a corporate strategy to integrate business tools across the corporation, providing common tools across Raytheon and demonstrating their commitment to a "one company, one vision" principle. (Gaston, Interview, 2010), (Jones, 2006) By integrating tools, specifically within the supply chain, Raytheon creates a competitive advantage—increasing its capability to respond faster to changing customer needs and demands. It enables material to flow between supplier sites (internal and external) faster, while increasing the visibility of inventory throughout the value stream.

The first phase of the deployment, dubbed APEX, implemented the financial instance of SAP. Activity related to the second major phase of the deployment, PRISM, significantly moved forward in 2004 with a detailed investigation of the potential costs and benefits of continuing with the incorporation of the SAP supply chain module. Several decisions made during these planning years were critical to the highly successful "go-live" implementation in January 2009 (see Chapter 3 for more details). Some of which include (Gaston, Interview, 2010):

- the selection of an ERP deployment consulting team that created a "best fit" with the Raytheon corporate culture and objectives;
- the decision to maintain the same core deployment team (including consultants and Raytheon employees) for the full duration of the planning and execution;
- the decision to deploy in two parts, starting with a single deployment in 2006 at a single site (under 300 users) and completing with a final deployment in 2009 at the remaining sites (over 3500 users); and
- the detailed implementation plan the gave as much emphasis to change management as to technical system transitions.

3.0 Setting the Stage - The Challenges and Opportunities of an ERP Deployment

In this chapter we discuss why a post-deployment ERP environment is an optimal environment to apply a DFPI methodology to gain accelerated return on investment. Firstly, in Chapter 3.1, we will present why a corporation would decide to invest significantly in an ERP system. Secondly, in Chapter 3.2, we will introduce some Critical Success Factors (CSF) put forward by various literatures as characteristic of successful ERP implementations. Thirdly, in Chapter 3.3, we will provide a detailed overview of Raytheon's ERP deployment journey including a discussion on why the deployment is considered "successful". Finally, in Chapter 3.4, we will establish why a DFPI methodology is ideal for use in a post-ERP deployment environment, such as the environment at Raytheon SAS and NCS.

3.1 Why Corporations Deploy an ERP System

Given that choosing to implement an ERP system exposes a corporation to the real probability of a failed multi-year and multi-million dollar investment, why would any corporation go-forward with deployment? We conclude that the potential benefits far outweigh the potential loss and that the risk of failure is almost entirely in the control of the corporation selecting to move forward. If a corporation adequately plans and prepares for ERP deployment (taking into account extensively documented CSFs) there is every reason to believe that a successful ERP implementation can be realized—as demonstrated by the Raytheon ERP deployment (see Chapter 3.3).

Thousands of companies of all sizes have pursued the implementation of an enterprise resource planning (ERP) systems, as represented by the more than 40,000 ERP customer implementations completed by leading ERP software provider SAP (SAP AG, 2008). Extensive literature documents that the main objective of the ERP system implementation is to establish enterprise-wide integration ultimately enabling increased operational efficiency and competitive advantage in the marketplace (Nah & Delgado, 2006);(Yuan-Du, Ching-Chow, Wen-Tsann, & Wei-Cheng, 2007); (Tsai, Fan, Leu, Chou, & Yang, 2007). This pursuit, though, can be elusive with numerous literature references to implementation failures resulting only in significant loss to the corporation in terms of time, morale and money (Parr & Shanks, 2000); (Chang, Cheung, Cheng, & Yeung, 2008).

A study completed by Jeff Stratman concluded that the strategic goal of the "ERP adopter" has a relationship with the magnitude of the realized benefits. If the adopter has an internal focus—meaning the goal of leveraging the integration capabilities of the ERP system is to modify the internal business processes, then they are more apt to realize competitive advantage in the marketplace (Stratman, 2007). This is reinforced by Mayere, Grabot and Bazet's (2008), whom stated that *"ERP systems are large and complex systems, which deeply modify the activities and organization of the companies in which they are implemented"* (Grabot, Mayere, & Bazet, 2008).

In conclusion, corporations who choose to implement an ERP system, believing that the software in-and-of itself is a silver bullet that will solve its integration problems, are setting themselves up for a potentially crippling financial failure. Corporations that choose to implement an ERP system as a mechanism to improve business processes and modify employee and corporate behaviors are positioning themselves to reap financial benefits. In the next section we will discuss in detail ten CSFs identified in literature as being highly influential to the success or failure of ERP system implementation.

3.2 ERP Deployment Critical Success Factors (CSFs)

There are numerous studies dating back to the early 1990s that present and discuss different CSFs that are seen in successful deployment of an ERP system. There are also numerous studies attempting to consolidate the proposed CSFs into a single comprehensive list. For this thesis application the consolidated list of ten CSFs proposed by Loh and Koh (2004) is used, as displayed in Figure 2. This consolidated list is similar to others proposed in additional literatures and was selected namely due to the through documentation done by Loh and Koh (2004), articulating their deduction process and linking the CSFs to Markus and Tanis' (2000) four-phase of ERP implementation life cycle (Markus & Tanis, 2000). The four-phase are described as follows(Loh & Koh, 2004):

Phase 1: Chartering – Building the business case, defining expectations.
Phase 2: Project – Prior to "go live", preparation activities for system transition, end-user training, business process mapping and modification.
Phase 3: Shakedown – Post "go-live", stabilization of process, recovery from any productivity disruption, troubleshooting of any system or process errors.
Phase 4: Onward & Upward – Regular maintenance, on-going new user support.

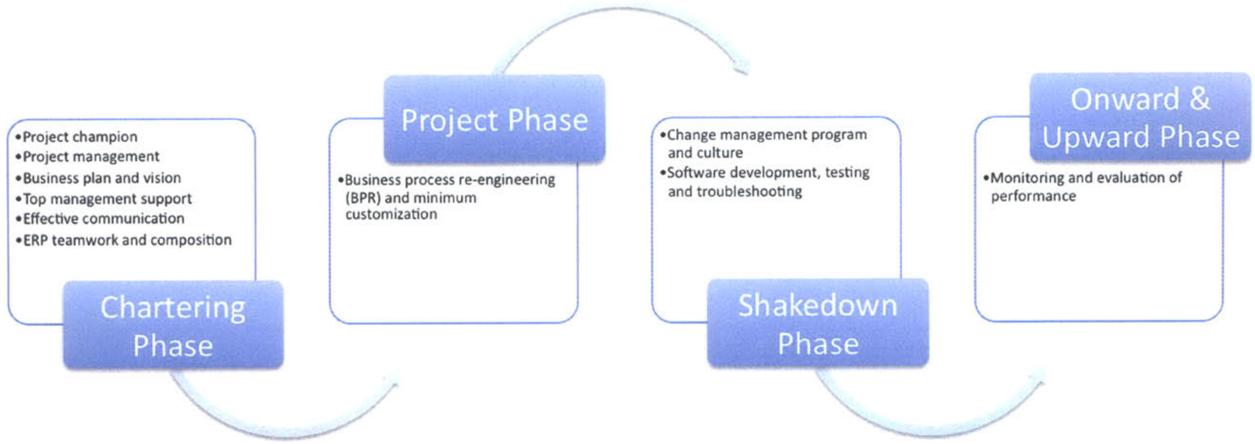


Figure 2: Conceptual assignment of CSFs of ERP implementation to ERP implementation phases (Loh & Koh, 2004, Figure 4)

The following is a brief definition of each of the ten CSFs. The definitions are derived from the descriptions provided by Loh and Koh (2004). The definitions also include the implementation phase Loh and Koh identified as being the primary phase, or the phase where Loh and Koh suggest the actions supporting that CSF should be most active (as represented in Figure 2). (Loh & Koh, 2004)

Project champion: This CSF's primary phase is the chartering phase. The champion is the leader (or small number of leaders) within the corporation that sponsors and is accountable for the implementation. This leader provides 'business perspective' and actively helps to resolve the conflicts or resistance within the stakeholder and user communities as they move from the legacy system to the ERP system.

Project management: This CSF's primary phase is the chartering phase. Project management of the implementation includes responsibility for scope definition, change management, schedule and status tracking.

Business plan and vision: This CSF's primary phase is the chartering phase. This CSF includes clear documentation of an overall *"plan and vision to steer the direction of the project"* throughout the implementation (Loh & Koh, 2004). It should include both strategic and tactical activities.

Top management support: This CSF's primary phase is the chartering phase. Top management refers to the executive level leaders of the corporation or business unit. Support should be demonstrative, including monetary linkages between success and management bonuses. One of the main objectives of this CSF is to enable alignment between the implementation team's actions and corporate leadership's expectations.

Effective communication: This CSF's primary phase is the chartering phase. This refers to communication at and across all levels from the end-user to top management. It should include general communication of information, education and expectations.

ERP teamwork and composition: This CSF's primary phase is the chartering phase. This factor includes identifying those individuals, representing different organizations and skills, that should make up the core implementation team, as well as mechanism for team expansion/contraction as appropriate during follow-on phases of the implementation. Team members should include both internal and external (e.g., consultants) individuals. These team members, especially core team members, should be assigned full-time to the implementation project to be most effective.

Business process re-engineering (BPR) and minimum customization: This CSF's primary phase is the project phase. It includes activities associated with aligning (or modifying) the business processes. It should also incorporate the process/rationale for identifying and approving any required customization to the selected ERP software/hardware solution (which should be minimized to be most effective).

Change management program and culture: This CSF's primary phase is the shakedown phase. It refers to the activities to enable permanent behavior changes. It refers to modification of the corporate culture that will enable the ERP system and the altered business process to become the way business is done—getting back to normal operations.

Software development, testing and troubleshooting: This CSF's primary phase is the shakedown phase. It includes the overall configuration of the ERP system architecture. It should also include considerations of transitioning data into the ERP system (which may include data cleaning requirements). This factor also considers any testing/simulation requirements to assure go-live won't prevent normal business activities.

Monitoring and evaluation of performance: This CSF's primary phase is the onward & upward phase. This factor is about establishing formal mechanisms to measure and monitor achievement. It should also incorporate a mechanism for feedback.

In our opinion, there is one weakness with the linkages Loh and Koh (2004) identify between ERP implementation phases and the Critical Success Factors. That is the identification of a "primary" phase. This identification can be interpreted as the <u>only</u> phase in which the Critical Success Factor is of importance; as was pointed out by one of the Raytheon managers (Gaston, Email, 2010). Because it is outside the scope of our thesis, we have chosen to accept the prescribed arrangement. Yet, we do offer one caution. Depending on the unique circumstances experienced during an actual implementation it is highly probable that one or more of the identified CSFs can and will be significant to the success of a phase not identified as its primary phase. Therefore, the framework provided should be used as a guide and not as a ground rule.

3.3 Raytheon's ERP Deployment Journey

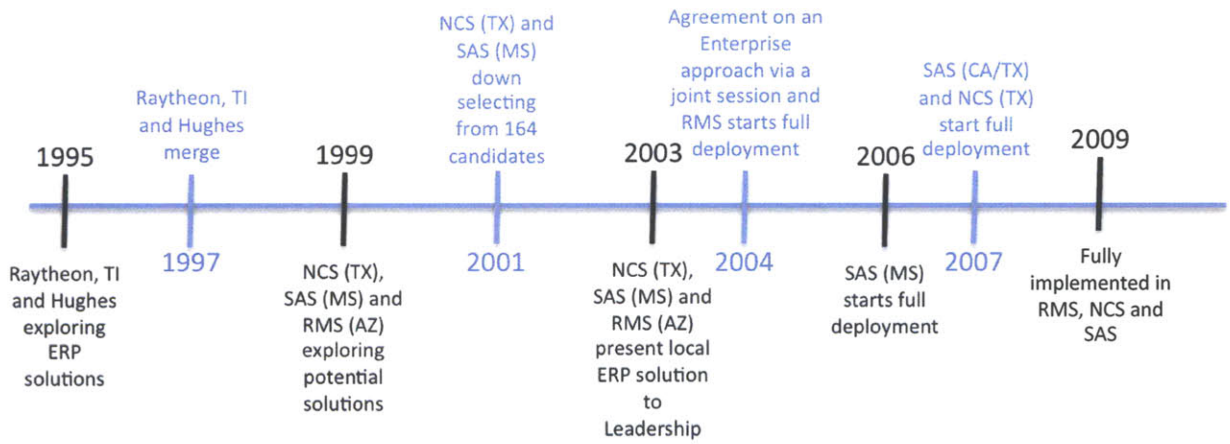


Figure 3: Raytheon ERP Deployment Timeline (Gaston, Interview, 2010)

For Raytheon Space and Airborne Systems (SAS) and Network Centric Systems (NCS) business units the long journey to implement an ERP system began over a decade ago, in 1995 (see Figure 3). At the time they were three separate companies—Raytheon Company, Texas Instruments (in Texas) and Hughes Aircraft (in California). Each company began to explore the possibility of implementing an ERP system. All three ultimately decided that a full implementation would be too risky and expensive—especially given that the defense & aerospace industry was somewhat "new frontier" for an ERP application and the aerospace and defense ERP solution offered by SAP was also relatively immature at the time (Gaston, Email, 2010). Yet, at least two of the three did move forward with partial or local site implementations.

Hughes attempted to implement an ERP solution from Manugistics. After an exhaustive study the identified cost and risk of the recommended approach resulted in a leadership decision not to pursue at that time. Texas Instruments implemented a partial ERP solution with a linkage to a manufacturing execution system software package that was a precursor to the VM solution offered by Visiprise. Their attempt was successful. By 1997 Raytheon had acquired both Texas Instruments and Hughes. Following the merger William Swanson eventually became CEO and president of the Raytheon. His leadership and background in operations and industrial engineering probably played a part in the eventual adoption of an ERP system throughout Raytheon Company. (Gaston, Interview, 2010)

In 1999 interest in the ERP implementation question was again raised at a local level. In 2001, two managers, one at NCS in Texas and one at SAS in Mississippi, discovered that they were both exploring the potential business case validity in parallel activities. The two decided to combine their efforts. They soon discovered that similar activities were being explored within the Missile Systems (RMS) business unit in Arizona. RMS had been utilizing an external consultant group, the Gartner Group, to explore the potential opportunities. Making the top of the Gartner Group's list was SAP, an industry leading business software company headquartered out of Walldorf, Germany (SAP, 2010). Despite the multiple exploratory actions that each of the three business units took, there was no corporate wide decision made at that time. (Gaston, Interview, 2010)

In November 2001, back in Texas and Mississippi, the two managers began formal activities to build a business case for implementing an ERP solution in their local environment (meaning an ERP solution customized to NCS in Texas and SAS in Mississippi). They identified 164 potential vendor candidates that offered an ERP solution. Over the next few years they continued activities to down select the candidate pool by:

- completing multiple site visits to vendors and other corporations to complete benchmarking analysis;
- hosting vendors on site at which time the vendors completed live system demonstrations using representative Raytheon data;
- hosting multiple meetings with consultant groups with expertise in ERP implementations; and
- sending two team members to participate in a three-month SAP proof-of-concept pilot at RMS in Arizona.

Finally, in 2003 the two managers had selected a small company, Cubicorp, that they reasoned was the best recommendation for their situation. They selected Cubicorp because the company had best demonstrated to them the characteristics they were looking for in an ERP solution provider, namely applicability to the defense industry; scalability within the specific site (e.g., user scalability); flexibility and adaptability to custom solution requirements; and affordability. The managers brought their recommendation forward to executive leadership. RMS also brought forward a recommended solution. To the NCS, SAS and RMS managers' chagrin, all of their local ERP solution recommendations were not well received. (Gaston, Interview, 2010)

Raytheon executive leadership was not open to hearing about the best "local" solutions. Instead they wanted a "big picture" solution. Their objectives for an ERP solution were more strategic in focus. First, the executive leadership team was looking for a solution that they could use as a mechanism to accelerate the unification of Raytheon Company. By 2003, Raytheon had grown considerably from multiple mergers and acquisitions. Leadership was focused on finding mechanisms to move to "one language" or "one company". An integrated ERP system was seen as a very strong potential catalyst to force the hard change management work to modify the multiple corporate legacy cultures and behaviors into "one" Raytheon corporate culture. Second, the executive leadership wanted a single solution. They wanted a solution that would work exceptionally well for each of the six Raytheon business units—not one that worked great for RMS, but only adequately for SAS or NCS. As a result of these two strategic objectives the ERP teams were sent back to the drawing board to find a "global" solution. (Gaston, Interview, 2010)

In January 2004, the three ERP teams from RMS, NCS and SAS came together in a long joint session to define and document the Raytheon "global" solution. The effort was successful. At the close of the joint session they had arrived at an agreement of an enterprise approach. Following the joint session RMS, who was most prepared for implementation (based on preparatory activities during the SAP proof-of-concept pilot in 2003), was given approval to move forward with implementing the "global" ERP solution. The business units continued to follow a systematic phased implementation approach. Leadership acknowledged that the phased implementation was more expensive in the short term, but all felt that it provided the best means of minimizing the risk of significant disruptions to the business and maximizing the probability of long-term adoption of the process and behavioral changes. Full implementation was completed in RMS by mid-2006. At that time implementation activities shifted to SAS in Mississippi. Full implementation was completed in Mississippi in March 2007, then shifting all efforts to California (SAS) and Texas (SAS and NCS). Full implementation completed in California and Texas in January 2009. At this time, implementation efforts have shifted to the IDS business unit with an ultimate goal of ERP system implementation across five of the six Raytheon business units concluding by the end of 2012[3]. (Gaston, Interview, 2010)

For Raytheon SAS and NCS, ERP system deployment is complete and has been categorized as a huge success by all parties involved. Post go-live there was no significant disruption to the business.

- There were no missed or delayed deliveries as a result of implementation.
- There were no halted production activities due to delayed inventory deliveries as a result of implementation.
- There were no missed or delayed supply chain payments as a result of implementation.
- There were no disruptions to payroll as a result of implementation.

In addition to minimizing business disruptions the Raytheon SAS and NCS ERP deployment success can also be seen in a review of the ten CSFs identified in Chapter 3.2. Table 2 presents each CSF, provides a short description of how the Raytheon deployment demonstrated or leveraged the factor, and presents a metric on a scale of 1 (being no influence) to 5 (being highly influential) to the overall success of the deployment (as assessed by a Raytheon manager who was a part of the ERP journey since 1999). (Gaston, Interview, 2010)

Table 2: Review of CSF in the Raytheon SAS and NCS ERP Implementation

Metric	Critical Success Factor (CSF) to ERP Implementation	Description of Contribution to Success during Raytheon SAS and NCS ERP Deployment
5	Project champion	The SAS and NCS Operations Vice Presidents completed this role. Both were key drivers and champions of the deployment. Both were responsible and accountable for the implementation.

[3] Implementation within the IIS business unit is under consideration due to the minimal manufacturing activity conducted within that Raytheon business unit. In addition, note that the 2012 end data is a rough estimate and may shift based on changing business conditions. Gaston, G. (2010, January 21). Email Coorespondance.

5	Project management	A formal internal ten-gate review and approval process was used to manage this implementation. Each gate had established requirements that must be met prior to moving forward as well as established status-tracking mechanisms.
5	Business plan and vision	A small number of core team members established the guiding vision at the start of the journey in 1999. This vision ultimately did not change, but the plan rightly evolved as additional information was learned. The plans (once set and approved via the gate process) were followed and any significant changes (e.g., schedule delays) were formally reviewed and approved. This helped to keep all parties across the multiple business units coordinated and on track.
5	Top management support	This factor, in many ways, was worked in parallel with the project champions whom helped ensure that leadership, on both an operation side and customer program side, were kept aligned. Efforts were continually made to ensure leadership was fully committed and supportive of activities. For example, prior to final "go-live" each program manager (meaning a major customer program) was met with in a face-to-face meeting to ensure they understood the transition process, potential disruption risks and deployment expectations. The meeting(s) were not considered complete until each program manager demonstrated understanding, acceptance and commitment to the upcoming deployment.
5	Effective communication	This was seen as a vital component of the implementation. Multiple actions were taken for different purposes. Some examples are as follows: ▪ Web site established where training material, general information, etc was made available to all Raytheon employees ▪ All-employee meetings held to cascade information face-to-face ▪ Team members were assigned roles in RMS ERP deployment to ensure a single corporate solution would be incorporated and to help cascade lessons learned from the RMS implementation phase to the SAS and NCS implementation phases.

5	ERP teamwork and composition	Core team members were permanently assigned for the life of the deployment (multiple year assignment). A single consultant (Deloitte) was used throughout the RMS, NCS and SAS deployment with most of the consultants staying in place for the entire multi-year deployment. Leadership pulled "the best and brightest" from other projects to staff the core team and other sub-teams as the implementation progressed.
4.5	BRP and minimum customization	There were only three customizations made to the selected standard SAP ERP solution (one of major significance and two of minor significance). The major customization was an integrated linkage to a non-SAP Manufacturing Execution System (MES) software package (VM from Visiprise). The minor customizations were to integrate Raytheon internal inventory warehouse carousel systems and bid/proposal requirements. The MES integration proved to be an ideal solution, with SAP later acquiring Visiprise in 2008 and integrating VM into their ERP solution now called SAP Manufacturing Execution (SAP, 2010).
5	Change management program and culture	Leadership made a conscious decision that this deployment was led by operations and not IT. This was because of the strategic focus for it to be a change to the business culture and processes not a computer system change. This was further demonstrated by ensuring that actions were taken early on to begin a general "awareness" of a change so resistance could be identified and resolved prior to go-live.
4	Software development, testing and troubleshooting	This factor was integrated and addressed early on, for example, in 2001 during the down selection of the ERP candidates. Raytheon provided sample data to vendors to test in live demonstrations. They also imbedded "surprises" in the data to test how the ERP solutions would react in potential realistic situations. This was also demonstrated in the RMS proof-of-concept pilot in 2003 when processes were tested to identify gaps between the "legacy" processes and the "new" processes aligned with the ERP solution. In addition, all customizations made to the SAP ERP solution were extensively tested prior to go live (full-unit tests, integration test cycles, practice dry run data conversions).

5	Monitoring and evaluation of performance	Formal checks and balances were integrated into the deployment. Some were already established via the internal Raytheon gate process, others were added specifically for this deployment. For example, six-weeks prior to the 2009 go-live weekly meetings were held with all organization represented to review current status and issues (similar to a command center for a space shuttle launch). Each organization provided go/no-go status. The group setting enabled problems to be immediately addressed and accelerated mitigation activities for any potential cross-organization impacts.

The final hurdle that remains for Raytheon SAS and NCS is to realize the anticipated financial ROI that was estimated within the business case. The payoff was anticipated to take multiple years to achieve, but operations leadership is continuing to take actions to accelerate the ROI. (Gaston, Interview, 2010) Acceleration will only occur by identifying new opportunities to leverage the integration capacity enabled by the ERP system solution to make improvements within additional business processes. It is here where the DPFI methodology can be applied in the post-ERP deployment environment.

3.4 Linking "Design for Project Implementation" Methodology to Accelerated Post-Deployment Return on Investment

The very fact that ERP systems enable modifications to business process and behaviors creates opportunity for additional value creation as a by-product of improvement activities (generally realized via improvement project implementation). Mayere, Grabot and Bazet (2008) articulate this opportunity, stating *"Their [ERP systems] collision with organization and individuals can be an opportunity for improving existing processes and behaviors. They can also be a way to identify discrepancies between real practices and standard processes which can be a source of motivated customization"* (Grabot, Mayere, & Bazet, 2008). This opportunity also introduces the project management dilemma articulated earlier—how does a corporation identify these project opportunities. In addition, how does the corporation make decisions on which project opportunities to support to get the optimal ROI from both the individual project implementation funding requirements and as an ROI from leveraging the ERP investment. We believe that the DFPI methodology is the link.

On a local basis DFPI can be utilized to identify and score improvement project opportunities (DFPI workshop evaluation tool and project leaders assessment tool). On a global basis the DFPI integrated business solution (e.g., reports, databases) can be used to sequence project go/no-go decisions to optimize benefit realization. Each of these tools will be addressed in greater detail in the chapters to follow.

4.0 Project Overview

In this chapter we introduce the details of the thesis research. First, the goals and objectives of the research, as generally applied to any industry and specifically applied to Raytheon, are established. Second, the detailed approach to investigating the hypothesis is presented. Finally, the project deliverables at a general level and specific to Raytheon are summarized.

4.1 Goals and Objectives

There are two primary goals for this thesis. For each goal multiple objectives are defined that will enable them to be successfully met. The goals and associated objectives are outlined in Table 3.

Table 3: Thesis Goals and Objectives

Goal	Associated Objectives
To develop an ideal "Design for Project Implementation" (DFPI) methodology that will enable users to better identify, plan and implement meaningful projects or initiatives while balancing and meeting competing business goals and customer needs.	To enable users to identify change management areas to focus on during planning and implementation to sustain long-term behavior changes.
	To enable users to identify and address productivity or functionality risk areas proactively.
	To enable users to accelerate return on investment of significant business process changes (such as an ERP system deployment).
	To enable users to better utilize resource capacity to support all approved projects or initiatives.
To develop a set of tools that users can utilize to apply the DFPI methodology to any project.	To enable users to utilize similar tools (e.g. questionnaires, reports) in multiple scenarios (e.g. workshops, project team meetings).
	To establish a common prioritization method that will enable all projects to be compared on an 'apples-to-apples' basis.
	To establish a common source of project information.
	To create a set of reports customized to the two primary users – Project Leaders and Project Sponsors.

4.2 Approach

In this section the approach used to investigate the hypothesis is presented in greater detail. The hypothesis is clarified, the DFPI tools are explained, pilot test applications are described and the process for incorporating testing feedback is specified.

4.2.1 Thesis Hypothesis

There is one primary hypothesis evaluated throughout this thesis:

A methodology and tools can be developed that will facilitate identifying, planning and managing the implementation of meaningful projects or initiatives, thereby balancing business goals and customer needs and accelerating return on investment through the application of two different design tools.

There are two secondary hypotheses explored in this thesis:

- The methodology and tools can be applied in a bottoms-up[4] approach by project leaders to investigate a potential project idea, highlighting critical project elements and providing specific recommendations to integrate into the project implementation plan; and
- The methodology and tools can be applied in a top-down[5] approach by project sponsors to identify potential high risk or high leverage areas for project leaders to investigate and to identify and address potential resource capacity constraints for in-process and upcoming projects.

Combined, the primary hypothesis and two secondary hypotheses provide a more specific description of the high-level hypothesis described in section explaining our thesis motivation (refer to Chapter 1.1).

4.2.2 The Design for Project Implementation (DFPI) Tools

There are four primary DFPI tools: evaluation worksheets, project database, project leader reports and project sponsor reports. The tools are discussed in greater detail in Chapter 5.

The DFPI methodology and associated tools can be implemented within a corporation along a progressive utilization scale based on the needs and expectations of leadership. Full utilization and socialization of all the tools within the targeted organization is necessary to realize the full potential of the DFPI methodology.

4.2.2.1 Evaluation Worksheets

The purpose of these worksheets is to document a project idea and collect the data necessary for the application of the evaluation algorithms. There are two versions of the evaluation worksheets. The first version, the **workshop evaluation tool**, is used in a workshop environment to document and evaluate project information quickly. The workshop tool uses the collected information to calculate real-time an "ease of implementation" score and an "impact to the business" score, which can be used for project comparison, decision-making and prioritization.

Project leaders or small teams use the second version, the **project leader assessment tool**. The tool guides the leader (or team) to consider the project from multiple angles and can stimulate detailed discussion about the potential of a given project. The worksheets guide the leaders in documenting the critical details of the project in a way that can be evaluated quantitatively, generating an overall assessment of the project's value proposition, along the two-complementary perspectives (impact to

[4] The term "bottoms-up" refers to action initiated at the bottom echelon of an organization, such as improvement projects started by mechanics working on the production line.

[5] The term "top-down" refers to action initiated at the top echelon of an organization, such as improvement projects started by senior executive management.

business and ease of implementation). The information documented in the project leader tool is also used to create a submission package to put forward for project approval.

4.2.2.2 Project Database

The purpose of the database is to establish a common source of project information. This database is meant to be the repository of all evaluation worksheets, in-work project status and actual project results. It is also used to produce all associated project reports.

4.2.2.3 Project Leader Reports

The purpose of project leader reports is two-fold, communicating

- information to consider during project exploration prior to go-forward approval or during project planning phases (project planning report package), and
- information to utilize during project execution and closure (project execution report package).

The project planning report package provides feedback in three areas, each of which represents critical areas the project leader or team will need to focus on to ensure success and sustained implementation. The areas are impact reports, benefit/risk reports and change management reports.

Impact reports identify

- business processes that may be impacted by the proposed changes,
- in-process or proposed projects that may be impacted by the proposed project, thus requiring some level of coordination, and
- organizations that may need to support the project in different stakeholder roles.

Benefit/risk reports identify

- projected resource cost estimates for project execution (e.g., number of people per skill code, estimated hours or level of effort),
- potential benefits or opportunities that will result from implementing and sustaining the proposed change (e.g., net present value of the opportunities, identification of intangible benefits), and
- potential risks that will result if the change is not implemented and sustained (e.g., net present value of missed deliveries, assessment of impact to future competitiveness).

Change management reports identify

- the most critical elements of change management that may be barriers to project implementation or sustainment and
- specific recommendations for change management tools that can be leveraged to address barriers to change.

The project execution report package provides information in two areas meant to assist the project leader with communicating project status and documenting project results at project closure.

Project status reports identify

- current project status, formatted in a standard template that can be easily integrated in various presentations.

Project closure reports summarize

- actual project results in cost, time or quality categories,
- effectiveness of the project implementation by comparing actual versus projected costs and benefits, and
- go-forward recommendations to monitor long-term sustainment of the change.

4.2.2.4 Project Sponsor Reports

The purpose of the project sponsor reports is to

- provide visibility at a high level of all the change activity across all business processes (e.g., visibility of the "landscape of change") and
- summarize benefits/risks at a high level (e.g., by organization, by business process, by project status category).

4.3 Deliverables

The following is a summary of the deliverables provided to the sponsor company, Raytheon. The deliverables represent applications of the methodologies and tools developed while exploring the hypothesis presented in this thesis. A generic version of each deliverable is described below and a customized version of each deliverable was provided to Raytheon at the conclusion of the research internship.

Evaluation worksheet deliverables include

- prototype of the workshop evaluation design tool and
- prototype of the project leaders assessment design tool.

Project database deliverables include

- documentation of required data tables with data relationships identified that can be used by an IT department to construct a DFPI project database (see Appendix A).

Project leader report deliverables include

- example of the project planning report package (includes output reports generated from the Design for Project Implementation tools, such as seen in Appendix F, K, O and Q) and
- example of the project execution report (see Appendix B)

Project sponsor report deliverables include

- example of a high-level "landscape of change" report (see Appendix C) and
- example of a high-level benefit/risk summary report (see Appendix D).

5.0 Design for Project Implementation (DFPI) Methodology

Chapter Five provides a detailed review of the Design for Project Implementation (DFPI) methodology proposed by this thesis. First, we will introduce a series of guidelines for applying the methodology. Second, we will establish how the DFPI methodology can be linked to a change management model. Third, we will present how the methodology is applied by describing how two different design tools evaluate a project, based on elements related to (1) the project's 'value proposition', which considers both the opportunity to the business by evaluating the project's impact to the business and (2) the cost to the business by evaluating the ease of project implementation. Finally, we will discuss how the methodology can be progressively implemented within a corporation based on the level of utilization leadership chooses.

5.1 Engineering "Design for..." Methodology Application

Over the last 20 to 30 years in the engineering community a number of powerful *"Design for..."* methodologies have been developed and are now commonly used in the product design (and re-design) process. One of the first, Design for Manufacturing and Assembly (DFMA), was introduced by Geoffrey Boothroyd, Peter Dewhurst and Winston Knight in the early 1980's (Boothroyd, Dewhurst, & Knight, Product DFMA, 1994). The main purpose of these design assessment tools is to provide engineers with a mechanism for evaluating a product from a particular focus (e.g., environmental, assembly, manufacturing, automation) and guiding them to areas of opportunity to alter the design resulting in cost, quality or competitive improvements (Boothroyd G. P., 1994). This thesis applies a similar methodology to a process instead of a product, establishing a mechanism for evaluating the project implementation process, guiding project managers to areas of opportunity to modify implementation plans to increase the effectiveness of the project.

Boothroyd, Dewhurst and Knight (1994) identify a list of requirements that the DFMA design tool should meet.

> *The design tool should provide quick results and be simple and easy to use. It should insure consistency and completeness in its evaluation of product assemblability. It should also eliminate subjective judgment from design assessment, allow free association of ideas, enable easy comparison of alternative designs, insure that solutions are evaluated logically, identify assembly problems areas and suggest alternative approaches for improving the manufacturing and assembly of the product."* (Boothroyd, Dewhurst, & Knight, Product DFMA, 1994)

This list of requirements provides a basis for a framework, which we utilized to develop the criteria or requirements for the DFPI methodology as a project design tool. The following is a list of modified requirements, adapting the DFMA-specific requirements to a DFPI intent.

- The project assessment tool should be simple and easy to use, providing results in a reasonable time frame depending on the situation application (e.g., workshop situation, project implementation team meeting).
- The project assessment tool should enable reliable comparison of projects by providing consistent and comparable output assessment results and metrics, thereby providing an evaluation of the effectiveness of the project or initiative.
- The project assessment tool should enable the appropriate level of project investigation, enabling stakeholders to explore the project from two primary perspectives (ease of implementation and impact to the business).
- The project assessment tool should enable the transformation of subject information into quantitative data to be used in calculating consistent and comparable metrics.

- The project assessment tool should identify areas for improvement to increase the overall effectiveness of the project implementation and make appropriate suggestions for modification.
- The project assessment tool should be easily adapted (or customized) to integrate with corporations' existing internal formal project improvement related processes (e.g., Six Sigma, formal gate development and approval processes).

Boothroyd and Dewhurst (1983) created a design handbook using the requirements described in the quotation above as a basic framework. The design handbook provides engineers some guidelines and applies those guidelines through a series of techniques to quantify how "efficient the design is in terms of assembly" (Boothroyd & Dewhurst, Design for assembly: a designer's handbook, 1983). The guidelines can be summarized in three basic criteria that the designer uses when examining a product. The criteria require the designer to look at how the product moves during an operation, questions the requirements for different material types used in the product and questions the necessity for different parts of the product to be assembled via individual sub-assemblies (Boothroyd G. P., 1994). The handbook then provides detailed techniques for evaluating quantitatively the product based on each criteria, and it provides results that guide the designer to *"develop a design that will be more easily assembled"* (Boothroyd, Dewhurst, & Knight, Product DFMA, 1994) as measured by the cost of assembly (Boothroyd & Dewhurst, Design for assembly: a designer's handbook, 1983).

The DFPI assessment tools functions in a similar method as the techniques described in Boothroyd and Dewhurst's (1983) Design Handbook. The workshop evaluation tool provides a series of techniques via a set of worksheets to assess a project idea at a high level of detail generating real-time results for project idea comparison and down selection. The project leader assessment tool provides a series of techniques via a separate set of worksheets to assess a project at a more detailed level generating real-time results for project leaders to identify implementation strengths or weaknesses and reporting specific implementation recommendations for the project leader to consider. These techniques will be discussed in greater detail in Chapter 5.3.

There is one area where the DFPI methodology differs greatly from the DFMA methodology. Because the DFPI methodology is being applied to a project implementation process instead of the design of a physical product the DFPI methodology must consider what human behaviors are being affected and how any required behavioral changes might impact the effectiveness of the implementation. Therefore, we define one final requirement: The project assessment tool should enable evaluation of the behavior changes required by the project and provide guidance on how to manage those behavioral changes successfully. This requirement is the catalyst for incorporating a change management model into the DFPI assessment tools. Chapter 5.2 introduces change management models and discusses how any model can be integrated into the DFPI assessment tool.

5.2 Change Management Model Application

Project implementation is all about changes in business processes—changes in the processes an individual or group of individuals execute to accomplish the expectations defined in their job descriptions. Therefore, at the heart of it, project implementation is about changing people's behaviors.

Effectively making and sustaining those changes is hard and must be done on two levels—physical and behavioral. Physical changes must be made to enable the modified process steps to occur. This could be changes to the physical layout of a factory, changes to computer software to enable different data to be accessed or it could be changes to a piece of equipment to enable different measurements to be made. Regardless of what physical changes are made, they are insufficient to permanent long-term process changes without behavioral changes as well.

In *Leading Change* Kotter (1996) makes the point that change is possible within a company—that *"organizations can be significantly improved, at an acceptable cost"* but that the change is often not achieved because *"history has simply not prepared us for transformational challenges"* (Kotter, Leading change, 1996). This is where a change management model can help. A change management model can provide a mechanism that project leaders can utilize to overcome the *"sources of inertia"* that prevent behavioral changes from becoming 'how business is done' (Kotter, Leading change, 1996). By integrating the multi-stage process steps of a change management model into the DFPI assessment tool, the project evaluation can provide project leaders with results that consider the sources of inertia that may prevent long-term adoption of the changes. The assessment tool can also utilize the change management model to provide the project leader with specific recommendations, or change tools, that can be used to help overcome the identified sources of inertia.

There are a number of different change management models or strategies described in management literature, and it is beyond the scope of this thesis to review each in great detail and identify an "optimal" model. Instead, we will highlight some common threads we have noted throughout the literature. We will then focus on one representative model, Kotter's eight-stage change management model described in *Leading Change*, to integrate into our DFPI design tools. (Kotter, Leading change, 1996). We selected Kotter's model because it is the basis for Raytheon's internal change management model.

Some of the common threads we have noted are as follows:

- Leadership, at all levels, plays a critical role in creating an environment for the change to take place and for enforcing sustainment. (Eckes, 2001);(Kotter, Leading change, 1996);(Collins, 2001)
- There must be a path for change. The individuals being asked to change must be able to see the reason for the change, understand what specific actions are expected of them and understand the consequences of not changing. (Hiatt & Creasey, 2003); (Kotter & Cohen, The heart of change, 2002)
- Change must be managed. It is not enough to "talk" change, it must be reinforced with actions. Those resisting the change must be identified and coached or removed. Those successfully changing must be recognized and rewarded. (Connellan, 1996);(Cohen & Kotter, 2005)

The Raytheon Company has instituted a proprietary corporate-wide change management model based on the eight-stage process developed and introduced by Kotter (1996) in *Leading Change*. Therefore, due to confidentiality constraints, we will utilize Kotter's change management model as a representative model for integration with the DFPI methodology instead of Raytheon's change management model. Kotter's model is based on an eight-stage process for implementing change. The eight steps, as described in *Leading Change*, are as follows (Kotter, Leading change, 1996):

1. Establishing a sense of urgency;
2. Creating the guiding coalition;
3. Developing a vision and strategy;
4. Communicating the change vision;
5. Empowering broad-based action;
6. Generating short-term wins;
7. Consolidating gains and producing more change; and
8. Anchoring new approaches in the culture.

D. Cohen published a field guide presenting a series of effective tools associated with each of the eight-stages (Cohen & Kotter, 2005). These change management tools can be utilized to execute the stage successfully and move closer to implementing and sustaining the targeted changes fully. Corporations with established change management models will also have a series of change management tools that support the stages (or elements) of the change model. In some situations the change model will be integrated with other programs, creating the opportunity for 'cross-over' tools. This is the situation at Raytheon.

The Raytheon change management model is integrated with the Raytheon Six Sigma program. There are over 20 different change related tools for each, the change management model and Six Sigma program. Combined these two tool sets create an extensive and effective 'toolbox' for change agents within Raytheon. The challenge is identifying the optimal subset of tools that should be utilized during the generally restricted project implementation timeline to effectively address the project's change management related concerns. We incorporate a change management report (applied to Kotter's change management model and Cohen's change management tools) in the project leaders assessment design tool addressing this challenge (see Chapter 5.3.4.2.2).

See Chapter 5.3 for a detailed description of the worksheet evaluation techniques used to assess a project based on the framework established via Kotter's eight-stage change management model.

5.3 DFPI Design Tools

In this section will provide an overview of how the DFPI methodology is used to evaluate a project via the two unique design tools—the **workshop evaluation design tool** and the **project leaders assessment design tool**. First, we explain how the two design tools evaluate a project and calculate quantitative individual element scores and overall scores for the project. Second, we will explain how the project leaders assessment design tool is customized to integrate a corporation's business processes into the evaluation process. Third, we will describe the elements used to evaluate a project's impact to the business. Finally, we will describe the elements used to evaluate a project's ease of implementation. In both of the last two sections the different elements will be defined, the assessment tool application(s) will be explained and the assessment results or feedback will be described.

5.3.1 Project Evaluation

When considering a project implementation there are two primary dimensions for evaluation. The first is *what is the purpose of the project*—meaning what is the potential impact to the business that the project is working to address. The second is *how difficult will the project be to implement*—meaning what is the ease of implementation. These two dimensions can be represented on an x-y coordinate graph creating a project evaluation matrix, as shown in Figure 4.

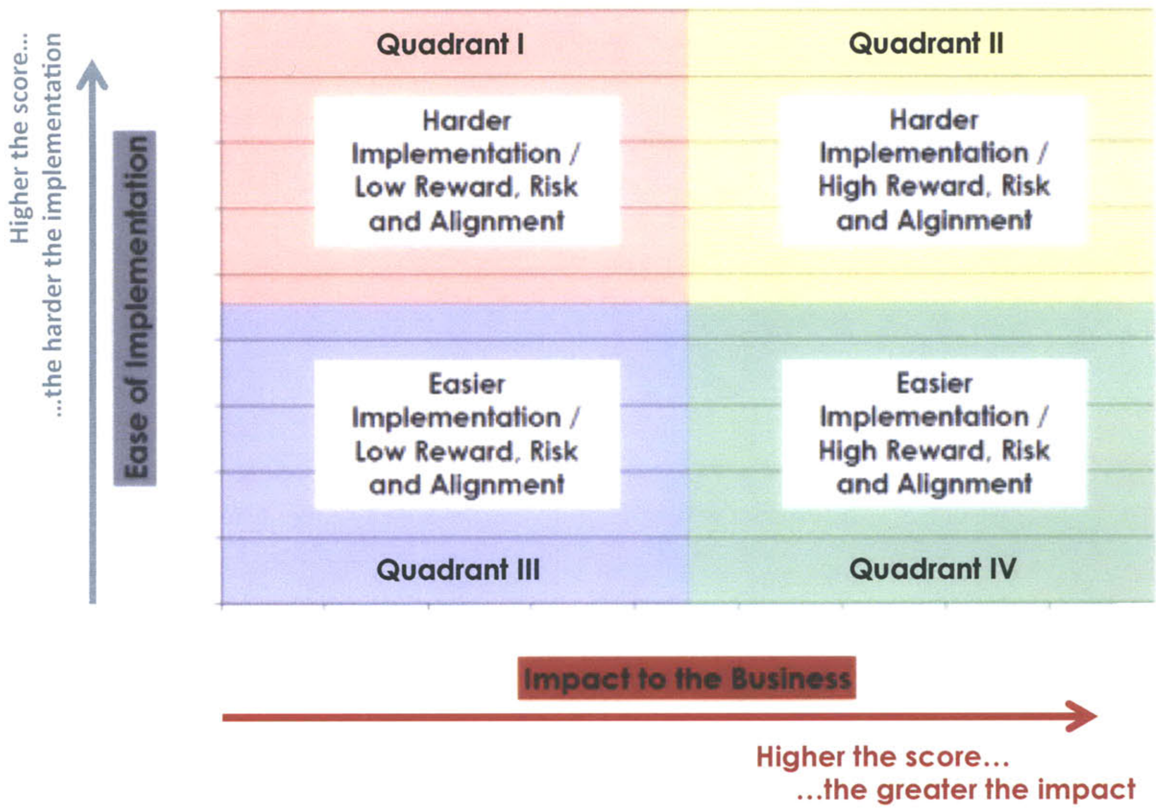


Figure 4: Project Evaluation Matrix

We divide the matrix into four different quadrants, with each quadrant representing different types of project combination based on the score. Each of the four quadrants is described as follows:

Quadrant I

Projects mapped to Quadrant I score high on the ease of implementation dimension and low on the impact to business dimension. Project leaders should generally not pursue these opportunities because the potential ratio of value to the business versus implementation costs is relatively low. There are few exceptions, for example if the risk to the business being addressed is one that impacts consumer safety.

Quadrant II

Projects mapped to Quadrant II score high on the ease of implementation dimension and high on the impact to business dimension. Project leaders should generally pursue these opportunities because the potential ratio of value to the business versus implementation costs is relatively high. These projects should be considered more as long-term implementation opportunities. Their high score on the ease of implementation dimension implies that they will take longer to implement successfully (e.g., over six months), but the high score on impact to the business dimension also implies that the project is important in a long-term strategic view.

Quadrant III

Projects mapped to Quadrant III score low on the ease of implementation dimension and low on the impact to business dimension. Project leaders should generally pursue these opportunities. Their potential ratio of value to the business versus implementation costs can be relatively high, providing benefits for little implementation efforts. They should be considered 'low-hanging fruit'.

Quadrant IV

Projects mapped to Quadrant IV score low on the ease of implementation dimension and high on the impact to business dimension. Project leaders should generally pursue these opportunities because the potential ratio of value to the business versus implementation costs is high. These projects should be considered more as short-term implementation opportunities. Their low score on the ease of implementation dimension implies that they will take a relatively short time to implement successfully (e.g., under six months). The high score on impact to the business dimension also implies that the project is strategically important and has the potential of earning some short term-momentum.

Each dimension can be broken down into different elements. Table 4 briefly highlights each element and identifies the DFPI tool that utilizes the element for project evaluation.

There is one element that is not linked to either dimension score, the project summary element. The ***project summary*** element, utilized in both tools, does not provide an individual quantitative score to the overall project evaluation score. This element provides the basic documentation of the project concept including the project title, a brief project description and documented project deliverables. The project summary worksheet has some differences depending on which tool it is being used for. This is necessary to enable the project leaders assessment tool version to capture additional levels of detail. Examples of both versions of the worksheet are provided in Appendix E.

The remaining ten elements are utilized to calculate the evaluation score for the dimension the element is associated with. The project is first evaluated in terms of each individual element, translated into an individual quantitative score. The scores are normalized over a given scale (as defined by the user and easily adapted) and used to calculate an overall score for each dimension, resulting in an x-y coordinate address for the project. That address is mapped on the project evaluation matrix, assigning the project to a specific quadrant. The project leader or workshop participants are then provided feedback as guidance on what were the drivers for the overall project evaluation as well (namely for the project leader assessment reports) what specific actions should be considered to make the implementation more effective. Finally, the two dimension scores can be used to calculate an overall project score that can be used to establish a global priority ranking for all the evaluated projects. Strategies for calculating and exploiting a global priority are discussed in more detail in Chapter 6.3.

Table 4: DFPI Evaluation Elements

	Element	Description	Workshop Evaluation Tool			Project Leaders' Assessment Tool		
			Used In	Score Variable	Weight Variable	Used In	Score Variable	Weight Variable
	Project Summary	Designed to capture basic project information such as the project title, problem statement and deliverables. This element does not contribute to the evaluation score.	✓	X	X	✓	X	X
IMPACT TO THE BUSINESS	Risk	Designed to understand the areas of potential risk to the business in terms of cost time or quality if the project ***is not*** implemented.	✓	R_N	W_R	✓	R_N	W_R
IMPACT TO THE BUSINESS	Reward	Designed to understand the areas of potential benefit to the business in terms of cost, time or quality if the project ***is*** implemented.	✓	B_N	W_B	✓	B_N	W_B
IMPACT TO THE BUSINESS	Alignment to User-Defined Characteristic	Designed to understand how well a project aligns to a given characteristic by asking if the project will make a positive, negative or neutral impact on the characteristic.	✓	A_N	W_A	X	X	X
IMPACT TO THE BUSINESS	Enterprise Business Goals Alignment	Designed to understand how well the project aligns to the corporate, or enterprise-wide business goals.	X	X	X	✓	AG_N	W_{AG}
IMPACT TO THE BUSINESS	Key Metrics Impact	Designed to understand if the project has the potential of impacting one or more key business metrics.	X	X	X	✓	K_N	W_K
IMPACT TO THE BUSINESS	Project Duration	Designed to understand the potential project timeline from go-forward approval through project closure.	✓	WD_N	W_{WD}	✓	X	X
IMPACT TO THE BUSINESS	Resource Requirements	Designed to understand the anticipated labor resources required to support the project implementation.	✓	WL_N	W_{WL}	✓	LL_N	W_{LL}
IMPACT TO THE BUSINESS	Change Management	Designed to understand the potential magnitude of effort required to implement and sustain the behavioral changes required by the project.	✓	WC_N	W_{CN}	✓	LC_N	W_{LC}
IMPACT TO THE BUSINESS	Business Process Complexity	Designed to understand the overall complexity of the business process that will potentially be impacted by the project.	X	X	X	✓	X_N	W_X
IMPACT TO THE BUSINESS	Formal Project Management Approval Process Impacts	Designed to understand the overall impact to different programs/products in-work throughout the organization based on their status on the established PM process.	X	X	X	✓	Y_N	W_Y

In the prototype versions of both the workshop evaluation tool and project leader assessment tool used in this thesis application two different scales for the project evaluation matrix were used for two reasons. First, the different scales are in alignment with the level of detail being explored using the different versions of the DFPI assessment tools. The project leaders assessment tool has a larger range, enabling the assessment results to be more sensitive to the data inputs. Second, the different scales used in the prototype demonstrate the flexibility of the tool. The scales can easily be adjusted to align with ranges generally used in the targeted corporate culture.

The workshop evaluation tool version utilizes a one-to-nine (1 to 9) scale with one (1) representing a "low" score (e.g., easier to implement or little to no impact to the business) and nine (9) representing a "high" score (e.g., harder to implement or significant impact to the business). All of the individual element scores in the workshop evaluation tool worksheets are normalized on the one-to-nine (1 to 9) scale.

The project leader assessment tool version utilizes a one-to-100 (1 to 100) scale with one (1) representing a "low" score and 100 representing a "high" score. All of the individual element scores in the project leader assessment tool worksheets are normalized on the one-to-100 (1 to 100) scale.

For some individual elements interpolation is used to normalize the individual score on the project evaluation matrix scale range (See Figure 5). Interpolation is used to "estimate values of data between two known values" (Dictionary, 2010). In general interpolation can be calculated as follows:

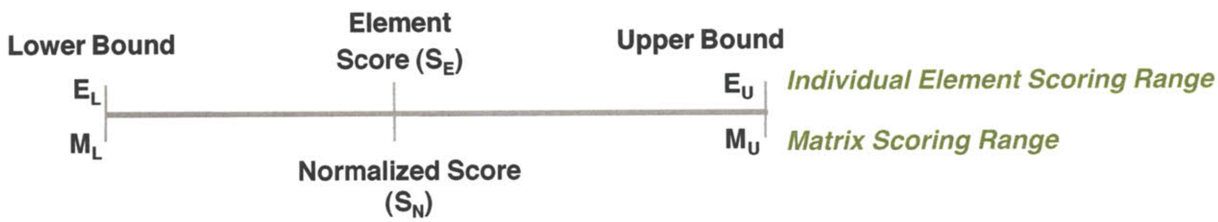


Figure 5: Basic representation of interpolation explanation

Below is a summary list of the variables and a detailed presentation of the equations used to calculate the evaluation scores discussed in the section above.

LIST OF VARIABLES

E_L = Lower bound of individual element scoring range

E_U = Upper bound of individual element scoring range

S_E = Individual element score

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

S_N = Individual element score

CALCULATION

$$\frac{M_U - M_L}{E_U - E_L} = \frac{M_U - S_N}{E_U - S_E} \quad \textit{Solve for the Normalized Score, } S_N$$

$$S_N = M_U - \frac{(M_U - M_L)(M_U - S_E)}{(E_U - E_L)}$$

Equation 1: Basic Interpolation Equation

The ***impact to business (WB_D or LB_D)*** dimension score and the ***ease of implementation (WE_D or LE_D)*** dimension score are calculated as follows (see Table 4 for the list of variables):

CALUCULATE DIMENION SCORES – WORKSHOP EVALUATION DESIGN TOOL

$$WB_D = \frac{(R_N \times W_R) + (B_N \times W_B) + (A_N \times W_A)}{W_R + W_B + W_A}$$

Equation 2: Impact to Business (WB_D) Dimension Score - Workshop Evaluation Design Tool

$$WE_D = \frac{(WD_N \times W_{WD}) + (WL_N \times W_{WL}) + (WC_N \times W_{CN})}{W_{WD} + W_{WL} + W_{CN}}$$

Equation 3: Ease of Implementation (WE_D) Dimension Score - Workshop Evaluation Design Tool

CALUCULATE DIMENION SCORES – PROJECT LEADERS ASSESSMENT DESIGN TOOL

$$LB_D = \frac{(R_N \times W_R) + (B_N \times W_B) + (AG_N \times W_{AG}) + (K_N \times W_K)}{W_R + W_B + W_A + W_K}$$

Equation 4: Impact to Business (LB_D) Dimension Score - Project Leaders Assessment Design Tool

$$LE_D = \frac{(LL_N \times W_{LL}) + (LC_N \times W_{LC}) + (X_N \times W_X) + (Y_N \times W_Y)}{W_{LL} + W_{LC} + W_X + W_Y}$$

Equation 5: Ease of Implementation (LE_D) Dimension Score - Project Leaders Assessment Design Tool

5.3.2 Business Process Integration

The primary strength of the project leaders assessment design tool is its ability to utilize the DFPI methodology to evaluate a project within the context of the business process the project is intended to change. In order to do this the assessment tool must be able to link the project information provided by the project leader to the existing business processes. In this section we will discuss how that integration is established by explaining how it was accomplished in our customized prototype at Raytheon using the business process related to the ERP system. In order to ensure confidentially of all proprietary Raytheon information, all data referenced in the examples used throughout this thesis has been altered.

5.3.2.1 Process Identification Mapping

The first requirement for the DFPI design tool is for it to be simple and easy to use. Therefore, the challenge that must be overcome to successfully integrate and utilize business processes as a factor for the DFPI project evaluation is how to identify repeatedly which business process may be impacted by any project without significant manual intervention. The scope of our prototype application at Raytheon included over 60 different business processes all related to managing work in the post-deployment ERP environment. Our goals for the prototype application were to design a project evaluation worksheet that project leaders could complete in a short period of time (target of 20 minutes) and that could accurately identify impacted processes. The proposed solution uses a series of yes/no question and follow-up statements, which are mapped to the business processes (here forth referred to as process identification statements). The worksheet presents only the process identification statement to the project leader. The electronic prototype utilizes the answers to the process identification statement to identify the potential impacted processes and to calculate a magnitude of impact.

The process identification mapping is a one-time event that is best completed with the participation of business process experts. The resulting mapping should be reviewed any time significant changes or updates are made to the business processes. The first step in the mapping exercise is to create the series of process identification statements. The optimal statement will map to multiple processes. For our application the target was to design statements that mapped to at least two ERP related business processes. An example statement is shown in Figure 6. If the question is answered "yes" the project leader is asked to select all those statements that demonstrate the topic. As shown in the Figure 6, each demonstrative statement is mapped to the business process that documents the activities related to described situation. The mapped "pairing" is represented by a one (1) in the intersecting matrix cell. We represent the pairing using variable $PP_{i,p}$ (read as the pairing value between process identification statement i and business process p). The resulting process identification statement versus business process matrix will here forth be referred to as the SA / BP matrix.

Once the mapping exercise is complete the "pairing" information is used to establish a maximum potential business process impact value. This is the total number of "pairs" for the process. For example refer to our representative mapping matrix in Figure 6.

		Process Identification Statement (i, I=6)	Answer for Process Identification Statement i from worksheet	Answer value for Process Identification Statement i (SAi)	Proposal Preparation Process	Proposal Submittal Process	Process for ordering Long Lead Material
	Business Process (p, P=3)				p=1	p=2	p=3
	Categorization of Potential Impact (High, Med, Low, None/Blank)				L	L	H
	Percentage Impact for Business Process p (PI_p)				50%	50%	100%
	Maximum Magnitude of Impact for Business Process p (MM_p)				4	4	1
	Magnitude of Impact for Business Process p (MI_p)				2	2	1
1.0	Will your project potentially impact how information will be collected or integrated for Bids for new business? If so, in what ways (check all that apply)?	N/A	Y	N/A			
1.1	Impacts ability to identify a proposal Bill of Material (BOM).	i=1		0	1	1	
1.2	Impacts coordination or handoff of information across impacted stakeholders.	i=2	X	1	1	1	
1.3	Impacts how/what historical information is available	i=3	X	1			
1.4	Impacts coordination activities / logistics between support organizations	i=4	X	1	1	1	1
1.5	Impacts decision making process in regards to deciding to continue pursuing the new business opportunity.	i=5		0	1		
1.6	Impacts coordination activities / integration process to create the actual bid that will be submitted to the potential customer.	i=6		0		1	

Pairing Value between Process Identification Statement i and Business Process p ($PP_{i,p}$)

Figure 6: Example of Process Identification Statement versus Business Process (SA / BP) Matrix

The "Proposal Preparation Process" has four "pairs" (as calculated by summing the "1" in the column), resulting in the Proposal Preparation Process having a maximum potential magnitude of impact value of four (or MM_1=4). The impact value represents the maximum number of opportunities the process has to be "impacted" by the project as determined by the answers to the process identification statements. In order to normalize the impact scores the impact percentage is used (or PI_p). Referring back to our example two of the possible four pairings were selected based on the answer to the process identification statements. Therefore the "Proposal Preparation Process" percentage impact is 50% (or PI_1=0.5). An arbitrary scale is used to categorize the business process to be used in an output report as follows:

- High potential of impact (percentage impact is greater than 70%)
- Medium potential of impact (percentage impact is between 60% and 70%)
- Low potential of impact (percentage impact is between 50% to 60%)

Business processes document the organizations (or labor skills) required to complete the different process activities (generally referred to as the 'intended user' of the process). This information is used within the electronic version of design tool to identify (via cross-reference) the intended user(s) that may also be impacted. The feedback report provided to the project leader shows the potentially impact business process and potentially impacted intended users. An example of the report is provided in Appendix F.

Below is a summary list of the variables and a detailed presentation of the equations used to calculate the evaluation scores discussed in the section above.

LIST OF VARIABLES

SA_i = Answer to process identification statement i

MI_p = Magnitude of impact for business process p

MM_p= Maximum magnitude of impact for business process p

$PP_{i,p}$ = Pairing value between process identification statement I and business process p

PI_p = Percentage impact for business process p

Where p = business process = 1,…,P

Given P = total number of business processes

P = 3 in the example shown in Figure 6

i = process identification statement = 1,…,I

Given I = total number of process identification statements

I = 6 in the example shown in Figure 6

CALCULATE MAGNITUDE OF IMPACT

$$SA_i = \begin{cases} 0 \; if\, answer\, is\, No\, or\, if\, statement\, is\, not\, selected\, given\, a\, yes\, answer \\ 1 \; if\, answer\, is\, yes\, or\, if\, statement\, is\, selected\, given\, a\, yes\, answer \end{cases}$$

Equation 6: Binary Calculation for Answer to Process Identification Statement (SA_i) Answer

$$PP_{i,p} = \begin{cases} 0 \text{ if there IS NO relationship between the process identification statement } i \text{ and business process } p \\ 1 \text{ if there IS a relationship between the process identification statement } i \text{ and business process } p \end{cases}$$

Equation 7: Binary Calculation for SA / BP Matrix Pairing Value ($PP_{i,p}$)

$$MI_p = \sum_{i=1}^{I} \left(SA_i \times PP_{i,p} \right) \quad \forall\ p = 1,\ldots,P$$

Equation 8: Magnitude of Impact (MI_p) Equation

CALCULATE MAXIMUM MAGNITUDE OF IMPACT

$$MM_p = \sum_{i=1}^{I} PP_{i,p} \quad \forall\ p = 1,\ldots,P$$

Equation 9: Maximum Magnitude of Impact (MM_p) Equation

CALCULATE PERCENTAGE IMPACT

$$PI_p = \frac{MI_p}{MM_p} \quad \forall\ p = 1,\ldots,P$$

Equation 10: Percentage Impact (PI_p) Equation

These values explained above in Equations 6 through 10 are significant inputs in the DFPI evaluation tools. They reflect quantitatively the magnitude of alignment between the project under evaluation and the business processes targeted for change. Therefore, these values become inputs in the calculation of other individual element scores used to evaluate the overall value proposition of the potential project. Namely, one or more value calculated using Equations 6 through 10 are used as inputs for the following elements to calculate their individual element scores:

- Enterprise Business Goal Alignment Element (see Chapter 5.3.3.4 for additional details).
  - Utilizes all five values (SA_i, MI_p, MM_p, $PP_{i,p}$ and PI_p) as input variables.
- Key Metric Alignment Element (Chapter 5.3.3.5 for additional details).
  - Utilizes one value (PI_p) as an input variable.
- Business Process Complexity Element (Chapter 5.3.4.4 for additional details).
  - Utilizes one value (MI_p) as an input variable.
- Formal Project Management Approval Process Impacts Element (Chapter 5.3.4.5 for additional details).
  - Utilizes one value (PI_p) as an input variable.

5.3.3 Impact to the Business Elements

In this sub-section five different elements that contribute to the ***Impact to the Business*** dimension (represented on the x-axis) will be presented. They are risks, rewards (or benefits), alignment to a user-defined characteristic, enterprise business goals alignment and key metric impacts.

5.3.3.1 Risk

The ***Risk*** element is designed to help the workshop participants or the project leader to understand the areas of potential risk to the business in terms of cost, time or quality if the project is not implemented. In this instance quality refers to how well the process/service/product is meeting user needs. The prototype worksheet for risk is identical for both tool versions.

To complete the risk worksheet the project leader or workshop participants are asked to populate four pieces of information for each identified risk. The prototype is formatted to allow the project leader or workshop participants to identify up to seven risks. The four pieces of information are as follows:

> **Risk Description**: A short sentence describing the risk.
>
> **Likelihood of Risk**: A number (between 0 to 100) representing the probability that the described risk will occur in the future if the project IS NOT implemented.
>
> **Magnitude of Risk**: A number (between 0 to 100) representing the level of negative impact to the business if the described risk occurs. The worksheet contains an example framework by risk type (cost, time or quality) to help the user apply the magnitude estimate consistently to each evaluated project.
>
> **Type of Risk**: User assigns one of three "type" classifications to categorize the risk (cost, time or quality). The electronic prototype (built in M.S. Excel) uses a drop-down selection box in order to limit the user's selection options.

An example of a completed risk worksheet is provided in Appendix G. A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual risk element score (R_E)*** and the ***normalized risk score (R_N)*** are as follows:

LIST OF VARIABLES

RL_r = Likelihood of Risk r

RM_r = Magnitude of Risk r

Where r = Individual described risk = 1,...,R

Given R = total number of described risk (number between 1 to 7)

R_E = Individual Risk Element Score

R_N = Normalized Risk Score

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = 100

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE INDIVIDUAL RISK ELEMENT SCORE

$$R_E = \frac{\sum_{r=1}^{R}\left(\frac{RL_r}{100} \times RM_r\right)}{R}$$

Equation 11: Individual Risk Element Score (R_E) Equation

CALCULATE NORMALIZED RISK ELEMENT SCORE

If the project evaluation matrix range is one (1) to 100 then the individual risk element score is equivalent to the normalized risk element score. If the project evaluation matrix range differs we adapt Equation 1 to calculate the normalized risk element score as:

$$R_N = M_U - \frac{(M_U - M_L)(M_U - R_E)}{(100-0)} = M_U - \frac{(M_U - M_L)(M_U - R_E)}{100}$$

Equation 12: Normalized Risk Element Score (R_N) Equation

5.3.3.2 Reward

The ***Reward*** element is designed to help the workshop participants or the project leader to understand the areas of potential benefit to the business in terms of cost, time or quality if the project *is* implemented. In this instance quality refers to how well the process/service/product is meeting user needs.

There is one prototype worksheet for the reward element for the workshop evaluation tool version. It operates similar to the risk element worksheet. Chapter 5.2.2.2.1 will describe this version of the reward element worksheet in greater detail.

There are two prototype worksheets for the reward element for the project leader assessment tool version. The first worksheet is virtually identical to the worksheet used in workshop evaluation tool version, but used only to describe time or quality reward opportunities (see Chapter 5.2.2.2.1). The second worksheet is used to document cost reward opportunities. The second worksheet is described in greater detail in Chapter 5.2.2.2.2. Because the reward element for the project leaders assessment tool is evaluated at a lower level of detail the individual reward element score (B_E) is calculated as an average of four sub-element factors as described in Equation 13 below.

A summary list of relevant variables and a detailed review of the equations associated with calculating the individual and normalized reward element scores are as follows:

LIST OF VARIABLES

B_{SY} = Single Year Reward Sub-Element Score

B_{MY} = Multiple Year (or Net Present Value, NPV) Reward Sub-Element Score

B_T = Average Time Reward Sub-Element Score

B_Q = Average Quality Reward Sub-Element Score

B_E = Individual Reward Element Score

B_N = Normalized Reward Element Score

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = 100

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE INDIVIDUAL REWARD ELEMENT SCORE (B_E)

$$B_E = \frac{B_{SY} + B_{MY} + B_T + B_Q}{4}$$

Equation 13: Individual Reward Element Score (B_E) Equation for use in the Project Leaders Assessment Tool

CACULATE NORMALIZED REWARD ELEMENT SCORE

If the project evaluation matrix range is one (1) to 100 then the individual reward element score is equivalent to the normalized reward element score. If the project evaluation matrix range differs we adapt Equation 1 to calculate the normalized reward element score as follows:

$$B_N = M_U - \frac{(M_U - M_L)(M_U - B_E)}{(100-0)} = M_U - \frac{(M_U - M_L)(M_U - B_E)}{100}$$

Equation 14: Normalized Reward Element Score (B_N) Equation for use in the Project Leaders Assessment Tool

5.3.3.2.1 Workshop Evaluation Tool Worksheet

To complete the reward worksheet the project leader or workshop participants are asked to populated four pieces of information for each identified reward opportunity. The prototype is currently formatted to allow project leader or workshop participants to identify up to seven rewards on the worksheet. The four pieces of information are as follows:

Reward Description: A short sentence describing the reward.

Likelihood of Reward: A number (between 0 to 100) representing the probability that the described reward will be realized in the future if the project *is* implemented.

Magnitude of Risk: A number (between 0 to 100) representing the level of positive impact to the business if the described reward is realized. The worksheet contains an example framework by reward type (cost, time or quality as applicable) to help the user apply the magnitude estimate consistently to each evaluated project.

Type of Reward: User assigns one of two or three "type" classifications to categorize the reward opportunity (cost, time or quality for the workshop evaluation tool version; time or quality for the project leader assessment tool version). The electronic prototype (built in M.S. Excel) uses a drop-down selection box in order to limit the user's selection options.

Examples of completed reward worksheets, including both the workshop evaluation tool version and the project leaders assessment tool version, are provided in Appendix J.

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual reward element score (B_E)*** and the ***normalized reward element score (B_N)*** used in the workshop evaluation tool are as follows:

LIST OF VARIABLES

BL_b = Likelihood of Reward (Benefit) b

BM_b = Magnitude of Reward (Benefit) b

Where b = Individual described reward = 1,...,B

Given B = total number of described rewards (number between 1 to 7)

B_E = Individual Reward Element Score

B_N = Normalized Reward Element Score

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = 100

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE INDIVIDUAL REWARD ELEMENT SCORE

$$B_E = \frac{\sum_{b=1}^{B}\left(\frac{BL_b}{100} \times BM_b\right)}{B}$$

Equation 15: Individual Reward Element Score (B_E) for use in the Workshop Evaluation Tool

CALCULATE NORMALIZED REWARD ELEMENT SCORE

If the project evaluation matrix range is one (1) to 100 then the individual benefit element score is equivalent to the normalized benefit element score. If the project evaluation matrix range differs we adapt Equation 1 to calculate the normalized reward element score as follows:

$$B_N = M_U - \frac{(M_U - M_L)(M_U - B_E)}{(100-0)} = M_U - \frac{(M_U - M_L)(M_U - B_E)}{100}$$

Equation 16: Normalized Reward Score (B_N) for use in the Workshop Evaluation Tool

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***average time reward sub-element score (B_T)*** and the ***average quality reward sub-element score (B_Q)*** used in the project leader assessment tool are as follows:

LIST OF VARIABLES

BL_t = Likelihood of Time Reward (Benefit) t

BM_t = Magnitude of Time Reward (Benefit) t

Where t = Individual described time reward = 1,...,T

Given T = total number of described time rewards (number between 1 to 7)

BL_q = Likelihood of Quality Reward (Benefit) q

BM_q = Magnitude of Quality Reward (Benefit) q

Where q = Individual described quality reward = 1,...,Q

Given Q = total number of described quality rewards (number between 1 to 7)

B_T = Average Time Reward Sub-Element Score

B_Q = Average Quality Reward Sub-Element Score

CONSTRAINTS

$1 \leq T \leq 7 \text{ and}$

$1 \leq Q \leq 7 \text{ and}$

$1 \leq T + Q \leq 7$

CALCULATE AVERAGE TIME REWARD SUB-ELEMENT SCORE

$$B_T = \frac{\sum_{t=1}^{T}\left(\frac{BL_t}{100} \times BM_t\right)}{T}$$

Equation 17: Average Time Reward Sub-Element (B_T) Equation for use in Project Leaders Assessment Tool

CALCULATE AVERAGE QUALITY REWARD SUB-ELEMENT SCORE

$$B_Q = \frac{\sum_{q=1}^{Q}\left(\frac{BL_q}{100} \times BM_q\right)}{Q}$$

Equation 18: Average Quality Reward Sub-Element (B_Q) Equation for use in Project Leaders Assessment Tool

5.3.3.2.2 Project Leaders Assessment Tool Worksheet

In addition to the time or quality reward worksheet (described in Chapter 5.3.3.2.1) the project leader will also complete a cost rewards worksheet. To complete the worksheet the project leader is asked to input the following pieces of information:

Cost Benefit Description: A short sentence describing the potential savings opportunity.

Type of Savings: User assigns one of three "type" classifications to categorize the savings type (non-recurring for a one-time savings assumed to occur during year 1 following implementation; recurring for a multiple year savings over the spread of some number of years; cost-avoidance to document an expense that will be avoided as a result of implementation). The electronic prototype (built in Microsoft Excel) uses a drop-down selection box to limit the selection options.

Cost Category: This piece of information may not be applicable to all benefit opportunities. It would be used to describe the type of charging (either direct for hourly cost assignments or in-direct for overhead cost allocations). The electronic prototype uses a drop-down selection box.

Estimated Savings: A number representing the estimated savings (in thousands).

Total or Annual: User assigns a description of the estimated savings as either an annually recurring estimate or a total estimated savings over the identified spread of years (or single year if savings is non-recurring).

Number of years to spread over: User assigns a number from a limited drop-down box selection (3, 5, 7 or 10 years). This piece of information is only required if the savings is recurring (may also be a recurring cost-avoidance savings).

Percent Spread Strategy: User selects one of three built in evaluation strategies. "Even split" for savings to be evenly spread over the identified years (same percentage applied during each year). "Front-loaded" for the largest percentage of the savings to be allocated to the earlier years (e.g., if cost is spread over three years than 66% of the estimated savings are is allocated on year one, 33% allocated on year two and 0% is allocated to year three). "Back-loaded" for the largest percentage of savings to be allocated to the later years.

The user is also offered the option (for recurring savings) to select a "not sure of years spread or percentage spread strategy". If the option is selected a default assumption is made for the evaluation and the user can update the selection once additional information is known.

An example of the completed cost rewards worksheet is provided in Appendix I.

The ***single year reward sub-element score*** ***(B_{SY})*** is the total present value (assuming a 5% discount rate) of year one (1) estimated savings. This includes all of the following categorized cost benefits:

- Non-recurring cost benefits,
- Recurring cost benefits, year one (1) only,
- Non-recurring cost avoidance cost benefits, and
- Recurring cost avoidance cost benefits, year one (1) only.

The ***multi-year reward sub-element score*** ***(B_{MY})*** is the total net present value (assuming a 5% discount rate) of all the estimated cost benefits over a ten (10) year time period.

5.3.3.3 Alignment to a User-Defined Characteristic

The ***alignment to a user-defined characteristic*** element is specific to the workshop evaluation tool. The purpose of this element it to help the user understand how well the project aligns to a given characteristic. For example, if the intent is to improve a set of metrics then this worksheet can be used to explore if workshop participants think the project under discussion will have a positive impact on the each metric—if it will *move the needle in the right direction*.

The worksheet used to evaluate the alignment element is customized by the workshop leaders based on the workshop goals or expectations prior to being utilized in the actual workshop. For example purposes for this thesis we will assume that the overall goal of the workshop is to identify, evaluate and prioritize post-deployment ERP related projects that address user concerns related to the ERP system. To customize the worksheet the following two-steps are followed:

> **Step 1:** Identify a set list of potential user concerns (or a list related to the selected user defined characteristic). For our application at Raytheon we completed this step via a survey that was distributed to over 6000 users, including both transactional users (users responsible for performing some activity within the ERP system) and informational users (users who receive reports generated from the ERP system or have read-only access to view information within the ERP system). The survey had a 25% response rate.
>
> Prior to creating the survey 21 areas of concern were identified in relation to the ERP environment. In the survey users were asked to rank each of the pre-defined areas of concern on a scale of one (1) to five (5) with one representing little or no concern about the issue and five representing a significant level of concern about the issue. Average response values were calculated for each area of concern. These values are the weight for each area of concern (W_a). By ranking the areas of concern by weight the top ten were identified and selected to be included in the customized alignment worksheet. Note, the pre-defined 21 areas of concern and their associated weights are also used in the project leaders assessment tool for use in evaluating the enterprise business goal alignment (see Chapter 5.3.3.4).
>
> **Step 2:** Edit the worksheet template to include the selected list of user concerns. The template also contains room for descriptions to be loaded to help users better understand each listed items.

The workshop facilitator (or sub-group leader) completes the alignment worksheet. Firstly, the facilitator records on the worksheet the total number of participants contributing input. Secondly, for each concern listed the facilitator asks the group *"Do you think Project A will have a positive impact, no impact or negative impact on user concern #1?* " If the workshop participants think the project will have a positive impact (e.g., implementing the project will address the user concern with a viable solution) then they "vote" by raising their hand with a "thumbs up". If the workshop participants think the project will have a negative impact (e.g., implementing the project will make the user concern worse or create new problems related to that concern) then they vote by raising their hand with a "thumbs down". If the workshop participants think the project will have no impact on the user concern (neutral) then they vote by raising their hand with "thumbs sideways". Finally, the facilitator counts each group of thumbs and records the count on the worksheet. If a workshop participant refrains from "voting", they are counted as a neutral vote. Each "thumbs up" is counted as a positive one (1). Each "thumbs down" is counted as a negative one (-1) and each "thumbs sideways" is counted as a zero.

An example of the completed alignment to a user defined characteristic worksheet is provided in Appendix J.

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual alignment element score (A_E)*** and the ***normalized alignment element score (A_N)*** used in the workshop evaluation tool are as follows:

LIST OF VARIABLES

AU_a = Total number of "thumbs up" votes for user concern a

AD_a = Total number of "thumbs down" votes for user concern a

AA_a = Average area of concern alignment score for user concern a

Where a = user area of concern = 1,…,A

Given A = total number of areas of concern

V = Total number of workshop participants contributing input ("voting")

A_E = Individual Alignment Element Score

A_N = Normalized Alignment Element Score

E_L = Lower bound of individual element scoring range = -1

E_U = Upper bound of individual element scoring range = 1

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE INDIVIDUAL ALIGNMENT ELEMENT SCORE

$$AA_a = \frac{AU_a - AD_a}{V} \quad \forall\, i = 1, \ldots, A$$

Equation 19: Average area of concern alignment score (AA_a)

$$A_E = \frac{\sum_{a=1}^{A} AA_a}{A}$$

Equation 20: Individual Alignment Element Score (A_E) for use in the Workshop Evaluation Tool

CALCULATE NORMALIZED ALIGNMENT ELEMENT SCORE

Based on the value assigned to the thumbs, the range for the individual score is negative one (-1) to one (1). Therefore, we adapt Equation 1 to calculate the normalized alignment element score as follows:

$$A_N = M_U - \frac{(M_U - M_L)(M_U - A_E)}{(1-(-1))} = M_U - \frac{(M_U - M_L)(M_U - A_E)}{2}$$

Equation 21: Normalized Alignment Element Score (A_N) for use in the Workshop Evaluation Tool

5.3.3.4 Enterprise Business Goals Alignment

The ***enterprise business goals alignment*** element is designed to help the project leader understand how well the project aligns to the enterprise-wide, or corporate, business goals. This element is used only in the project leaders assessment tool. The basic assumption behind the element is that a meaningful project should contribute towards the organization's ability to successfully meet corporate business objectives or goals. The business goal alignment element evaluation quantifies the alignment via the normalized score. The higher the score, the more aligned the project is to the corporate business objectives or goals.

As referenced in Chapter 5.3.3.3, we identified 21 areas of concern related to business processes executing in an ERP environment. Each area of concern is mapped to related business processes creating a matrix (referred to here forth as the AC/BP matrix). An example of the AC/BP matrix is provided in Figure 7. Each area of concern is also mapped to the corporate business goals creating a second matrix (referred to here forth as the AC/Goal matrix). An example of the AC/Goal matrix is provided in Figure 8. Both matrices and the process impact category assignments (as described in Chapter 5.3.2.1) are used to calculate the individual enterprise business goal alignment element score (AG_E).

	Area of Concern (a, A=4)	*Magnitude of Applicability (MAa)*	Proposal Preparation Process	Proposal Submittal Process	Process for ordering Long Lead Material
Business Process (p, P=3)			p=1	p=2	p=3
Magnitude of Impact (MI_p)			2	2	1
Data Input	a=1	3		1	1
System Functionality	a=2	0			
Training	a=3	4	1	1	
Rework Related Processes	a=4	5	1	1	1

Pairing Value between Area of Concern a and Business Process p ($PA_{a,p}$)

Figure 7: Example of Area of Concern versus Business Process (AC/BP) Matrix

Generating the pairing relationships used in the AC/Goal matrix is completed via a subjective judgment evaluation best led by executive leadership. We adapted the matrix interaction technique developed by Brynjolfsson, Renshaw and Van Alstyne (1997) in *The Matrix of Change*. In *The Matrix of Change* pairing interactions between existing processes and target processes are evaluated and one of three interactions are assigned. Reinforcing interactions, or complementary practices, are assigned a plus sign. Interfering interactions, or competing practices, are assigned a minus sign. Practices with no perceived interaction or weak interactions are left blank. (Brynjolfssen, Renshaw, & Van Alstyne, 1997)

The AC/Goal matrix requires leadership to consider the interaction between each pairing of an area of concern and a business goal. Leadership then assigns one of three interaction values:

- 1, meaning the area of concern is an enabler for the business goal, or
- 0, meaning there is no perceived relationship between the area of concern and the business goal, or

- -1, meaning the area of concern is detrimental or has a negative impact on the business goal.

	Area of Concern (a, A=4)	*Area of Concern Weight (W_a)*	Improve Customer Service	Ensure a lean, cost-effectivproduction process	Grow our market	Fulfill our commitments 100% of the time	Anticipate & exceed our customers' need	Achieve performance excellence as demonstrated by a Malcolm-Baldridge Award
Corporate Business Goal Weight (W_g)			**1**	**3**	**2**	**5**	**3**	**4**
Corporate Business Goal (g, G=6)			**g=1**	**g=2**	**g=3**	**g=4**	**g=5**	**g=6**
Data Input	**a=1**	**2**				1		
System Functionality	**a=2**	**4**				1		
Training	**a=3**	**1**	1	1	1	1	1	1
Rework Related Processes	**a=4**	**5**		-1		-1		-1

Pairing Value between Area of Concern a and Corporate Business Goal g ($PG_{a,g}$)

Figure 8: Example of Area of Concern versus Enterprise or Corporate Business Goal (AC/Goal) Matrix

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual goal alignment element score (AG_E)*** and the ***normalized goal alignment element score (AG_N)*** used in the project leaders assessment tool are as follows:

LIST OF VARIABLES

SA_i = Answer to process identification statement i

MI_p = Magnitude of impact for business process p

MM_p= Maximum magnitude of impact for business process p

PI_p = Percentage impact for business process p

MA_a = Magnitude of applicability for area of concern a

$PA_{a,p}$= Pairing value between area of concern a and business process p

$PP_{i,p}$ = Pairing value between process identification statement I and business process p

$PG_{a,g}$= Pairing value between area of concern a and corporate business goal g

W_a = Weight for area of concern a

Note: for our application the weights were determined based on survey results (see Chapter 5.3.3.3)

W_g = Weight for corporate business goal g

Note: Weights should be assigned by leadership

$A_{a,g}$ = Alignment score between area of concern a and corporate business goal g

Where a = user area of concern = 1,...,A

Given A = total number of areas of concern

p = business process = 1,...,P

Given P = total number of business processes

g = user area of concern = 1,...,G

Given G = total number of enterprise or corporate business goals

i = process identification statement = 1,...,I

Given I = total number of process identification statements

AG_E = Individual Enterprise Business Goal Alignment Element Score

AG_N = Normalized Enterprise Business Goal Alignment Element Score

E_L = Lower bound of individual element scoring range = -4

E_U = Upper bound of individual element scoring range = 4

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE MAGNITUDE OF APPLICABILITY

$$PA_{a,p} = \begin{cases} 0 \text{ } \textit{if there IS NO relationship between area of concern a and business process p} \\ 1 \text{ } \textit{if there IS a relationship between area of concern a and business process p} \end{cases}$$

Equation 22: Binary Calculation for AC / BP Matrix Pairing Value ($PA_{a,p}$)

$$MA_a = \sum_{p=1}^{P} \left(PA_{a,p} \times MI_p \right) \quad \forall\, a = 1,\ldots,A$$

Equation 23: Magnitude of Applicability (MA_a) Equation

CALCULATE ALIGNMENT SCORE BETWEEN AREA OF CONCERN AND BUSINESS GOAL

$$PG_{a,g} = \begin{cases} 1 \text{ } \textit{if area of concern a is an enabler for business goal g} \\ 0 \text{ } \textit{if there is no perceived relationship between area of concern a and business goal g} \\ -1 \text{ } \textit{if area of concern a has a negative impact on business goal g} \end{cases}$$

Equation 24: Calculation for AC / Goal Matrix Pairing Value ($PG_{a,g}$)

$$A_{a,g} = MA_a \times W_a \times W_g \times PG_{a,g} \quad \forall\, a = 1,\ldots,A \text{ and } g = 1,\ldots,G$$

Equation 25: Alignment Value ($A_{a,g}$) Equation

CALCULATE INDIVIDUAL ENTERPRISE BUSINESS GOAL ALIGNMENT ELEMENT SCORE

$$AG_E = \frac{\sum_{a=1}^{A} \sum_{g=1}^{G} A_{a,g}}{A \times G}$$

Equation 26: Individual Enterprise Business Goal Alignment Element (AG_E) Score Equation

CALCULATE NORMALIZED ENTERPRISE BUSINESS GOAL ALIGNMENT ELEMENT SCORE

Through simulation of various pairing values for $PG_{a,g}$ we determined that the basic range for individual enterprise business goal alignment element scores is between negative four (-4) to four (4). Using this information and adapting Equation 1, the normalized enterprise business goal alignment element score can be calculated as follows:

$$AG_N = M_U - \frac{(M_U - M_L)(M_U - AG_E)}{(4-(-4))} = M_U - \frac{(M_U - M_L)(M_U - AG_E)}{8}$$

Equation 27: Normalized Enterprise Business Goal Alignment Element (AG_N) Score Equation

5.3.3.5 Key Metric Impacts

The ***key metric impact*** element is designed to help the project leader understand if the project has the potential of impacting one or more key business metrics. The evaluation does not identify if the potential impact will be positive or negative, instead each metric is evaluated as having a low, moderate or high potential for impact. The key metric impact element is used in the project leaders assessment tool only. As one of the outputs from this element's evaluation, project leaders are provided with a report that identifies the potential impact level of each metric as well as identifying the business processes that may be influencing the impact ranking. An example of the metric output report can be found in Appendix K.

The key metric impact element evaluation uses a pairing matrix documenting interaction relationships between the identified key metrics and the business processes (here forth referred to as the Metric/BP matrix). An example of the Metric/BP matrix is provided in Figure 9. Executive leadership should identify the key metrics included for consideration for this evaluation. The set of identified metrics should represent the primary measures leadership utilizes to measure the overall health of the business from a predictive and tactical perspective. The set should include a mix of metrics that are either quality or delivery related. Like the matrices used for the enterprise business goal alignment element, leadership or business process subject matter experts should be actively involved in the mapping exercise and the mapping should be reviewed/updated if significant changes to the business process are released. There are three possible interaction values that can be assigned for each key business metric (k) and business process (p) pairing ($PK_{k,p}$). They are as follows:

- 0, meaning there is no perceived interaction or relationship between the key business metric and the business process, or
- 3, meaning the business process may have an indirect effect on the key business metric, or
- 5, meaning the business process may have a direct effect on the key business metric.

	Business Process (p, P=3)	Percentage Impact for Business Process p (PIp)	Categorization of Influence of Business Prcess p on the Key Business Metrics	Key Metric Influence Score for Business Process p (KIp)	Engineering Release Metric	Program Scorecard	ERP System Load Status	First Pass Yield Metric	Rework Metric	Root Cause Analysis Metric	Part Availability Metric	Customer Delivery Metric
Key Business Metric (k, K=9)					k=1	k=2	k=3	k=4	k=5	k=6	k=7	k=8
Average Impact Score for Key Metric k (KA_k)					0.01	1.68	0.01	1.00	0.00	0.00	0.01	0.00
Impact Categorization for Key Metric k					Low	Med	Low	Low	Low	Low	Low	Low
Proposal Preparation Process	p=1	50%	Med	4.0		5		3				
Proposal Submittal Process	p=2	50%	Med	4.0		5		3				
Process for ordering Long Lead Material	p=3	1%	Low	0.1	3	3	3				3	

Pairing Value between Key Business Metric k and Business Process p ($PK_{k,p}$)

Figure 9: Example of the Key Business Metric versus Business Process (Metric/BP) Matrix

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual key metric impact element score (K_E)*** and the ***normalized key metric impact element score (K_N)*** used in the project leaders assessment tool are as follows:

LIST OF VARIABLES

PI_p = Percentage impact for business process p

KI_p = Key metric influence score for business process p

$PK_{k,p}$ = Pairing value between key metric k and business process p

$II_{k,p}$ = Impact indicator between key metric k and business process p

KA_k = Average impact score for key metric k

Where k = key metric = 1,...,K

Given K = total number of key metrics

p = business process = 1,...,P

Given P = total number of business processes

K_E = Individual Key Metric Impact Element Score

K_N = Normalized Key Metric Impact Element Score

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = 5

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE AVERAGE IMPACT SCORE FOR KEY METRIC

$$PK_{k,p} = \begin{cases} 0 \text{ } if \text{ } no \text{ } perceived \text{ } interaction \text{ } between \text{ } key \text{ } metric \text{ } k \text{ } and \text{ } business \text{ } process \text{ } p \\ 3 \text{ } if \text{ } business \text{ } process \text{ } p \text{ } may \text{ } have \text{ } an \text{ } indirect \text{ } effect \text{ } on \text{ } key \text{ } metric \text{ } k \\ 5 \text{ } if \text{ } business \text{ } process \text{ } p \text{ } may \text{ } have \text{ } a \text{ } direct \text{ } effect \text{ } on \text{ } key \text{ } metric \text{ } k \end{cases}$$

Equation 28: Calculation for Metric/BP Matrix Pairing Value ($PK_{k,p}$)

$$II_{k,p} = \begin{cases} 1 \text{ } if \text{ } PK_{k,p} > 0 \\ 0 \text{ } if \text{ } PK_{k,p} = 0 \end{cases}$$

Equation 29: Binary Calculation for Impact Indicator ($II_{k,p}$) between Key Metric k and Business Process p

$$KI_p = PI_p \times \sum_{k=1}^{K} PK_{k,p} \quad \forall \text{ } p = 1,\ldots,P$$

Equation 30: Key Metric Influence Score for Business Process p (KI_p) Equation

$$KA_k = \frac{PI_p \times KI_p}{\sum_{p=1}^{P} II_{k,p}} \quad \forall \text{ } k = 1,\ldots,K$$

Equation 31: Average Impact Score for Key Metric k (KA_k) Equation

CALCULATE INDIVIDUAL KEY METRIC IMPACT ELEMENT SCORE

$$K_E = \frac{\sum_{k=1}^{K} KA_k}{K}$$

Equation 32: Individual Key Metric Impact Element (K_E) Score Equation

CALCULATE NORMALIZED KEY METRIC IMPACT ELEMENT SCORE

K_E can range between zero (0) and five (5), based on the possible pairing values between the key metrics and the business processes. Using this information and adapting Equation 1, the normalized key metric impact element score can be calculated as follows:

$$K_N = M_U - \frac{(M_U - M_L)(M_U - K_E)}{(5-0)} = M_U - \frac{(M_U - M_L)(M_U - K_E)}{5}$$

Equation 33: Normalized Key Metric Impact Element (K_N) Score Equation

5.3.4 Ease of Implementation Elements

In this sub-section five different elements that contribute to the ***Ease of Implementation*** dimension (represented on the y-axis) will be presented. They are project duration, resource requirements, change management, business process complexity and formal project management approval process impacts.

5.3.4.1 Project Duration

The ***project duration*** element is designed to help the workshop participants or the project leader to understand the anticipated project timeline from go-forward approval through project closure. There are two different versions of the project duration element worksheet—one for each design tool.

5.3.4.1.1 Workshop Evaluation Tool Worksheet

The workshop evaluation tool version for the project duration element examines the project timeline on a high-level basis. Three duration categories are offered to the workshop participants. The participants then select the most appropriate category (D_S), which is assigned a normalized project duration score (WD_N) based on the project evaluation matrix range selected for the workshop evaluation tool. Table 5 provides an example of the duration categories and the normalized score calculation we utilized for the prototype at Raytheon. For the prototype we utilized a scaling factor (SF) of 33% to anchor the 'medium' qualitative category. This scaling factor can be adjusted to best fit the needs of the user. An example of the completed worksheet is provided in Appendix L.

Table 5: Calculating the Normalized Project Duration Element (WD_N) Score for the Workshop Evaluation Tool Version

Qualitative Category (D_s)	Duration Range (Customized to Workshop)	Calculation Range	Normalized Score (WD_N)
Low	3 months or less	= Matrix Lower Bound = M_L	1
Medium	Between 3 and 6 months	= ⅓ Matrix Upper Bound = ⅓ M_U	3
High	Over 6 months	= Matrix Upper Bound = M_U	9

A summary of the variables and a detailed review of the equations used to calculate the ***normalized project duration element score (WD_N)*** used in the Workshop Evaluation Tool are as follows:

LIST OF VARIABLES

D_S = Indicator if project duration qualitative category s is selected

Where s = project duration qualitative category s = 1, 2, 3 (representing low, medium and high respectively)

SF = 'Medium' Qualitative Scaling Factor Scaling Factor = 0.33

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE NORMALIZED PROJECT DURATION ELEMENT SCORE

$$D_S = \begin{cases} 0 \text{ if the project duration qualitative category } s \text{ IS NOT selected} \\ 1 \text{ if the project duration qualitative category } s \text{ IS selected} \end{cases}$$

Equation 34: Binary Calculation for Project Duration Qualitative Category Indicator (D_s)

$$WD_N = Max\begin{pmatrix} D_1 \times M_L \\ D_2 \times M_U \times SF \\ D_3 \times M_U \end{pmatrix}$$

Equation 35: Normalized Project Duration Element Score (WD_N) Equation

5.3.4.1.2 Project Leader Assessment Tool Worksheet

The project duration element worksheet for the project leader assessment tool examines the project timeline at a lower level of detail. The level of detail utilized in the worksheet is customizable to better align with the existing corporate culture where the DFPI methodology is being utilized. Within Raytheon there is an established proprietary Six Sigma application instituted within the corporate culture, well understood by all stakeholders and frequently utilized to manage improvement projects. Therefore, to ease the socialization of the DFPI assessment tools within Raytheon we selected to use the Raytheon Six Sigma phases to set the detail level for the project timeline. Due to the confidentiality constraints this thesis will use the standard Six Sigma phases (***D**efine, **M**easure, **A**nalyze, **I**mprove and **C**ontrol—or DMAIC*) in the prototype worksheet example (Vining & Kowalski, 2006).

To complete the project duration worksheet the project leader populates the estimated "dedicated" duration (in weeks) for each specific phase of the project and populates an estimated start date for the project. The worksheet acknowledges that the phases, in reality, will be iterative or that some work will overlap multiple phases. The "dedicated" duration estimate provides the data necessary to calculate an estimated overall project duration. An example of a completed project duration worksheet is provided in Appendix M.

Below is a short description of the Six Sigma phases used in the prototype worksheet.

Define Phase

During the define phase the project is characterized. At a minimum the project leader and sponsor are involved. The problem or situation the project should address is described, the project team is chartered, the project goals are defined and the project evidence of success (or deliverables) is documented. (US Army, 2009)

Measure Phase

During the measure phase data is collected and used to establish a current state baseline. The goal of the phase is to identify the source of the problem using facts and data—or to narrow down the potential sources of the problem to identify areas of investigation.(US Army, 2009)

Analyze Phase

During the analyze phase investigations are carried out to *"develop theories of root causes, confirm the theories with data, and finally identify the root cause(s) of the problem."* The identified root cause provides a *"basis for solutions"* to be used in the Improve phase. (US Army, 2009)

Improve Phase

During the improve phase solutions are developed. The solutions should be demonstrative, via fact and data, that they do resolve the sources of the problems. (US Army, 2009)

Control Phase

During the control phase the solutions are piloted and/or implemented. The goal of the control phase to is to insure the problem won't reoccur following implementation and to identify any potential unexpected side effects. (US Army, 2009)

The project leaders assessment tool does not include a normalized project duration element score as one of the element scores contributing to the overall Ease of Implementation project score. Instead, it is one of the factors utilized to calculate the normalized resource requirement element score. See Chapter 5.3.4.2.2 for additional information.

5.3.4.2 Resource Requirements

The ***resource requirements*** element is designed to help the workshop participants and project leader understand the anticipated labor resources required to support the project through all phases of planning and implementation. Like the project duration there are two different versions of the resource worksheet for use with each of the two DFPI design tools.

5.3.4.2.1 Workshop Evaluation Tool Worksheet

The workshop evaluation tool version of the resource requirements worksheet evaluates labor requirements on a high-level basis. It provides the workshop participants with a checklist of organizations. Participants are asked to check those organizations that will have responsibility and/or accountability for some activity during project planning or implementation. The workshop leaders are responsible for customizing the resource checklist based on the workshop goals and objectives. The electronic prototype is currently formatted to include up to twelve (12) different organizations. An example of a completed resource requirements worksheet is provided in Appendix L.

The number of organizations selected in the resource requirements worksheet is used to calculate the ***normalized resources requirements element score (L_N)***. A summary list of relevant variables and a detailed review of the equations associated with calculating the normalized resource requirements element score are as follows:

LIST OF VARIABLES

L_s = Indicator if organization or labor skill s has been selected on the resource requirement checklist

Where s = organization or labor skill = 1,…,S

Given S = total number of organizations or labor skills included in checklist

WL_E = Individual Resource Requirements Element Score, Workshop Evaluation Tool Version

WL_N = Normalized Resource Requirements Element Score, Workshop Evaluation Tool Version

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = S

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE INDIVIDUAL RESOURCE REQUIREMENTS SCORE

$$L_s = \begin{cases} 1 \text{ if selected in the resource requirement checklist} \\ 0 \text{ if not selected in the resource requirment checklist} \end{cases}$$

Equation 36: Binary Calculation for Resource Selection Indicator (L_s)

$$WL_E = \sum_{s=1}^{S} L_s$$

Equation 37: Individual Resource Requirement Element (WL_E) Score Equation, Workshop Evaluation Tool Version

CALCULATE NORMALIZED RESOURCE REQUIREMENTS SCORE

WL_E can range between zero (0) and S where S is the total number of organizations or labor skills workshop leaders included in the resource checklist. Using this information and adapting Equation 1, the normalized resource requirements element score in the workshop evaluation tool version can be calculated as follows:

$$WL_N = M_U - \frac{(M_U - M_L)(M_U - WL_E)}{(S-0)} = M_U - \frac{(M_U - M_L)(M_U - WL_E)}{S}$$

Equation 38: Normalized Resource Requirements Element (WL_N) Score Equation, Workshop Evaluation Tool Version

5.3.4.2.2 Project Leaders Assessment Tool Worksheet

The resource requirements worksheet for the project leaders assessment tool examines the labor resources requirements at the Six Sigma implementation phase level as described in Chapter 5.3.4.1.2. When completing the worksheet the project leader selects an organization or labor skill from a drop down box. The leader then records the number of people from that organization or labor skill as well as the required level of effort per phase. An example of a completed worksheet is provided in Appendix N.

The data collected from both the project duration worksheet and the resource requirements worksheet is used to generate an output report for the project leader. The data is also used to calculate the total estimated labor hours required to complete the project. This estimate is the individual resource requirement element (LL_E) score. The upper bound (E_U) for the individual score range of LL_E is infinity. Therefore, to simplify our calculation we assume a large number to use as a substitute. For the prototype we assume 15,000 hours. A prototype of the resource requirement output report is provided in Appendix O.

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual resource requirements element (LL_E)*** score and the ***normalized resource requirement element (LL_N)*** score are as follows:

LIST OF VARIABLES

L_n = Number of people required for support from organization n

l_d = Number of weeks estimated duration for implementation phase d

$LE_{n,d}$ = Level of effort (%) for organization n during implementation phase d

Where n = organization or labor skill = 1,...,N

Given N = total number of organizations or labor skills

d = implementation phase = 1,...,D

Given D = total number of implementation phases

LL_E = Individual Resource Requirements Element Score, Project Leaders Assessment Tool Version

LL_N = Normalized Resource Requirements Element Score, Project Leaders Assessment Tool Version

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = ∞ (we assumed a large number, 15000)

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE INDIVIDUAL RESOURCE REQUIREMENTS ELEMENT SCORE

$$LL_E = \sum_{n=1}^{N}\sum_{d=1}^{D}\left(LE_{n,d} \times L_n \times I_d \times 40\, hrs\ per\ week\right)$$

Equation 39: Individual Resource Requirement Element (LL_E) Score Equation for use in the Project Leaders Assessment Tool

CALCULATE NORMALIZED RESOURCE REQUIREMENTS SCORE

As noted earlier LL_E can range between zero (0) and ∞. Therefore, we assume a large number (15,000) in the place of ∞. Using this information and adapting Equation 1, the normalized resource requirements element score in the project leaders assessment tool version can be calculated as follows:

$$LL_N = M_U - \frac{(M_U - M_L)(M_U - LL_E)}{(15{,}000 - 0)} = M_U - \frac{(M_U - M_L)(M_U - LL_E)}{15{,}000}$$

Equation 40: Normalized Resource Requirements Element (LL_N) Score Equation for use in the Project Leaders Assessment Tool

5.3.4.3 Change Management

The ***change management*** element is designed to help the workshop participants and project leader to understand the potential magnitude of effort required to implement and sustain the behavioral changes associated with the process changes. There are two different versions of the resource worksheet for use with each of the two DFPI design tool versions. As referenced in Chapter 5.2, our prototype DFPI design tools integrate Kotter's change model as described in *Leading Change* (Kotter, Leading change, 1996).

5.3.4.2.1 Workshop Evaluation Tool Worksheet

The workshop evaluation tool version evaluates the project's change management challenge on a high-level basis. Three change management situational descriptions are presented to the workshop participants.

Change Management Situational Description #1

It may be difficult to communicate a clear rationale for why the change is needed. It may be difficult to win over sponsors who are credible and willing to support the change. Level of resistance will be high. It will be difficult to communicate or socialize. Involves and benefits a limited number of stakeholders.

Change Management Situational Description #2

There is clear rationale for why the change is needed, but it may be difficult for stakeholders to agree on a common direction (path to get there) or to see it as possible. Credible sponsors are available, but may not yet be willing to commit to supporting the change. Level of resistance will be moderate. Some level of commitment amongst users already exists.

Change Management Situation Description #3

There is a clear rationale for the change. There is a common vision and strategy for implementation that stakeholders view as possible. Credible sponsors are identified and committed to support the change. Level of resistance is low. It will be relatively easy to communicate the needed level of commitment to all users. Involves & benefits many stakeholders.

Each situational description is assigned a normalized change management element score (WC_N) based on the project evaluation matrix range selected for the workshop evaluation tool (see Table 6 for an example of the normalized score assignment). The participants are asked to select the qualitative description (C_s) that best describes the potential project's current implementation environment, thereby determining the normalized change management element score. For the prototype we utilized a scaling factor (SF) of 33% to anchor the 'medium' qualitative category (socialization conern). This scaling factor can be adjusted to best fit the needs of the user. An example of the completed worksheet is provided in Appendix L.

Table 6: Calculating the Normalized Change Management Element (WC_N) Score for the Workshop Evaluation Tool Version

Qualitative Category	Change Management Situational Description	Calculation Range	Normalized Score (WC_N)
Highly Challenging	Statement #1	= Matrix Upper Bound = M_U	1
Moderately Challenging	Statement #2	= ⅓ Matrix Upper Bound = ⅓ M_U	3
Least Challenging	Statement #3	= Matrix Lower Bound = M_L	9

A summary of the variables and a detailed review of the equations used to calculate the ***normalized change management element score (WC_N)*** used in the Workshop Evaluation Tool are as follows:

LIST OF VARIABLES

C_s = Indicator if change management qualitative category s is selected

Where s = change management qualitative category s = 1, 2, 3 (representing low, medium and high respectively)

SF = 'Medium' Qualitative Scaling Factor Scaling Factor = 0.33

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE NORMALIZED CHANGE MANAGEMENT ELEMENT SCORE

$$C_S = \begin{cases} 0 \text{ } if \text{ } the \text{ } change \text{ } management \text{ } qualitative \text{ } category \text{ } s \text{ } IS \text{ } NOT \text{ } selected \\ 1 \text{ } if \text{ } the \text{ } change \text{ } management \text{ } qualitative \text{ } category \text{ } s \text{ } IS \text{ } selected \end{cases}$$

Equation 41: Binary Calculation for Change Management Qualitative Category Selection Indicator (C_s)

$$WC_N = Max \begin{pmatrix} C_1 \times M_L \\ C_2 \times M_U \times SF \\ C_3 \times M_U \end{pmatrix}$$

Equation 42: Normalized Change Management Element Score (WC_N) Equation

5.3.4.2.2 Project Leaders Assessment Tool Worksheet

The change management element worksheet for the project leaders assessment tool guides the project leader in completing a gap assessment analysis for each change management stage. The assessment output is used to generate a report for the project leader and to calculate the normalized change management element score.

To complete the worksheet the project leader is asked two questions for each change management stage. The two questions are as follow:

1. What level of acceptance do you think is needed for the project to be implemented and for the behavioral changes to be sustained long-term?
2. If you were to implement the project today what current level of acceptance do you think would exist?

The first question establishes the predicted level of acceptance (CP_m) for each stage (m). The second question establishes the current level of acceptance (CC_m) for each stage (m). The answers are a number ranking the level of acceptance required by the targeted change recipients in relation to the change management stage. The rankings are against a scale of one (1) to five (5). One represents the lowest level of acceptance and five represents the highest level of success. For example consider Kotter's stage one – *Establish a Sense of Urgency* (Kotter, Leading change, 1996). A "one" represents an implementation environment where the change recipients do not acknowledge that a problem exits; whereas a "five" represents an implementation environment where the change recipients are asking for immediate assistance for resolution of a 'showstopper' situation. An example of a completed worksheet is provided in Appendix P.

The predicted and current level of acceptance values are utilized for three deliverables. First, they are used to calculate a gap score. The gap score enables us to identify *'delaying'* and *'obstructing'* change management stages. A 'delaying' stage is an area of caution for the project leaders; an area where the project leaders may need to focus some extra attention in order to avoid letting change resistance to grow. An 'obstructing' stage is an area of where the project leader may need to take immediate action to counter change resistance that may already exist. Both the 'delaying' and 'obstructing' change management stages are published in the change management report. A prototype of the change management report is provided in Appendix Q.

Second, the levels of acceptance values, in conjunction with a change management tool versus stage matrix, are used to calculate influence scores (CI_x) for each change management tool. The change management tool versus stage matrix (here forth referred to as the CM tool/ CM stage matrix) documents the relationship between each change management tool and stage. If the tool (x) provides a mechanism for supporting successful execution of the change management stage (m) then a pairing value of one is assigned ($PC_{x,m}=1$). If there is no perceived relationship—tool (x) does not support execution of the change management stage (m)—then a pairing value of zero is assigned ($PC_{x,m}=0$). The resulting influence scores are sorted from highest to lowest and assigned a ranking. The rankings are used to publish three progressive tool subsets to the program manager (a strongly recommended subset, highly recommended subset, and recommend subset) via the change management report (see Appendix Q). Based on project timeline constraints the program manager can utilize the three subsets to prioritize and focus their change management related activities.

Finally, the levels of acceptance are used to calculate the individual normalized change management element scores, contributing to the overall ease of implementation dimension score.

A summary list of relevant variables and a detailed review of the equations associated with calculating the change management gap scores (CG_m), the tool recommendations, the ***individual change management element (LC_E)*** score and the ***normalized change management element (LC_N)*** score are as follows:

LIST OF VARIABLES

CP_m = Predicted level of acceptance needed for change management stage m
CC_m = Current level of acceptance for change management stage m
CG_m = Gap score between predicted and current level of acceptance for change management stage m
CD_m = Indicator for which level (predicted or current) is dominate for change management stage m
CS_m = Assessment gap score for change management stage m
$PC_{x,m}$= Pairing value between change management tool x and change management stage m
CI_x = Influence score for change management tool x
CM_x = Maximum potential influence for change management tool x
CR_x = Rank of change management tool x (based on a highest to lowest sort of CI_x)

Where m = change management stage = 1,...,M
Given M = total number of change management stages
x = change management tool = 1,...,X
Given X = total number of change management tools

LC_E = Individual Change Management Element Score, Project Leaders Assessment Tool Version

LC_N = Normalized Change Management Element Score, Project Leaders Assessment Tool Version

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = 5

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE ASSESSMENT GAP SCORE

$$CG_m = CC_m - CP_m$$

Equation 43: Gap score (CG_m) Equation

$$CD_m = \begin{cases} CC_m \text{ if } CC_m > CP_m \\ CP_m \text{ if } CC_m < CP_m \end{cases}$$

Equation 44: Calculating indicator for which level is dominate (CD_m)

$$CS_m = \left| CD_m \times CG_m \right|$$

Equation 45: Assessment gap score (CS_m) Equation

CALCULATE CHANGE MANAGEMENT TOOL RECOMMENDATION

$$PC_{x,m} = \begin{cases} 1 \text{ if the change management tool } x \text{ enables or supports change management stage } m \\ 0 \text{ if there is no perceived relationship between change management tool } x \text{ and stage } m \end{cases}$$

Equation 46: Pairing value for the change management tool versus stage (CM Tool / CM Stage) matrix ($PC_{x,m}$)

$$CM_x = \sum_{m=1}^{M} PC_{x,m} \quad \forall\ x = 1,\ldots,X$$

Equation 47: Maximum potential influence (CM_x) Equation

$$CI_x = CM_x \times \sum_{m=1}^{M} \left(PC_{x,m} \times CS_m \right) \quad \forall\ x = 1,\ldots,X$$

Equation 48: Influence Score (CI_x) Equation

$$\text{Tool Recommendation} = \begin{cases} \text{Strongly Recommended if } \frac{CR_x}{X} \le 0.1 \\ \text{Highly Recommended if } 0.25 \le \frac{CR_x}{X} < 0.1 \\ \text{Recommended if } 0.55 \le \frac{CR_x}{X} < 0.25 \end{cases}$$

Equation 49: Calculating change management tool recommendation category

CALCULATE INDIVIDUAL CHANGE MANAGEMENT ELEMENT SCORE

$$LC_E = \frac{\sum_{m=1}^{M} CG_m}{M}$$

Equation 50: Individual change management element (LC_E) score equation

CALCULATE NORMALIZED CHANGE MANAGEMENT ELEMENT SCORE

The individual change management element score (LC_E) can range between zero (0) and five (5) based on the scale participants' are utilizing to rank the current and predicted level of acceptance for each change management stage. Using this information and adapting Equation 1, the normalized change management element score in the project leaders assessment tool version can be calculated as follows:

$$LC_N = M_U - \frac{(M_U - M_L)(M_U - LC_E)}{(5-0)} = M_U - \frac{(M_U - M_L)(M_U - LC_E)}{5}$$

Equation 51: Normalized change management element (LC_N) score equation

5.3.4.4 Business Process Complexity

The ***business process complexity*** element is designed to help project leaders understand the overall complexity of the business processes that will potentially be impacted by the project. This element is only utilized in the project leaders assessment tool. The guiding assumption behind the element is that the more complex the impacted business process the more complexities the project team will need to consider during project planning and implementation.

We define four factors (f) that contribute to business process complexity. They are as follows:

External Flow Interruptions

This refers to the number of instances the process is intentionally interrupted by another processes. The interruption could be a point where the process cannot proceed until output is delivered from another process or it could be a point where the process is providing output into another process.

Loop Backs

This refers to the number of instances the process intentionally requires the users to repeat actions already performed earlier in the process.

Major Organizational Handoffs

This refers to the number of instances within the process where the organization responsible and accountable for completing the identified actions changes to separate organization (E.g., engineering is responsible for steps 1 through 7, quality is responsible for steps 8 through 12 then supply chain is responsible for the remaining steps—resulting in two major organizational handoffs to complete the business process).

Number of Steps

This literally refers to the number of steps required to complete the business process under the assumption, for example, that a business process with 40 steps is more complex than a business process with five steps.

Each business process is analyzed based on the four factors and assigned a complexity rating between one (1) to three (3). The complexity scale can be adjusted to best fit the organization. For our prototype project leaders assessment tool we utilized the complexity ranking scale provided in Table 7. This ranking scale was established in coordination with one of the ERP related business process experts at Raytheon.

Table 7: Business Complexity Ranking Scale

Complexity Qualitative Rank	Complexity Quantitative Rank	External Flow Changes	Loop Backs	Major Organizational Handoffs	Number of Steps
Simple	1	0-2	0-2	0-2	0-20
Moderate	2	3-5	3-6	3-4	21-40
Complex	3	6 or more	7 or more	5 or more	41 or more

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual business complexity element (X_E)*** score and the ***normalized business complexity element (X_N)*** score are as follows:

LIST OF VARIABLES

MI_p = Magnitude of impact for business process p

$PX_{p,f}$ = Business complexity rating for business process p in relation to complexity factor f

Note: Assigned based on the complexity rating scale depicted in Table 7

XA_p = Average complexity score for business process p

XI_p = Indicator if business process p has the potential for impact by the project

Where f = business complexity factor = 1,…,F

Given F = total number of business complexity factors

p = business process = 1,…,P

Given P = total number of business processes

X_E = Individual Business Complexity Element Score, Project Leaders Assessment Tool Version

X_N = Normalized Business Complexity Element Score, Project Leaders Assessment Tool Version

E_L = Lower bound of individual element scoring range = 1

E_U = Upper bound of individual element scoring range = 3

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE INDIVIDUAL BUSINESS COMPLEXITY ELEMENT

$$XA_p = \frac{\sum_{f=1}^{F} PX_{p,f}}{F} \quad \forall\ p = 1,\ldots,P$$

Equation 52: Average complexity score (XA_p) Equation

$$XI_p = \begin{cases} 1\ if\ MI_p > 0 \\ 0\ if\ MI_p = 0 \end{cases} \quad \forall\ p = 1,\ldots,P$$

Equation 53: Calculating indicator (XI_p) if business process p may be impact by the project

$$X_E = \frac{\sum_{p=1}^{P} \left(XA_p \times XI_p \right)}{\sum_{p=1}^{P} XI_p}$$

Equation 54: Individual business complexity element (X_E) score equation

CALCULATE NORMALIZED BUSINESS COMPLEXITY ELEMENT SCORE

The individual business complexity element score (X_E) can range between one (1) and three (3) based on the complexity rating scale. Using this information and adapting Equation 1, the normalized business complexity element score in the project leaders assessment tool version can be calculated as follows:

$$X_N = M_U - \frac{(M_U - M_L)(M_U - X_E)}{(3-1)} = M_U - \frac{(M_U - M_L)(M_U - X_E)}{2}$$

Equation 55: Normalized business complexity element (X_N) score equation

5.3.4.5 Formal Project Management Approval Process Impacts

The ***formal project management approval process impacts*** element (here forth referred to as the PM process element) is designed to help the project leaders understand the overall impact the project may have on ongoing programs being managed via an established project management approval process. This element is highly dependent on the corporate structure the DFPI methodology is being deployed at and is only utilized in the project leaders assessment design tool.

Raytheon utilizes an established multi-stage project management structure (referred to as a gate process) to manage all activities, including all production programs and projects. Therefore, if a project is altering the processes that contribute to meeting the deliverables to complete a stage then all of the in-work activities currently at that stage may be impacted. The evaluation related to the PM process element is designed to identify which stage may have a low, moderate or high potential for impact. The project leader can then take any necessary actions to mitigate potential impacts to in-work activities.

In order to complete the PM process element evaluation each business process is mapped to each PM stage, similar to the mapping completed in the Metrics/BP matrix described in Chapter 5.3.3.5. Each interaction between PM stage (y) and business process (p) is represented by one of three possible pairing values ($PS_{y,p}$). They are as follows:

- 0, meaning there is no perceived interaction or relationship between the PM stage y and the business process p
- 3, meaning the business process p may have an indirect effect on meeting the deliverables required to complete PM stage y
- 5, meaning the business process may have a direct effect on meeting the deliverables required to complete PM stage y

The matrix resulting from the PM stage and business process matrix will here forth be referred to as the PM Stage/BP matrix. The prototype report for the PM process element contains Raytheon confidential information and is therefore not provided in this thesis. A generalized example of a PM Stage/BP matrix is provided in Figure 10.

	Business Process (p, P=3)	Percentage Impact for Business Process p (PI p)	Categorization of Influence of Business Prcess p on the PM Stage	PM Stage Influence Score for Business Process p (SI p)	PM Stage #1	PM Stage #2	PM Stage #3	PM Stage #4	PM Stage #5	PM Stage #6	PM Stage #7	PM Stage #8
PM Stage (y, Y=8)					y=1	y=2	y=3	y=4	y=5	y=6	y=7	y=8
Average Impact Score for PM Stage y (SA_y)					1.00	2.67	1.00	2.67	1.67	2.50	1.00	0.00
Impact Categorization for PM Stage y					Low	Med	Low	Med	Med	Med	Low	Low
Proposal Preparation Process	p=1	50%	Med	6.5		5		3		5		
Proposal Submittal Process	p=2	50%	Med	4.0		5		3				
Process for ordering Long Lead Material	p=3	100%	High	27.0	3	3	3	5	5	5	3	

Pairing Value between PM stage y and Business Process p ($PS_{y,p}$)

Figure 10: Example of a generic PM stage/BP matrix

A summary list of relevant variables and a detailed review of the equations associated with calculating the ***individual PM process element score (Y_E)*** and the ***normalized PM process element score (Y_N)*** used in the project leaders assessment tool are as follows:

LIST OF VARIABLES

PI_p = Percentage impact for business process p

SI_p = PM stage influence score for business process p

$PS_{y,p}$ = Pairing value between PM stage y and business process p

$II_{y,p}$ = Impact indicator between PM stage y and business process p

SA_y = Average impact score for PM stage y

Where y = PM stage = 1,...,Y

Given K = total number of key metrics

p = business process = 1,...,P

Given P = total number of business processes

Y_E = Individual PM Impact Element Score

Y_N = Normalized PM Impact Element Score

E_L = Lower bound of individual element scoring range = 0

E_U = Upper bound of individual element scoring range = 5

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

CALCULATE AVERAGE IMPACT SCORE FOR PM STAGE

$$PS_{y,p} = \begin{cases} 0 \text{ if no perceived interaction between PM stage y and business process p} \\ 3 \text{ if business process p may have an indirect effect on PM stage y} \\ 5 \text{ if business process p may have a direct effect on PM stage y} \end{cases}$$

Equation 56: Pairing value ($PS_{y,p}$) between PM stage y and business process p

$$II_{y,p} = \begin{cases} 1 \text{ if } PS_{y,p} > 0 \\ 0 \text{ if } PS_{y,p} = 0 \end{cases}$$

Equation 57: Calculating impact indicator ($II_{y,p}$) between PM stage y and business process p

$$SI_p = PI_p \times \sum_{y=1}^{Y} PS_{y,p} \quad \forall\ p = 1,\ldots,P$$

Equation 58: PM stage influence score (SI_p) Equation

$$SA_y = \frac{PI_p \times SI_p}{\sum_{p=1}^{P} II_{y,p}} \quad \forall\ y = 1,\ldots,Y$$

Equation 59: Average impact score for PM stage y (SA_y) Equation

Note: Mathematically the pairing value $II_{y,p}$ can be zero, but in application this value is assumed to never be zero. This is based on the assumption that there will always be some perceived interaction between the PM stage, y, and business process, p.

CALCULATE INDIVIDUAL PM PROCESS ELEMENT SCORE

$$Y_E = \frac{\sum_{y=1}^{Y} SA_y}{Y}$$

Equation 60: Individual PM process element score (Y_E) Equation

CALCULATE NORMALIZED PM PROCESS ELEMENT SCORE

Y_E can range between zero (0) and five (5), based on the possible pairing values between the PM stage and the business process. Using this information and adapting Equation 1, the normalized PM process element score can be calculated as follows:

$$Y_N = M_U - \frac{(M_U - M_L)(M_U - Y_E)}{(5-0)} = M_U - \frac{(M_U - M_L)(M_U - Y_E)}{5}$$

Equation 61: Normalized PM process element score (Y_N) equation

5.4 Progressive Utilization of the Design for Project Implementation Methodology

There are four progressive stages of DFPI utilization, as shown in Figure 11. The first two stages incorporate use of the design tools and can be completed on individual projects. The final two stages introduce a "system" view concluding with utilizing the DFPI methodology in an integrated business solution for managing all project related activity throughout the corporation. During our research at Raytheon we implemented the first two progressive stages via pilot applications.

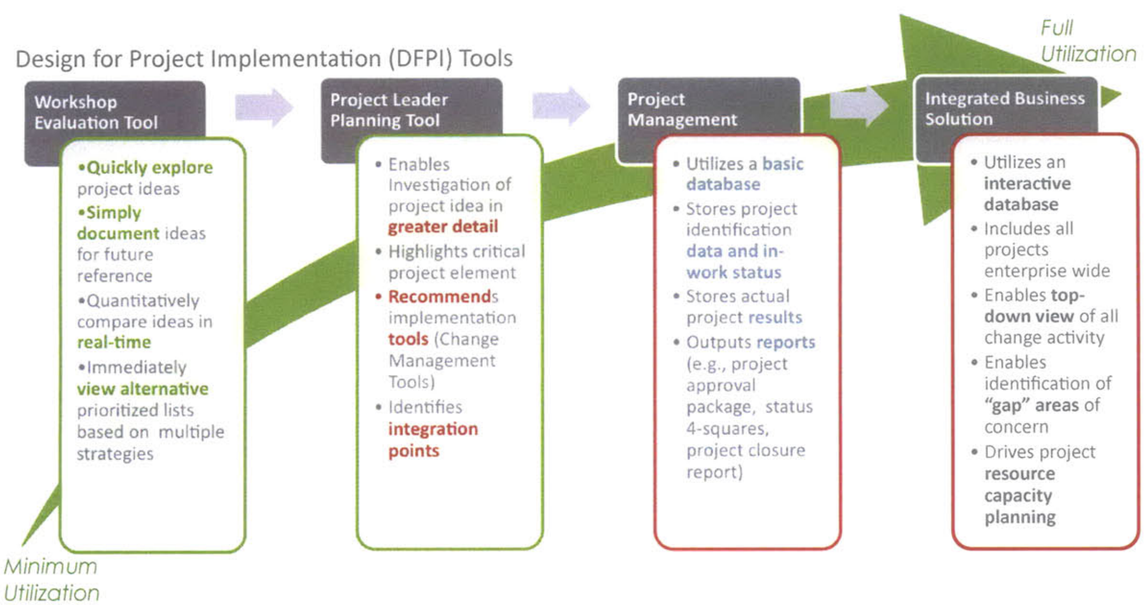


Figure 11: Progressive Stages of DFPI Methodology Utilization

In this section we will explain each stage of DFPI methodology utilization by tracking how the methodology would apply to project(s)

5.4.1 DFPI Methodology - Stage One

Stage one of DFPI methodology utilization is encapsulated in the use of the workshop evaluation tool. In this stage projects are being identified at a high-level via workshop environments. As workshops are conducted different project concepts are brainstormed. Each project is evaluated using the workshop evaluation design tool, resulting in projects consistently evaluated against the same criteria with comparable quantitative evaluation scores. Those scores can be used to identify the high-level projects with the highest 'value proposition' from each workshop. The next progressive step would be to evaluate each of the 'high value' project concepts in greater detail—leading to stage two of the DFPI methodology utilization.

5.4.2 DFPI Methodology - Stage Two

In stage two of DFPI methodology utilization, project leaders utilize the project leaders assessment tool to examine the 'high value' projects in greater detail. This is most likely an iterative process, with the project leader utilizing the feedback reports to either strengthen the project concept or determine that the project concept should not be pursued. If the former is true, then the final version of the project's feedback reports can be used as a project submittal package that can be sent to the appropriate leadership team to grant go/no-go approval to move forward with project implementation. This leads us to the third stage of DFI methodology.

5.4.3 DFPI Methodology - Stage Three

Stage three is an environment where the methodology is utilized for project management on a 'local' scale—meaning at one facility or within one organization. In this stage of utilization all of the evaluations completed using either the workshop evaluation tool or the project leaders assessment tool are input into a basic database. This allows the project data to be accessed from a common source, opening the opportunity for information to be cross-referenced across projects and for project status to be recorded in real time.

Project status, such as *under evaluation, submitted for go forward approval* or *in-work* can be tracked for each project. For any "in-work" project the database can include basic forms where the project leader can record current status and actual costs or results as they occur. The database can then use that data to generate project status reports or project closure reports for each project.

In summary, stage three is characterized by moving all project evaluations to a common data source that can be utilized to manage project activity from project concept inception to project closure. This leads to the final stage as the scope of included projects expands to include the entire enterprise.

5.4.1 DFPI Methodology - Stage Four

The final DFPI methodology utilization stage is an integrated business solution. In this stage the basic database is expanded to incorporate interactive functionality. It is also the common source of all project activity within the corporation. This enables a top-down view of all change activity within the corporations regardless of business unit, organization or facility. Leadership can utilize this 'top-down' perspective to identify gap areas that they may need to deploy project leaders for focused activity. They can also use the integrated view to drive better resource capacity planning because they will have access to current project resource utilization as upcoming requirements.

6.0 Utilizing Design for Project Implementation (DFPI)

During our research at Raytheon we completed two pilot applications of the workshop evaluation design tool and one pilot application of the project leaders assessment design tool. The feedback from all three pilots was favorable, and each is demonstrative of a different perspective. In this chapter we will discuss how DFPI can be utilized from these three different perspectives, supporting each perspective's unique needs. First, using the workshop evaluation design tool pilot for a Raytheon Business Improvement Team (BIT) workshop, we will discuss how DPFI supports cross-organizational coordination. Second, using the project leaders' assessment design tool pilot on an ERP process improvement, we will discuss how DFPI supports individual project leaders. Finally, using the workshop evaluation design tool pilot for a Raytheon Benefits Achievement Team (BAT) workshop, we will discuss how DFPI supports project sponsors.

6.1 Organizational Utilization

Successful process improvement project implementation and sustainment generally requires the coordinated efforts of multiple organizations. The resulting challenge is to coordinate cross-organizational activities consistently, leveraging limited resources to implement effective projects that not only generate process improvements but also proactively address user concerns before they disrupt productivity. The Design for Project Implementation methodology successfully addresses this challenge via the design tools, as was demonstrated during our pilot application in a BIT team workshop.

Raytheon's BIT team includes mid-level executive leaders from multiple organizations within Raytheon SAS, including engineering, operations, quality, IT, communications, human resources, manufacturing and supply chain. The team is tasked with working together to coordinate efforts for large-scale project implementation. They meet regularly to discuss project activities being completed within their own organizations as well as identify activities they need to support cross-organizationally. The purpose of the workshop was to complete a high-level evaluation and prioritization of 25 high-impact projects in preparation for making resource commitments for 2010. The workshop was an ideal environment to pilot the workshop evaluation tool for multiple reasons:

- The workshop logistics had three constraints—a large number of projects (25) needed to be evaluated; a large number of stakeholders needed to participate in the evaluations (over 30); a limited amount of time was available to complete the workshop (8 hours).
- The primary deliverable was to generate quantitative scores for each project that could be used to generate a common prioritized list of projects, but the BIT team reserved the option to consider multiple prioritization strategies.
- The workshop leaders objective was to ensure that each project evaluation was consistent and that the evaluation process avoided enabling stakeholder biases to prejudice the results.

The DFPI workshop evaluation design tool did successfully meet the workshop leader's objective, as well as provided the primary workshop deliverable, within the required time limitations. In addition, the BIT team also received an electronic file for each project documenting the evaluation via completed worksheets (as described in Chapter 5) and a summary file mapping all 25 projects on a project evaluation matrix. Finally, the workshop leaders were provided with a report that presented three different prioritization list based on three alternative strategies.

Alternative Prioritization Strategy #1: Combined Weighted Average

This strategy utilizes all of the normalized element scores and their associated weights to calculate a single weighted average for the project (see Equation 58), resulting in an overall project weighted average (WW). All of the project weighted averages are ranked from highest to lowest to create the final prioritized list.

$$WW = \frac{(R_N \times W_R) + (B_N \times W_B) + (A_N \times W_A) + (WD_N \times W_{WD}) + (WL_N \times W_{WL}) + (WC_N \times W_{CN})}{W_R + W_B + W_A + W_{WD} + W_{WL} + W_{CN}}$$

Equation 62: Overall Project Weighted Average (WW) - Workshop Evaluation Tool

Alternative Prioritization Strategy #2: Long-Term

This strategy ranks the projects with the highest ease of implementation dimensional score and highest impact to the business dimensional score as the highest priority. Visually this would be accomplished by drawing a line with a slope of one on the project evaluation matrix (as seen in Figure 12). As the line is moved diagonally from quadrant II to quadrant III it will intersect with

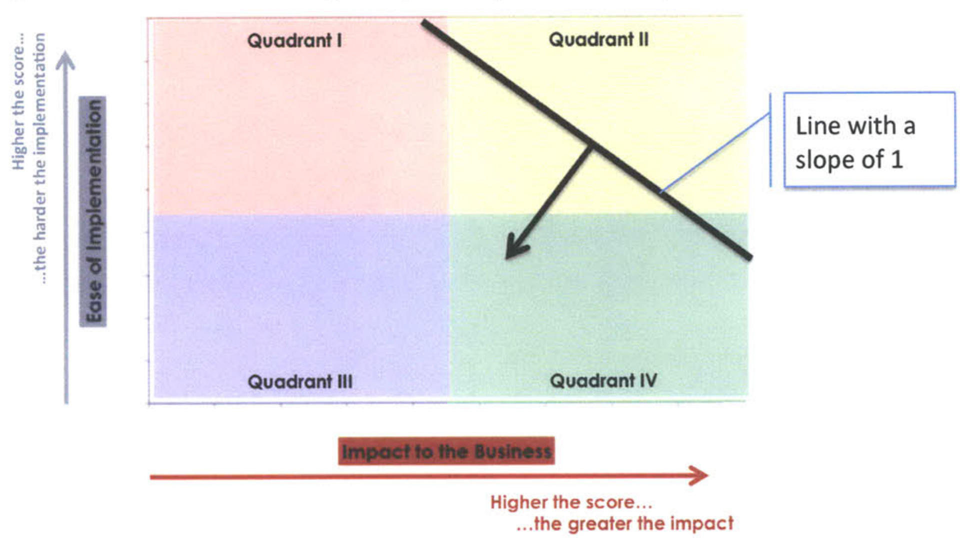


Figure 12: Visual for prioritization strategy #2 (long-term)

the projects scores plotted on the matrix. The projects are ranked in the order of intersection.

The prioritization is accomplished mathematically by ranking the y-intercept of each project in the project evaluation matrix from highest to lowest. The y-intercept is calculated using the equation of a line (y = mx + b) with a slope of one (m = 1), see Equation 59.

$$
\begin{aligned}
&y = mx + b \quad \textit{solve for } b \\
&b = y - mx = WE_D - (1 \times WB_D) = WE_D - WB_D \\
&\textit{where } m = \textit{slope} = 1 \\
&\qquad x = \textit{Impact to Business Dimensional Score} = WB_D \\
&\qquad y = \textit{Ease of Implementation Dimensional Score} = WE_D \\
&\qquad b = y\textit{-intercept}
\end{aligned}
$$

Equation 63: Equation Used to Calculate y-intercept to Prioritize Projects Based on a Long-Term Strategy

Alternative Prioritization Strategy #3: Short-Term

This strategy ranks the projects with the lowest ease of implementation dimensional score and highest impact to the business dimensional score as the highest priority. Visually this would be accomplished by drawing a line with a slope of negative one on the project evaluation matrix (as seen in Figure 13). As the line is moved diagonally from quadrant I to quadrant IV it will intersect with the projects scores plotted on the matrix. The projects are ranked in the order of intersection.

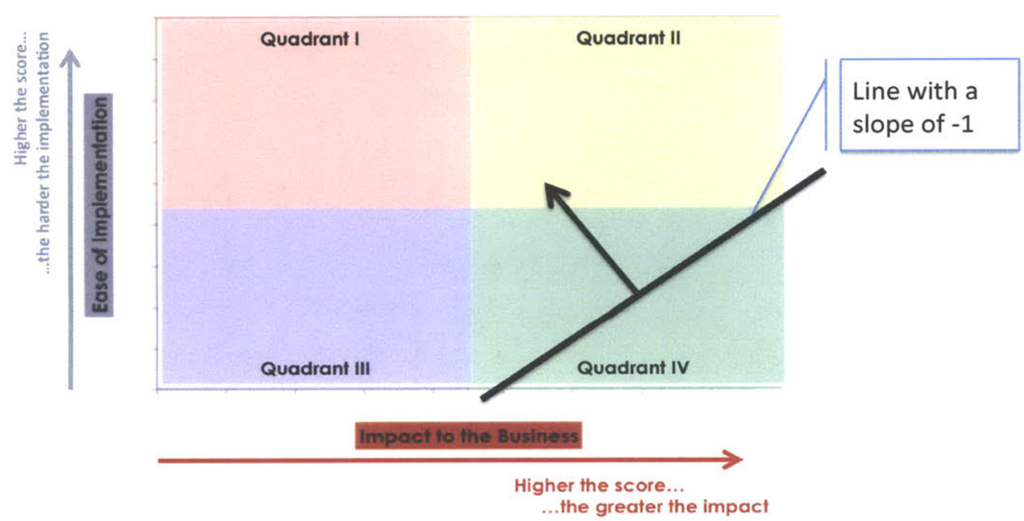


Figure 13: Visual for prioritization strategy #3 (short term)

The prioritization is accomplished mathematically by ranking the y-intercept of each project in the project evaluation matrix from highest to lowest. The y-intercept is calculated using the equation of a line (y = mx + b) with a slope of negative one (m = -1), see Equation 60.

$$y = mx + b \quad \textit{solve for } b$$
$$b = y - mx = WE_D - (-1 \times WB_D) = WE_D + WB_D$$
$$\textit{where } m = \textit{slope} = -1$$
$$x = \textit{Impact to Business Dimensional Score} = WB_D$$
$$y = \textit{Ease of Implementation Dimensional Score} = WE_D$$
$$b = y\text{-}\textit{intercept}$$

Equation 64: Equation Used to Calculate y-intercept to Prioritize Projects Based on a Short-Term Strategy

A survey on the effectiveness of the DFPI workshop evaluation design tool was distributed to the BIT workshop participants immediately following the completion of the workshop. The survey had a response rate of approximately 23%. Each participant was asked to read five statements regarding the tool and rank their level of agreement with the statement on a scale of one (1, very much disagree) to five (5, very much agree). A summary of the responses is provided in Figure 14. The participants were also offered the option to comment on what they liked or disliked about the design tool and to make improvement recommendations.

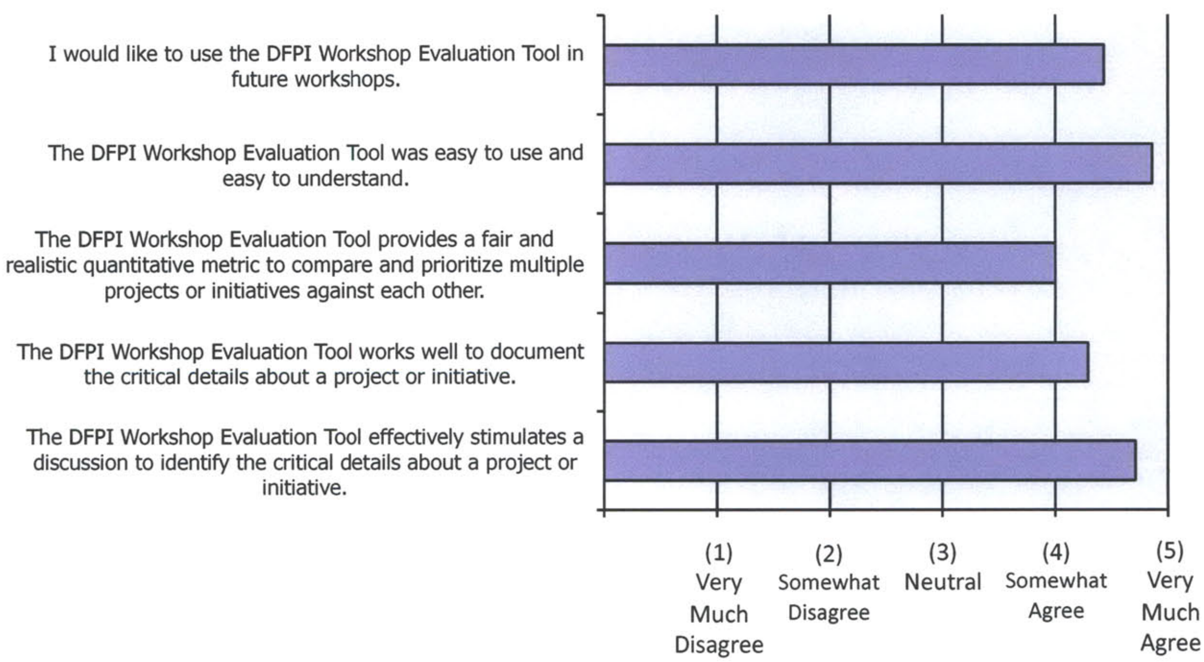


Figure 14: BIT Workshop Participants Feedback Survey Results

In regards to supporting cross-organizational coordination we believe it is significant that all responders agreed that the DFPI design tool effectively stimulated discussion between the stakeholders. Comments from the survey, such as the tool provided a *"structured non-biased assessment approach"* and *"provided a logical method for evaluating multiple projects against one another…"*, reflects how the DFPI design tool is meeting the objective to enable evaluation consistency across multiple projects (BIT Participants, 2009). Based the survey response we can conclude that the DFPI design tool is effectively supporting cross-organizational coordination of activities.

6.2 Project Leader Utilization

The project leader is tasked with identifying and leading project implementations while balancing four competing objectives:

- sustain long-term behavioral changes,
- protect against productivity slumps (in this context we mean returning to the productivity slump experienced immediately following ERP deployment),
- utilize available resources effectively, and
- accelerate return on investment capital.

We put forward that the DFPI project leaders' assessment design tool (introduced in stage two of DFPI methodology utilization) and a basic DFPI database (introduced in stage three of DFPI methodology utilization) are effective mechanisms project leaders can exploit to accomplish their task while balancing the four objectives.

First, integrating a change management model into the design tool helps to enable long-term sustainment of behavioral changes via the project leaders evaluation worksheet and feedback report. The evaluation worksheet forces the project leader to consider each stage of change management and the potential affects to their project. The change management report (see Appendix Q) recommends specific change management tools that the project leader can leverage to address the change management challenges specific to their project.

The project leader can gain additional leverage by using the worksheet and report as a starting point for a consultation with change management experts within their corporation. The expert can discuss with the project leader their rationale behind the identified predicted and current levels of acceptance, enabling the project leaders to validate the projects change management evaluation. The expert can also provide guidance on using any of the change management tools recommended in the feedback report.

Second, by integrating user's areas of concern into the design tool we are enabling the project leader to evaluate proactively how well the project is aligned with current user's concerns. Because the user concerns are weighted based on actual user's assessment (via a survey) the alignment element score can be an indicator on predicting productivity regression. The project leader can also utilize the area of concern weights to identify productivity slump indicators.

For example, the 21 areas of concern we defined specific to Raytheon's post-ERP environment can be grouped into four primary categories: business process related, productivity related, system functionality related and visibility related. If users are highly concerned about the essentials for operating in the ERP environment, as indicated by a majority of the highest weighted areas of concern not being related to business processes, then the project leader can conclude that the probability of experiencing productivity regression is relatively high. By monitoring which categories are consistently weighted as the highest areas of concern the project leader can assess the likelihood of a productivity slump and, if necessary, take action to identify projects to address any indicators.

Third, the resource requirement feedback report (see Appendix O), the business processes and intended users impact report (see Appendix F) and the DFPI basic database provide mechanisms the project leader can utilize to evaluate resource requirements and make better decisions on where to deploy available resources. The impact report identifies those organizations or skills potentially impacted by the project based on the impacted business processes. These users are potential project stakeholders, especially those identified as having a 'high potential of impact'. These stakeholders are most likely the organizations that should be responsible or accountable for actions during some phases of implementation in order for the change to be sustained long-term. Cross-referencing the list of resources identified on the resource requirement feedback report with the potential project stakeholders identified on the impact report the project leader can gauge if the right resources are being utilized for project implementation.

The resource requirement report is also a forcing mechanism for the project leader to use in assessing if there will be enough resources available when needed. For example, if the report identifies the need for 240 labor hours from a four-person organization during a two-week phase of the project that includes Thanksgiving holiday the project leader may have a resource capacity problem. In this situation the report is indicating the need for an average of three of the four-person group to be fully utilized for 40-hrs each of the two-weeks! The information provided on the resource requirement feedback report would prompt the project leader to take actions to address the anticipated resource constraint in advance, supporting a more effective use of available resources.

The DFPI basic database can also be an effective tool for the project leader to leverage in making decisions about resource utilization. The database is a single source of information for project activity, and all of the project evaluations will include the resource requirement element. Therefore, the project leader can use database search features to identify potential resource utilization during their project's timeline. By viewing resource requirements by date of already in-work projects the project leader may be able to make better decisions on for their own project plan, adjusting their timeline to avoid known resource capacity peaks.

Finally, the project leaders' assessment tool supports the project leader in accelerating the return on investment capital (ROIC) by providing a robust mechanism for assessing the 'value proposition' offered by the project they are considering. The feedback reports, as well as the overall mapping of the project evaluation matrix, enables the leader to determine if the project in its current design offers a good balance between opportunity to the business versus cost of implementation. The leader can then choose either to pursue another project opportunity, or use the feedback reports to make changes in the project plan to strengthen the 'value proposition'. By accessing the DFPI project database the project leader may also gain opportunity to strengthen their projects 'value proposition' by identifying other projects that, once implemented, will create additional value-added opportunities. The leader can then coordinate activities with the other project leaders.

During the pilot application of the project leaders' assessment tool the Raytheon Project Co-leaders completed the assessment on a completed project as if it had not been implemented. The resulting report was then reviewed in comparison to the actual project implementation plan and the realized results. The feedback reports were an accurate representation of reality, but we recommend additional applications in the future to test the validity of the assessment criteria (see Chapter 7.2 for additional discussion).

6.3 Project Sponsor Utilization

The project sponsor's primary objective is to maintain a "big picture" perspective—enabling them to deploy project improvement activities strategically to optimize the overall value proposition to the corporation while addressing user concerns. We consider the DFPI methodology to be effective in enabling the project sponsor to meet that objective in two ways—through utilization of the design tools and through utilization of the DFPI database.

The DFPI design tools provide a consistent means of reviewing and comparing potential projects. At the workshop utilization level the ability to view all of the evaluated projects in a summary project evaluation matrix as well as to quickly create and compare alternative priority lists based on the consistent evaluation scores helps project sponsors to focus detailed project investigation at an early stage. This increases the probability that project sponsors will focus project leaders efforts are on more 'high value' activity. The pilot application of the workshop evaluation design tool in the Raytheon Benefits Achievement Team (BAT) workshop was a good demonstration of the "big picture" capability. One of the objectives for the Raytheon BAT team is to implement ERP related projects, helping to realize ROI from the ERP deployment.

The BAT team scheduled a workshop in late October 2009 to initiate the process of identifying and prioritizing projects to be funded in 2010, selecting to utilize the DFPI workshop design tool to facilitate the activity. The workshop was successful. Once the workshop participants had identified a list of potential projects the design tool was used to evaluate the top ten concepts (as identified by a participant subjective vote). After the workshop concluded follow-on plans were made to utilize the workshop design tool to complete the evaluation on the remaining projects and to help finalize the list of 2010 projects. Like with the BIT workshop, we surveyed the workshop participants to solicit their opinion on the effectiveness of the design tool. The BAT survey had approximately a 35% response rate. The results of the survey are provided in Figure 15.

The BAT workshop pilot application was the first deployment of the workshop design tool. In the BAT survey, the average agreement scores were not as high—ranging from 3.89 to 4.44, but overall all scores were favorable. Participants' comments also highlighted the tools effectiveness in stimulating discussions and enabling consistent, unbiased evaluations. For example, one participant commented *"the tool forced a robust, consistent response"* and another participant stated, *"it [the tool] seemed to* *easily and effectively stimulate a discussion to identify the critical details about the project"* (BAT Participants, 2009).

Participants' comments regarding potential improvements to the workshop design tool were taken into consideration during the second deployment. For example, multiple participants commented that the introduction and explanation were *too fast*. Therefore, we made adjustments to the tool introduction and explanation during the BIT workshop. Based on the increased scores (BIT workshop averages ranged from 4.00 to 4.71) we concluded that the adjustments were effective.

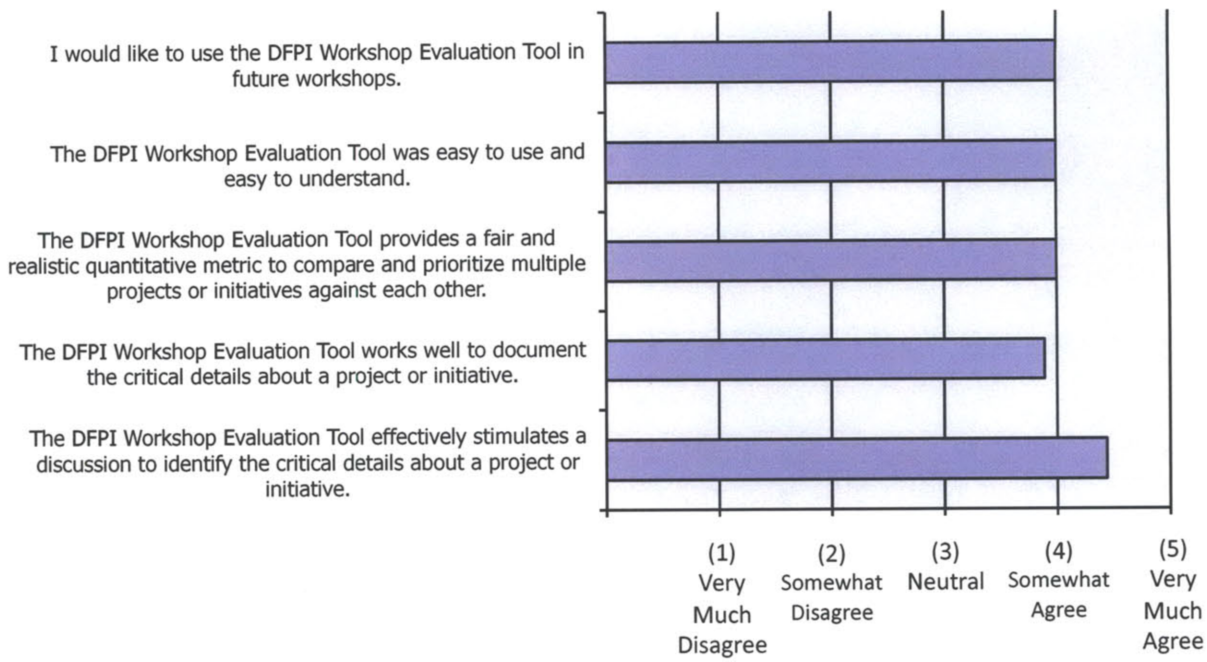


Figure 15: BAT Workshop Participants Feedback Survey Results

The DFPI databases provide a means of taking a top-down view of the change activity. The DFPI "Landscape of Change" report is one mechanism that enables this top-down perspective. A prototype of the report is provided in Appendix C. The report works similar to a map. The visual depicts a high-level mapping of the business processes, showing linkages between the processes. The colored dots identify projects, with the different colors reflecting the project status (investigation, in-work, deferred, cancelled or completed). The dots are located on the business processes they may impact. The resulting map visually shows which business processes are being impacted by change and the maturity level of the change activity. An alternative view of the map could overlay the areas of concern weights on the landscape as well. This view would enable the sponsor to easily see if the project activity is aligned to areas of high user concern. The sponsors could then take action to deploy project activity to any gap areas.

The DFPI database can also be utilized to create summary reports. The reports could be customized to show breakdowns in different groupings, such as by organization, by sponsor or by facility. Some examples would include:

- Summary of resource requirements
- Summary of potential benefits
- Summary of potential risks
- Summary of actual benefits and costs

7.0 Conclusion and Next Steps

In this chapter we will summarize our findings and suggest some go-forward recommendations specific to Raytheon. We will also discuss some potential areas for future study.

7.1 Summary of Findings

Corporations continue to grapple with the dilemma of identifying, developing and managing the implementation of meaningful process improvement projects while simultaneously meeting business goals and customer needs. In this thesis we propose a new methodology that we call *Design for Project Implementation* (DFPI). It combines the strengths of the ***"Design for..."*** **methodologies** that have revolutionized product development and re-engineering in terms of cost and time within the design community with **change management models** that enable long-term sustainment of the behavioral changes that accompany process transformations (Boothroyd & Knight, 1993), (Pennino & Potechin, 1993). The methodology guides the user in evaluating a project on two different dimensions—ease of implementation and impact to the business. The completed evaluation results in quantitative scores that can be utilized to map the project on an evaluation matrix and to generate prioritization lists consistently comparing multiple projects.

We propose a series of guidelines for applying the DFPI methodology (see Chapter 5.1) and suggest a progressive implementation path that scales utilization up through two design tools (described in Chapter 5.2) to a fully integrated business solution.

The first design tool targets application in a workshop environment, referred to as the workshop evaluation design tool. It is a robust tool that forces participants to focus project discussions on elements related to the two dimensions and generates a quantitative evaluation based on documented summaries of the discussion. The workshop evaluation design tool was tested in two pilot applications at Raytheon SAS and NCS. Based on feedback from both pilot applications we conclude that the workshop design tool effectively applies the methodology to stimulate discussion, preventing biases from coloring the evaluation results and encouraging participants to consider ramification of the project from different perspectives.

The second design tool targets application by individual project leaders (or small project teams), referred to as the project leaders' assessment tool. It fosters a more detailed investigation of the project on the same two dimensions as the workshop design tool. We tested the project leaders' assessment tool with one pilot application on an already complement project. The project co-leaders completed the assessment worksheets as if they were at the start of the project, prior to gaining go-forward approval. The project co-leaders reviewed the assessment results, documented on a prototype report. Based on their feedback we conclude that the project leaders' assessment tool successfully enables project leaders to evaluate the value proposition of their project, as well as provides meaningful recommendations the project leaders can utilize to strengthen their value proposition.

The final stage of the progressive DFPI implementation plan concludes with a fully integrated business solution that is managed via an interactive DFPI database. The premise of the full business solution is that all project activity throughout the enterprise is documented via the DFPI design tool evaluations. The database incorporates project management functionality to document on-going status and realized actuals (costs and benefits) for approved projects. The database is ultimately a single source of information for all change activity within the corporation. As such, we believe that the data can be leveraged to enable a top-down perspective of change activity. We believe that this top-down perspective presents a rich opportunity for future study, see Chapter 7.3 for additional discussion.

In summary we feel that the two DFPI design tools demonstrate that a methodology and tools can be developed that facilitate the identification and planning of meaningful projects. We put forward that the two-dimensional evaluation process provides a means of balancing the needs of the business (via the impact to business perspective) and a means to accelerate return on investment (via the ease of implementation perspective). Secondly, the design tools also demonstrate one of our two secondary hypotheses. Namely, that the methodology and tools can be applied in a bottoms-up approach to investigate the value proposition of a project, highlighting critical project elements and making specific recommendations that can be iteratively integrated into the project plan.

Finally, the proposed integrated business solution provides no evidence to reject our remaining secondary hypothesis. That is to say, we have no evidence to reject the hypothesis that the proposed DFPI methodology and tools (design tools in conjunction with an interactive DFPI database) can be applied in a top-down approach.

7.2 Summary of Go-Forward Recommendations

We have two recommendations to suggest specifically in regards to the implementation at Raytheon. First, we advocate that the project leaders' assessment design tool be utilized on multiple projects that have yet to be approved and completed. These additional test applications enable the Raytheon customized version to be validated. The single use on Project X resulted in positive feedback, but additional projects uses are necessary to validate the initial mapping completed for the input matrices (e.g., SA / BP matrix, AC / BP matrix, AC / Goal matrix, Metric / BP matrix and PM Stage / MP matrix). In addition, multiple applications of the assessment tool will generate data points that can help identify the sensitivity ranges for each evaluation element. This information would be useful for understanding which elements have the largest impact on the overall dimension scores.

Finally, we recommend that Raytheon consider developing a basic DFPI database. As more projects are evaluated using the two design tools it becomes more important to have a single source to store the evaluation data. The database would enable better documentation of dependencies between projects and would facilitate better utilization of the evaluation information by project sponsors.

7.3 Future Areas of Study

We suggest three areas for future research in regards to the DFPI methodology and design tools.

First, we advocate that it is possible to develop a linear programming (LP) model utilizing the quantitative evaluation scores. The LP model could be applied to identify a limited number of projects to select that will optimize the overall value proposition while abiding by business constraints. Some constraints that may potentially be incorporated into the model would include:

- resource constraints based on budgetary concerns (e.g., labor hour available per week per organization),
- timeline constraints restricting project activity during specific periods of the business year (e.g., holiday shutdown periods or peak season production periods),
- organizational capacity constraints restricting the level of effort available by organization, or
- location constraints to level load project activity across different corporate sites.

Second, we suggest that their may be a way to link DFPI and DFMA together to create a synergy enabling better transition between new-product development to recurring steady state production. We believe that by thinking of new-product launch as a large "project" that the DFPI methodology can be leveraged to facilitate the transition from development to recurring production. Applying the two-dimensional evaluation techniques (as described in the project leaders' assessment design tool) may assist corporations in developing more effective implementation plans for new product launch and long-term recurring production sustainment.

Finally, we propose that their may be an avenue of research that uses the quantitative evaluation results generated from the DFPI design tools as inputs into multi-criteria selection processes utilizing multi-attribute utility theory (MAUT). Sanayei et. al. (2008) describes MAUT as being *"used to assess the decision-maker's preference structure and model it mathematically with a multiple attributes utility function"* (Sanayei, Mousavi, Abdi, & Mohaghar, 2008). We suggest that instead of using weights assigned by leadership to influence the overall dimension score, the individual element scores can be incorporated into a 'preference structure' and MAUT can be utilized to identify the "best" projects of those being evaluated.

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Appendix

Appendix A Data Relationship Maps

NOTE: For a larger scale version of Figures 16 and 17 refer to pages 111 and 112 respectively.

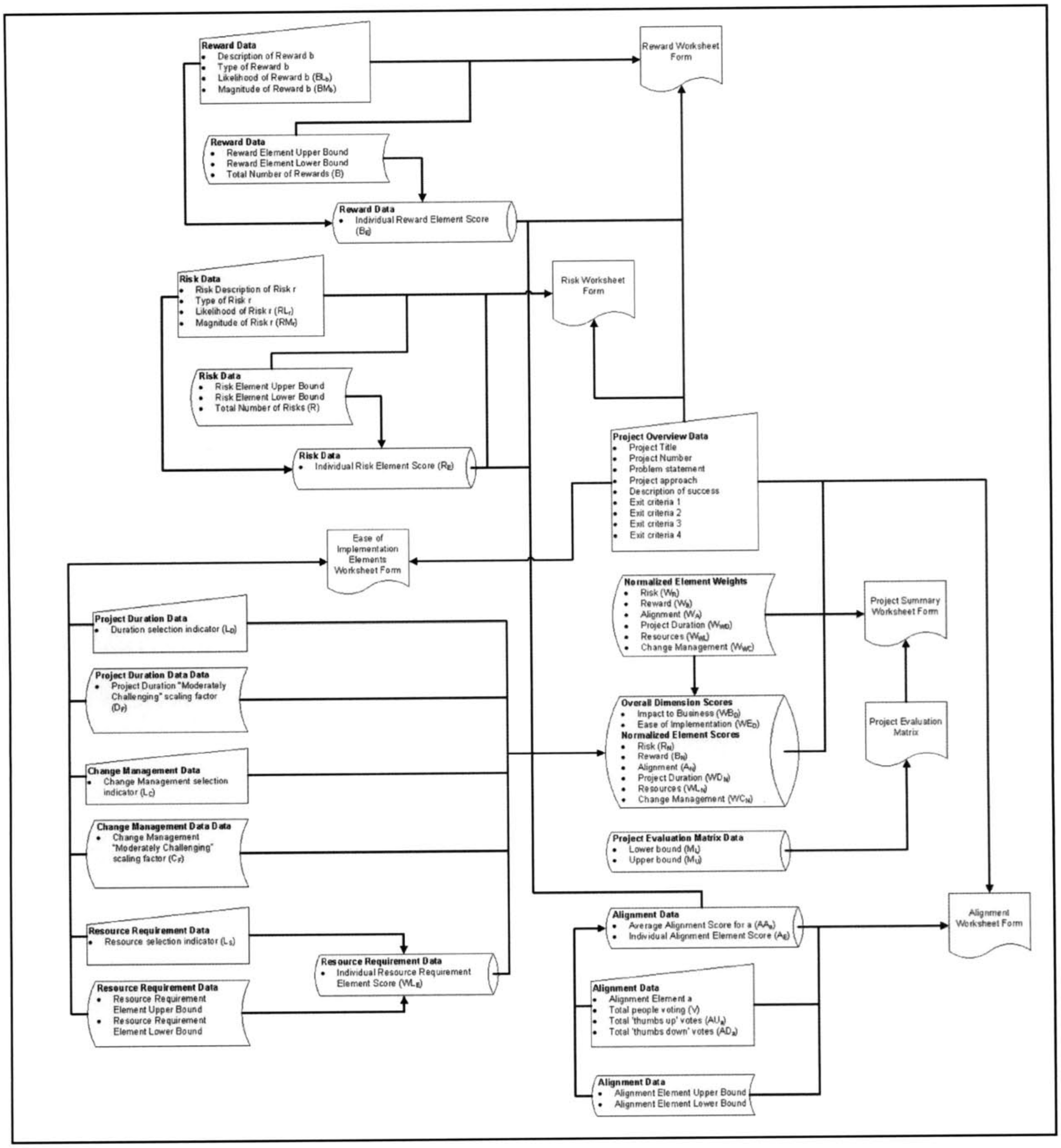


Figure 16: Data Relationship Map - Workshop Evaluation Tool Version

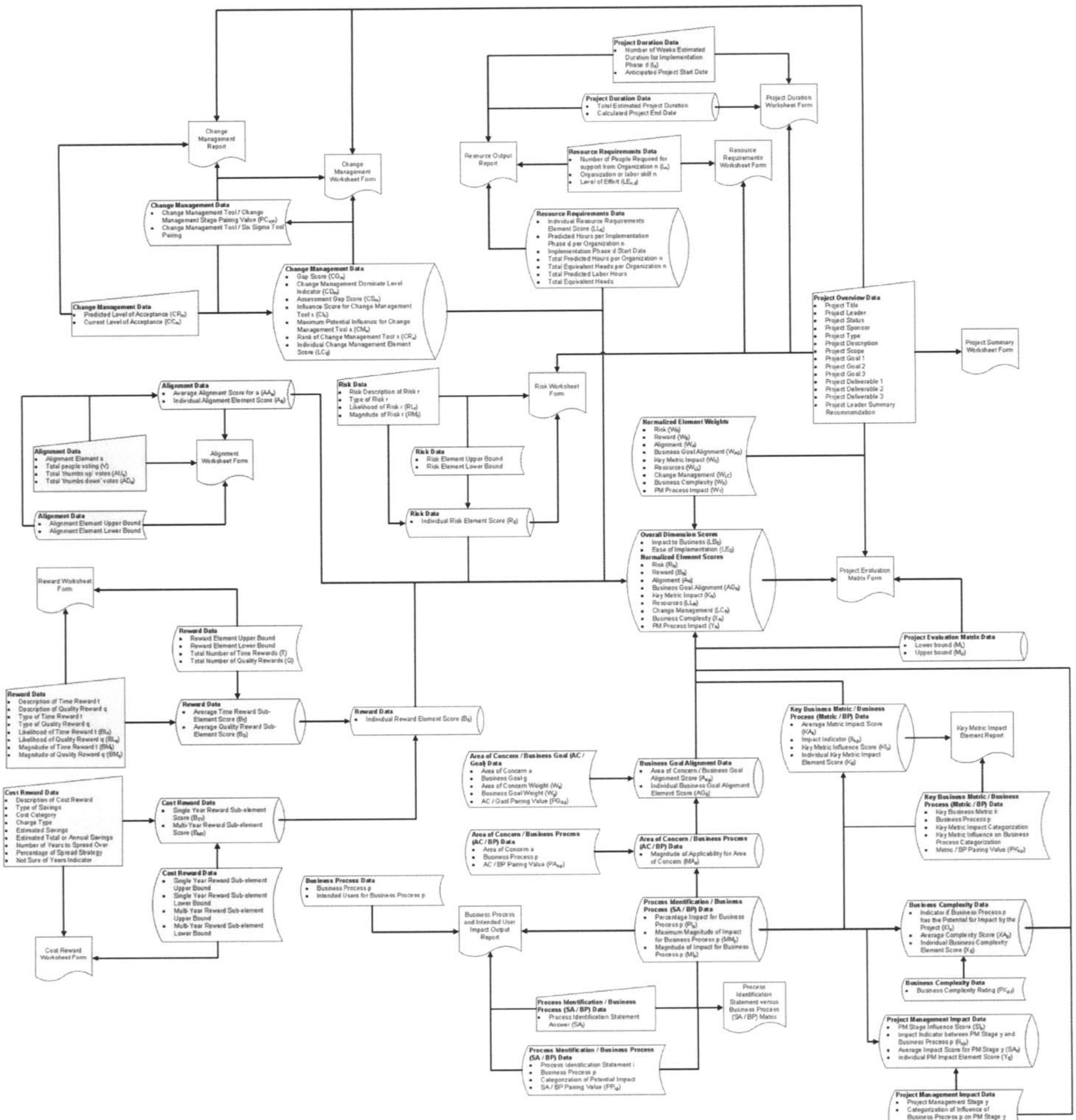


Figure 17: Data Relationship Map - Project Leader's Assessment Tool Version

Appendix B Project Execution Report Prototype

The following is one example of an execution report. These reports can be customized to the user's needs. The prototype shown is based on a standard project 4-square report commonly used within Raytheon.

MIT LGO INTERNSHIP PROJECT

Project Lead: Julie Chun

Project Sponsor: Bob Chatterson

Project Description:
A methodology and tools can be developed that will facilitate identifying, planning and managing the implementation of meaningful projects or initiatives, thereby balancing business goals and customer needs and accelerating return on investment.

Project Deliverables:

- Prototypes of workshop tool, project leader planning tool, and any applicable reports.
- Data mapping for conceptual basic and interactive database.

UPCOMING ACTIVITIES

- Final presentation (ECD 12/8/2009)
- MIT Knowledge Review presentation (ECD 1/29/2010)

PROGRESS

- Tested workshop tool in the 2010 BAT Strategic Planning Workshop (Complete - 10/28/2009)
- Tested workshop tool in the BIT Workshop (Complete - 11/12/2009)
- Working prototypes for workshop tool and project leader planning tool (Complete - 12/2/2009)
- Identified points of contact for handoff of prototype tools
- Data mapping for databases (In-work)
- Thesis writing (In-work, current word count of 4,329)

CONCERNS / HELP NEEDED

- NO HELP NEEDED AT THIS TIME

Figure 18: Example of a project execution report

Appendix C High-Level Landscape of Change Report Prototype

NOTE: The following is an example using a generic fictional process. It is meant to provide a visual prototype of the *Landscape of Change* report.

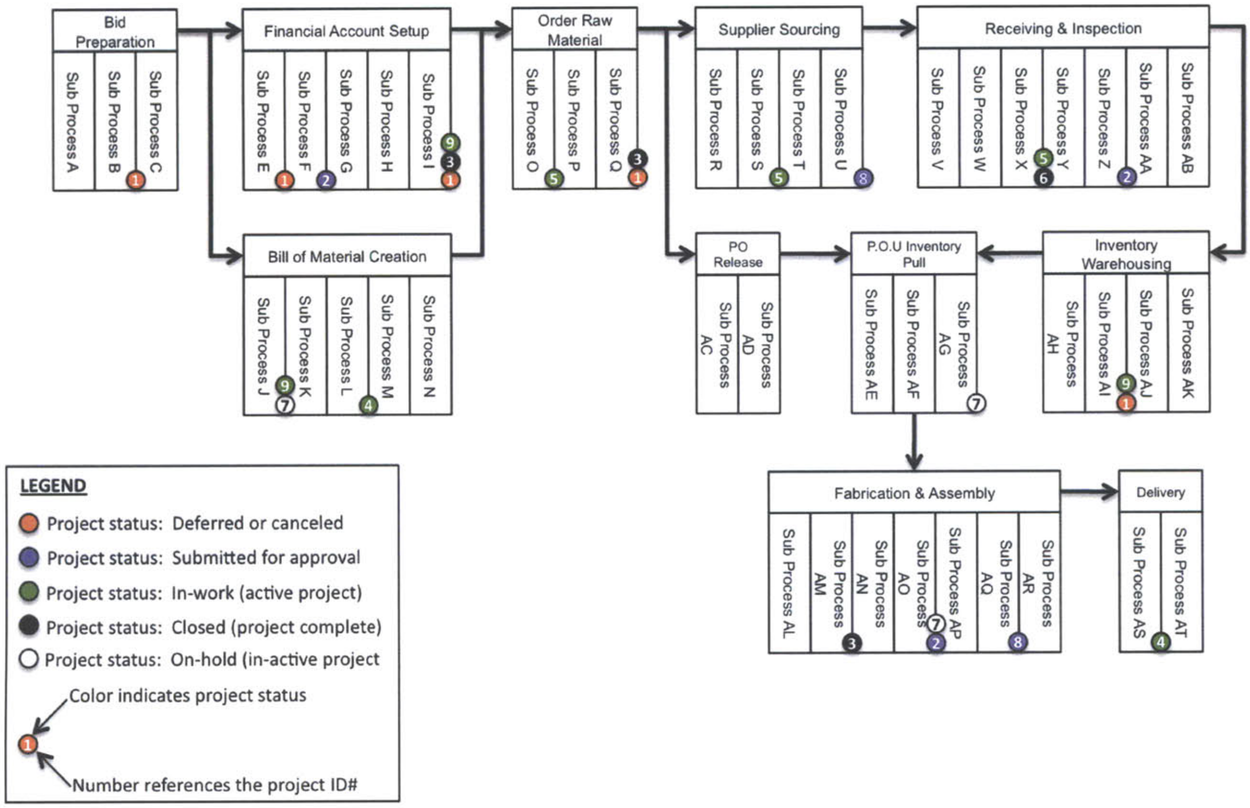


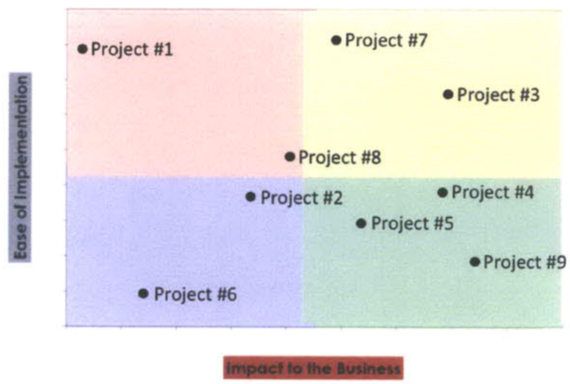
Figure 19: Prototype of the Landscape of Change report

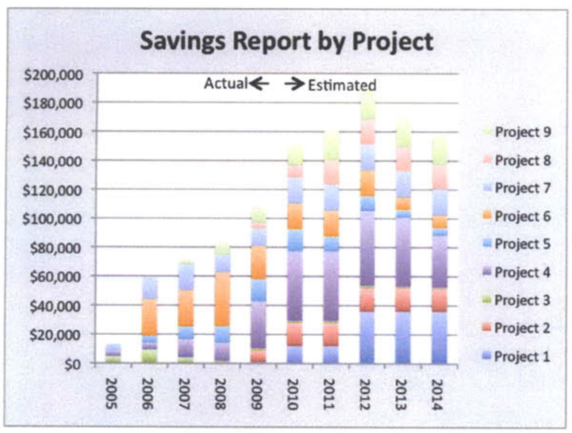
Appendix D High-Level Benefits/Risk Summary Report Prototype

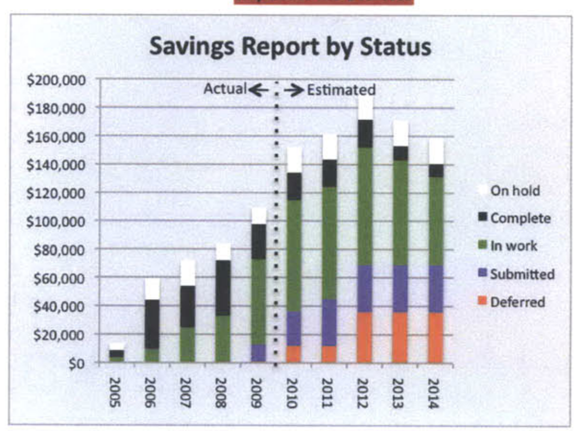
This report can be customized to match user's requirements. The prototype provides basic summary information for nine fictional projects. Note the priority rankings provided reflect the three alternative prioritization methods discussed in Chapter 6.1.

High Level Benefits / Risk Summary Report

Project	Status	Savings		Priority Ranking		
		Actual	Estimated	Long Term	Short Term	Avg
1	Deferred	$0	$133,000	8	9	9
2	Submitted	$0	$88,000	7	6	7
3	Complete	$22,000	$6,000	1	4	2
4	In work	$33,200	$264,500	3	2	3
5	In work	$25,000	$60,000	5	3	4
6	Complete	$110,000	$72,000	9	8	8
7	On hold	$38,000	$114,000	2	7	5
8	Submitted	$0	$80,700	6	5	6
9	In work	$24,400	$99,000	4	1	1







Note: This is a prototype report to present potential report format. The depicted projects are fictional.

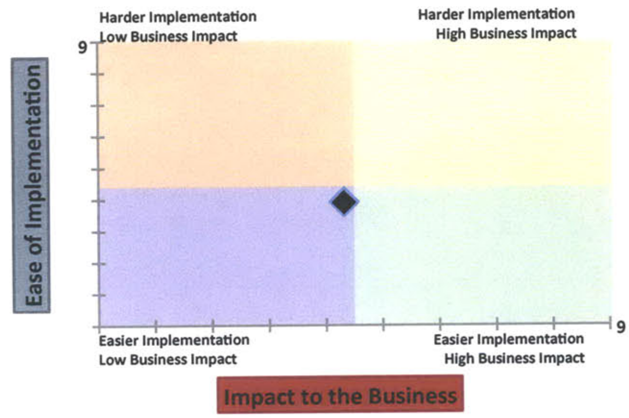
Figure 20: Prototype of high-level benefit/risk summary report

Appendix E Project Summary Worksheet Prototype

Project Number:	0001	Total Project Score:	4.1
Project Title:	SAMPLE PROJECT		

Impact to the Business Score:		4.3
Alignment	Benefits	Risks
5.2	3.2	3.8
50	30	20
Ease of Implementation Score:		**3.9**
Duration	Resource Rmts	Change Mgmt
3.0	5.0	3.0
10	45	45

Note: The gray cells are the weight value for the element above it. For example, the alignment variable currently has a weight of 50. In this examplet all the buisness impact weights sum to 100. To adjust the weight, change the value in the gray cell.



Project Overview		
Problem Statement	A BRIEF DESCRIPTION OF THE CURRENT SITUATION	
Project Approach	PERFORM ROOT CAUSE ANALYSIS, IMPLEMENT IN PRODUCTION AREA B AS A PILOT APPLICATION	
What does success look like	*Description of Success:*	PROBLEM IS RESOLVED
	Exit Criteria #1:	PROCESS DOCUMENTATION MODIFIED TO REFLECT ANY PROCESS CHANGES
	Exit Criteria #2:	METRICS ADJUSTED TO MEASURE AND CONTROL THE NEW PROCESS
	Exit Criteria #3:	TRAINING MATERIAL UPDATED AND ALL USERS TRAINED
	Exit Criteria #4:	DEBRIEF MEETING WILL ALL STAKEHOLDERS IS COMPLETE AND LESSONS LEARNED DOCUMENTED

This workshop tool created by Julie Chun (2010 MIT LGO Intern) for use with Thesis on Design for Project Implementation (DFPI) Methodology.

NOTE: ALL DATA IS FICTION FOR EXAMPLE PURPOSES ONLY.

Figure 21: Project Summary Worksheet Prototype - Workshop Evaluation Tool Version

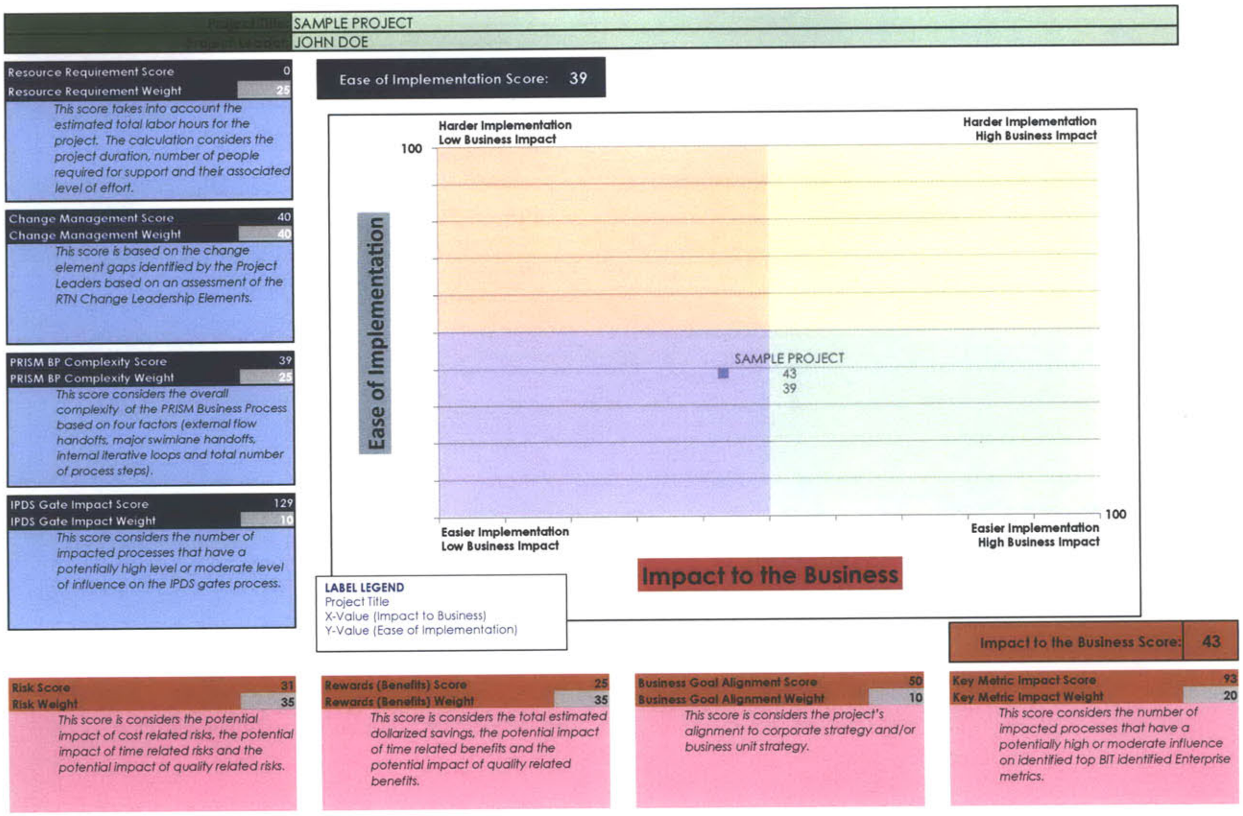


Figure 23: Project Evaluation Matrix Prototype – Project Leader's Assessment Tool Version

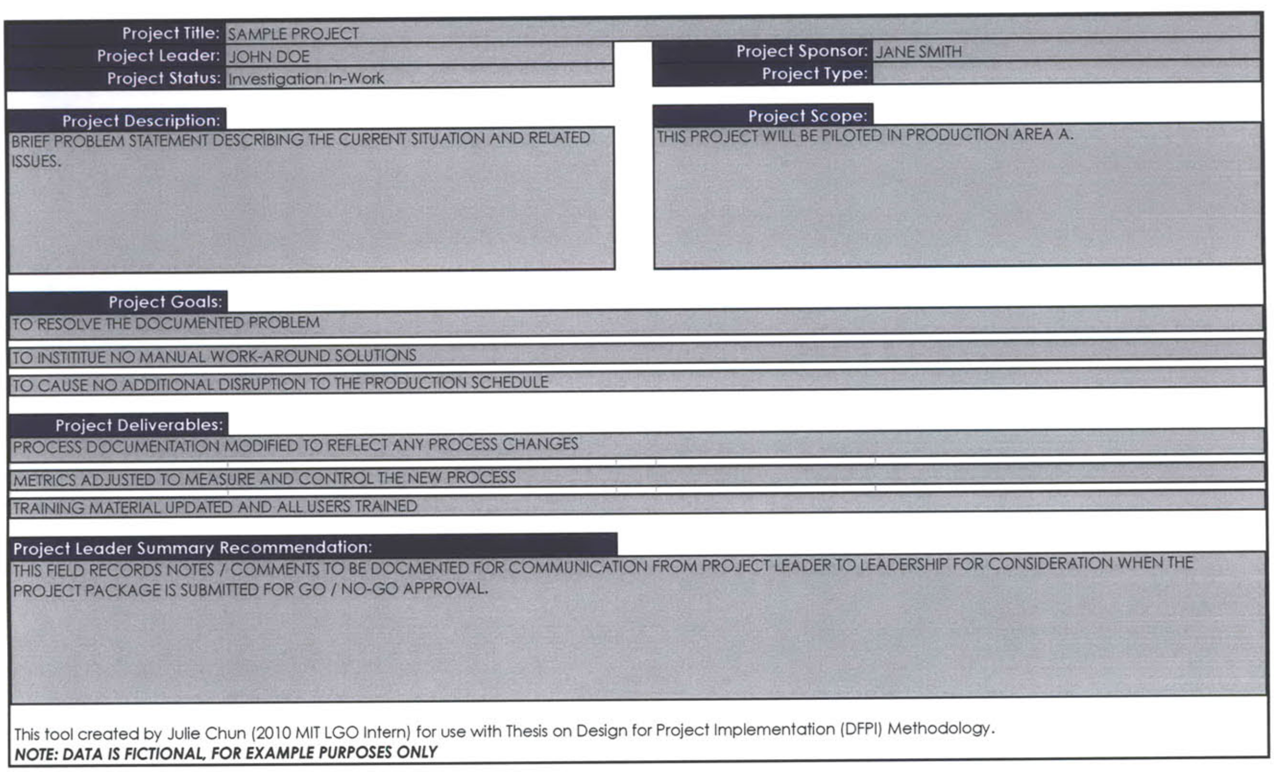


Figure 22: Project Summary Worksheet Prototype - Project Leaders' Assessment Tool Version

Appendix F Business Process and Intended User Impact Report Prototype

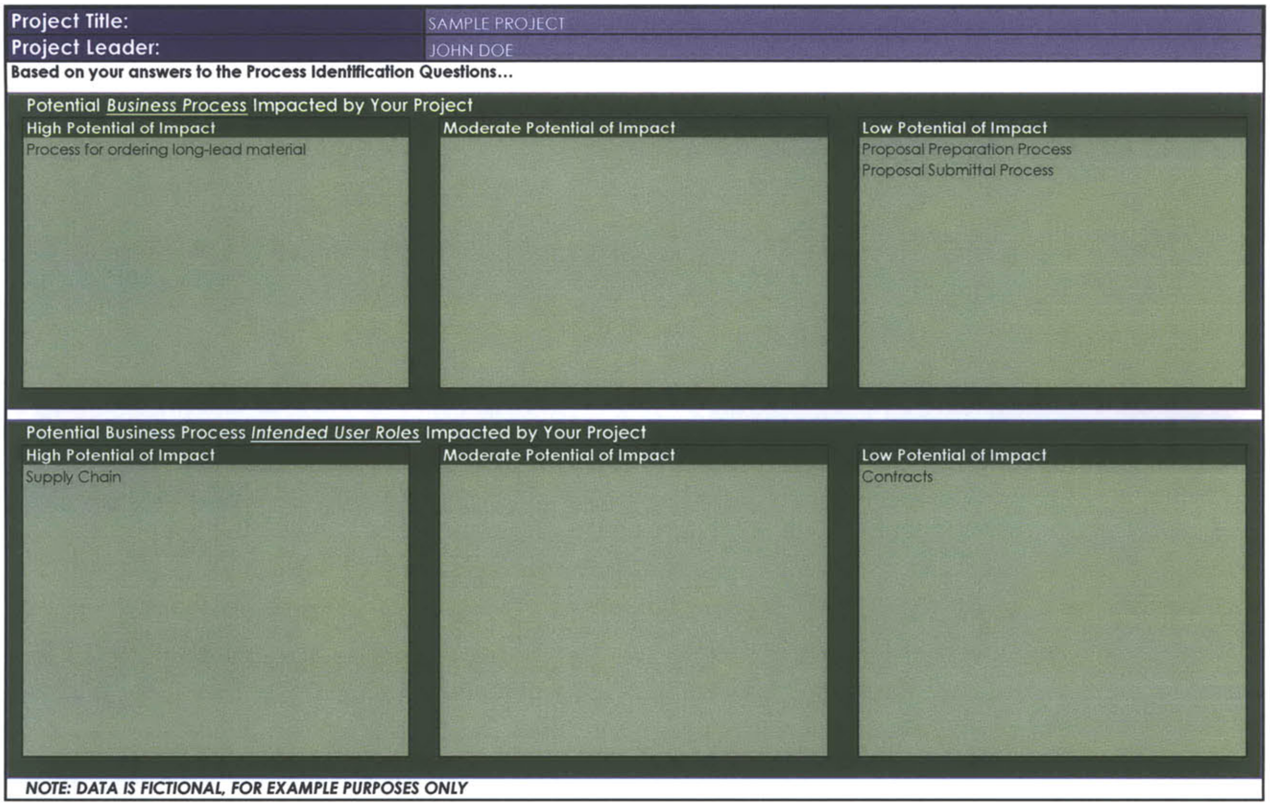


Figure 24: Business Process and Intended User Impact Output Report Prototype - Project Leaders Assessment Tool Version

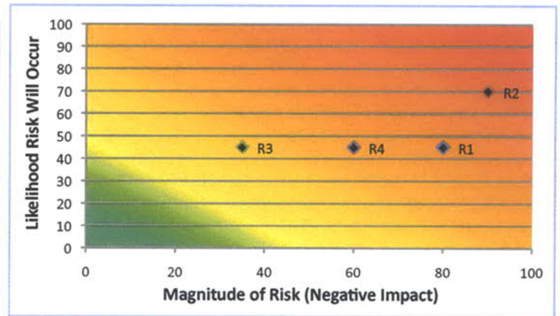
Appendix G Risk Worksheet Prototype

Estimated Risks

Project Title: INSERT TITLE HERE

Risk Examples:

Cost:	Low (Less than 30) =	Budget overrun less than $250K
	Med (30 to 65) =	Budget overrun between $250K to $600K
	High (Greater than 65) =	Budget overrun greater than $600K
Time	Low (Less than 30) =	Missed delivery less than 1 week
	Med (30 to 65) =	Missed delivery between 1 to 3 weeks
	High (Greater than 65) =	Missed delivery by more than 3 weeks
Quality	*Examples:*	*Competatativeness , Customer Satisfaction*
	Low (Less than 30) =	Discover a problem late in build process
	Med (30 to 65) =	Discover a problem after build but before ship
	High (Greater than 65) =	Product fails in the field--a customer discovery



Risk No.	Risk Description	Likelihood of Risk	Magnitude of Risk	Type
R1	Undetectable errors passing through from production to customer	45	80	Quality
R2	Loss of customer confidence due to existing product failures resuting in bids for additional orders being rejected.	70	90	Quality
R3	Extensive rework to correct quality error after discovery	45	35	Cost
R4	Delivery delays due to disruptions for extensive rework on returned products.	45	60	Time
R5				
R6				
R7				

Figure 25: Risk Worksheet Prototype - Both DFPI Design Tools Versions

Appendix H Reward Worksheet Prototype

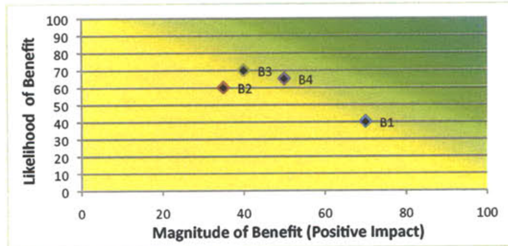
Project Title:	INSERT TITLE HERE	Project Number:	INSERT ##
		Benefit Score:	3.19

Magnitude of Benefit Examples

Cost:
Low (Less than 30) = Dollar savings less than $250K
Med (30 to 65) = Dollar savings between $250K to $600K
High (Greater than 65) = Dollar savings is greater thatn $600K

Time
Low (Less than 30) = Reduction less than 10%
Med (30 to 65) = Reduction is between 10% to 40%
High (Greater than 65) = Reduction is greater than 40%

Quality
Examples: Defect Reduction , Customer Satisfaction
Low (Less than 30) = Delta less than 10%
Med (30 to 65) = Delta is between 10% to 40%
High (Greater than 65) = Delta is greater than 40%



Benefit No.	Benefit Description	Likelihod of Benefit	Magnitude of Benefit	Type
B1	Cycle time reduction of 45%	40	70	Time
B2	Customer satisfaction increased because able to increase capacity and requests to fill additional orders	60	35	Quality
B3	Increase First Pass Yield by 15%	70	40	Quality
B4	Reduction in dedicated labor resources by 20%	65	50	Cost
B5				
B6				
B7				

Note: Data is fictional for Example Purposes Only

Figure 26: Reward Worksheet Prototype - Workshop Evaluation Tool Version

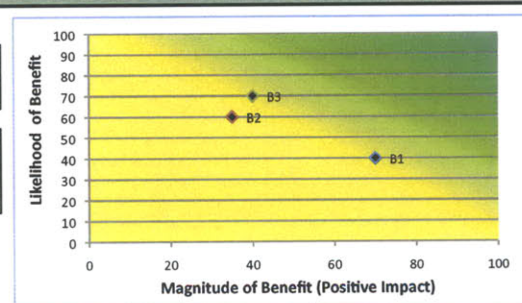
Estimated Time or Quality Related Benefits

Project Title:	INSERT TITLE HERE

Benefit Examples

Time
Low (Less than 30) = Reduction less than 10%
Med (30 to 65) = Reduction is between 10% to 40%
High (Greater than 65) = Reduction is greater than 40%

Quality
Examples: Defect Reduction , Customer Satisfaction
Low (Less than 30) = Delta less than 10%
Med (30 to 65) = Delta is between 10% to 40%
High (Greater than 65) = Delta is greater than 40%



Benefit No.	Benefit Description	Likelihod of Benefit	Magnitude of Benefit	Type
B1	Cycle time reduced by 45%	40	70	Time
B2	Customer satisfaction increased because able to increase capacity and requests to fill additional orders	60	35	Quality
B3	Increase First Pass Yield by 15%	70	40	Quality
B4				
B5				
B6				
B7				

Note: Data is fiction for example use only

Figure 27: Reward Worksheet Prototype - Project Leaders' Assessment Tool Version

Appendix I Project Leaders' Assessment Tool – Cost Reward Worksheet Prototype

Estimated Cost Related Benefits

Project Title: INSERT TITLE HERE

Description of Section

This section is designed to understand the what benefits (savings) may be realized if the change(s) is implemented and sustained. The goal is to understand the magnitude of the savings (after go-forward a more detailed analysis should be done).

Directions

Using the worksheet below describe the potential cost related benefits. For each row populate as much know information as possible . Select from pull down menus, where applicable, to describe the benefit.

Use the following Table to Document Cost Benefits (Benefits that can be Dollarized)

							Only applicable if recurring		
Benefit No.	Cost Benefit Description*	Type of Savings*	Cost Category	Charge Type	Estimated Savings ($K)*	Total or Annual?*	# of years to spread over**	% Spread Strategy**	Not Sure on yrs or spread**
CB1	Fewer dedicated resources required enabling a reduced headcount from 8 to 6 over time.	Recurring	Touch	Direct	$ 300.00	Annual	3	Back Loaded	
CB2	Reduced warehouse space required. Resulting in a incremental saving as leased space is released.	Recurring	Mat'l & ODC		$ 200.00	Annual	5	Back Loaded	
CB3	Sell / Reallocation of equipment (one time cost reduction)	Non-Recurring	Mat'l & ODC		$ 560.00	Total			
CB4	No need to activate 2nd production line to meet delivery commitments	Cost Avoidance	Mat'l & ODC		$ 1,250.00	Total			
CB5									
CB6									
CB7									
CB8									
CB9									
CB10									

*These are required fields regardless of the type of savings to make the report calculate correctly.

**These fields are required if the cost is recurring or a recurring cost-avoidance. Either the "Not sure" box should be check, or the # of years and % spread strategy selected. Without these field populated the benefit will either not count, or count as a single non-recurring cost savings on year 1

Note: Data is fiction for example use only

Figure 28: Cost Reward Worksheet Prototype - Project Leaders' Assessment Tool Version

Appendix J Alignment to User Defined Characteristic Worksheet Prototype

Project Title:	SAMPLE PROJECT		Project Number:	0001
Alignment to User ERP Areas of Concern			Alignment Score:	5.19
Number of People Voting (Evaluating):	15			

Number	Alignment Element: User Area of Concern	Alignment to Project -1 = may make worse 0 = no impact +1 = may improve	Brief Description of Alignment Element
1	Data Input	0.40	Includes various means of inputing data into the system: manual via typing, automated system updates, import via spreadsheets, etc
2	System Functionality	0.20	Includes all basic software complexity and navigation. E.g., how many "clicks" to complete a transaction, availability of help screens, number of windows required to view data.
3	Training	(0.53)	Includes training for new users (new to company), users with a new role, or training for gaining additional expertiese (e.g., advanced level training). Includes all media types.
4	Reports	0.47	Includes availability, applicability and accuracy of reports genered directly out of the system.
5	Inventory Related Processes	(0.27)	Includes all process related to traking, storing, deilivering and transporting inventory from receipt to delivery to customer.
6	Delivery Related Processes	0.20	Includes all precess related to delivering product to customer.
7	System Reliability	0.20	Includes all issues such as unplanned downtime, required maintenance, system freezes, data loss due to freezes or unplanned downtime, etc.
8	System Accuracy	0.13	Includes processes for data cleaning, processes for ensuring data accuracy, etc.
9	Rework Related Processes	0.33	Includes all process related to rework including rework instructions, approval, verification, etc.
14	System Integration Links	(0.67)	Includes any links to external ERP systems such .

NOTE: DATA IS FICTIONAL, FOR EXAMPLE PURPOSES ONLY

Figure 30: Alignment to User Defined Characteristic Worksheet Prototype - Workshop Evaluation Tool Version

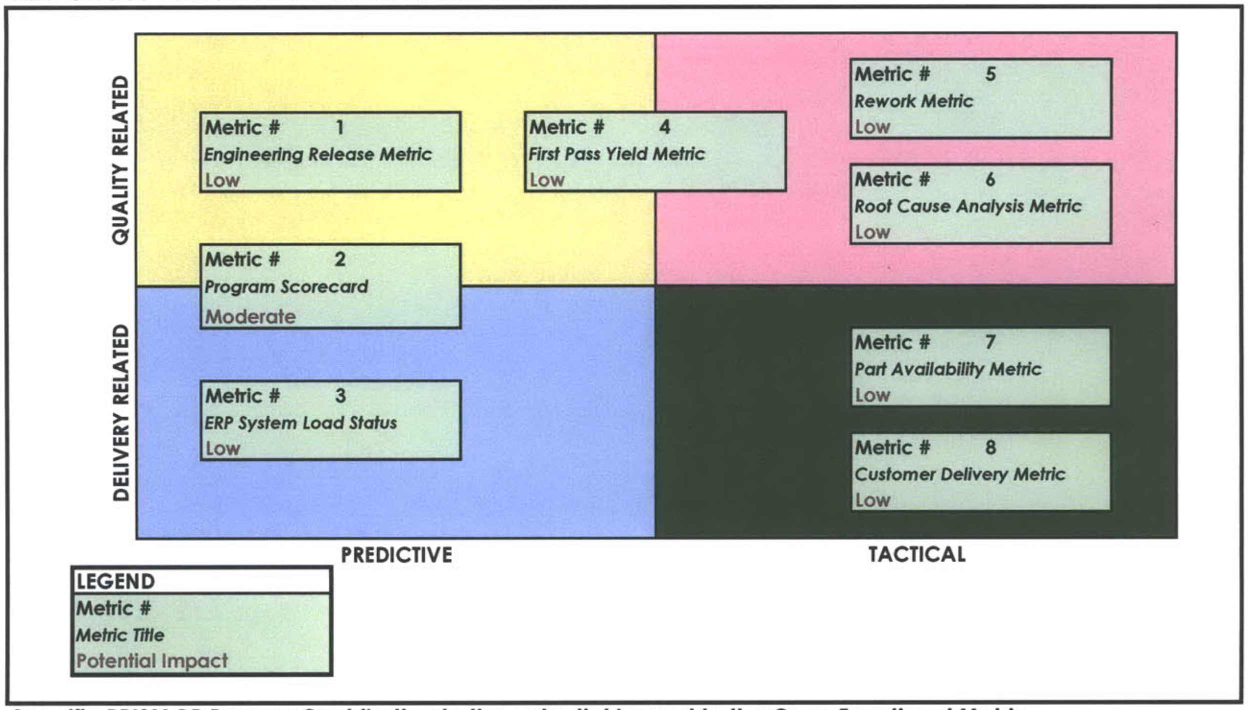
	Voting Input Section			
				
Number	Number of Thumbs Down	Number of Thumbs Sideways	Number of Thumbs Up	Has Everyone Voted?
1	2	5	8	Yes
2	4	4	7	Yes
3	9	5	1	Yes
4	3	2	10	Yes
5	8	3	4	Yes
6	5	2	8	Yes
7	5	2	8	Yes
8	4	5	6	Yes
9	4	2	9	Yes
14	11	3	1	Yes

Figure 29: Input Table for "Thumb Votes" used with the Alignment to User Defined Characteristic Worksheet - Workshop Evaluation Tool Version

Appendix K Key Metric Impact Element Output Report Prototype

Project Title:	SAMPLE PROJECT
Project Leader:	JOHN DOE

KEY CROSS FUNCTIONAL BUSINESS METRICS



Specific PRISM BP Process Contributing to the potential Impact to the Cross Functional Metric

BP Process contributing a ***moderate*** *influence to the potenital impact to the individual metric*

	Cross Functional Metric Number							
BP #	1	2	3	4	5	6	7	8
1			✓					
2			✓					

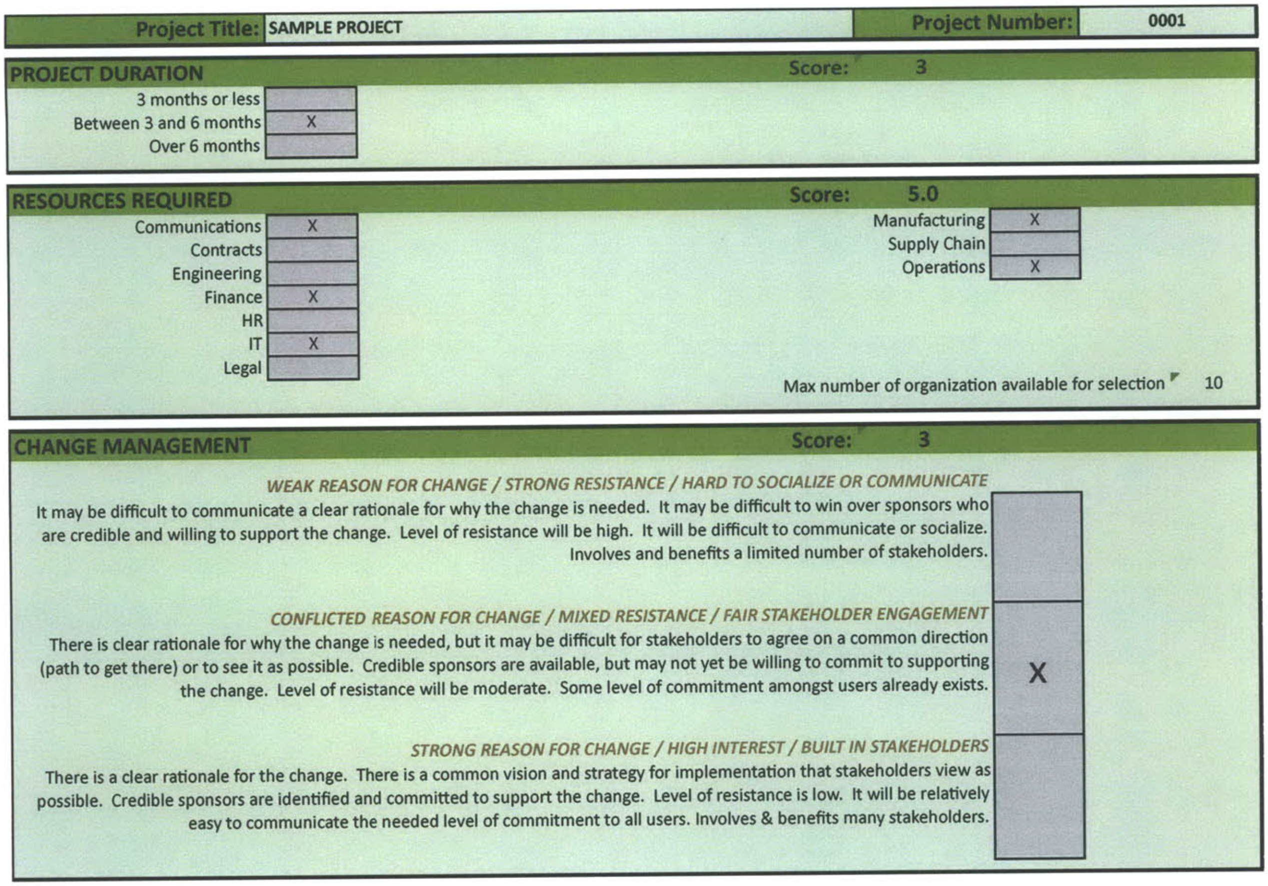
BP Process contributing a ***high*** *influence to the potenital impact to the individual metric*

	Cross Functional Metric Number							
BP #	1	2	3	4	5	6	7	8

NOTE: DATA IS FICTIONAL FOR EXAMPLE ONLY

Figure 31: Key Metric Impact Element Output Report Prototype - Project Leaders' Assessment Tool Version

Appendix L Ease of Implementation Worksheet Prototype – Workshop Evaluation Tool Version



Project Title:	SAMPLE PROJECT	Project Number:	0001

PROJECT DURATION — Score: 3

3 months or less	
Between 3 and 6 months	X
Over 6 months	

RESOURCES REQUIRED — Score: 5.0

Communications	X	Manufacturing	X
Contracts		Supply Chain	
Engineering		Operations	X
Finance	X		
HR			
IT	X		
Legal			

Max number of organization available for selection 10

CHANGE MANAGEMENT — Score: 3

WEAK REASON FOR CHANGE / STRONG RESISTANCE / HARD TO SOCIALIZE OR COMMUNICATE It may be difficult to communicate a clear rationale for why the change is needed. It may be difficult to win over sponsors who are credible and willing to support the change. Level of resistance will be high. It will be difficult to communicate or socialize. Involves and benefits a limited number of stakeholders.	
CONFLICTED REASON FOR CHANGE / MIXED RESISTANCE / FAIR STAKEHOLDER ENGAGEMENT There is clear rationale for why the change is needed, but it may be difficult for stakeholders to agree on a common direction (path to get there) or to see it as possible. Credible sponsors are available, but may not yet be willing to commit to supporting the change. Level of resistance will be moderate. Some level of commitment amongst users already exists.	X
STRONG REASON FOR CHANGE / HIGH INTEREST / BUILT IN STAKEHOLDERS There is a clear rationale for the change. There is a common vision and strategy for implementation that stakeholders view as possible. Credible sponsors are identified and committed to support the change. Level of resistance is low. It will be relatively easy to communicate the needed level of commitment to all users. Involves & benefits many stakeholders.	

Figure 32: Ease of Implementation Elements Worksheet Prototype - Workshop Evaluation Tool Version

Appendix M Project Leaders' Assessment Tool – Project Duration Worksheet Prototype

Estimated Project Time Line

Project Title: INSERT TITLE HERE

Description of Section

This section is designed to understand the anticipated project timeline.

Directions

Populated the GRAY colored cells with the estimated "dedicated" duration (in weeks) for the specific stage. Populate the anticipated start date (GRAY cell).

	Description of Phase	DEFINE	MEASURE	ANALYZE	IMPROVE	CONTROL
DEFINE	Characterize the problem (current state). Align sponsorship. Charter the team. Document goals and deliverables.	3				
MEASURE	Collect data. Establish the current performance or state baseline. Identify potential areas of investigation.		7			
ANALYZE	Complete investigations to identify root cause(s). Establish the "basis for solutions."			4		
IMPROVE	Develop solutions based on facts and data.				7	
CONTROL	Implement or pilot solutions. Establish plans for future full-up implementations (if necessary).					2
	Total Estimated Project Duration	**23 weeks**				
	Anticipated Start Date	*01-Feb-10*				
	Calculated End Date	*12-Jul-10*				

Assumptions

Each phase begins with a "dedicated" phase duration.

Some work will overlap. The phases are anticipated to be iterative.

The provided durations are an <u>estimate</u>. It is understood that they may alter once a detailed plan is developed.

SOURCE: US Army. (2009, August 25). Lean Six Sigma. Retrieved January 12, 2010, from US Army Knowledge Center: http://www.army.mil/ArmyBTKC/focus/cpi/tools3.htm

Figure 33: Project Duration Worksheet - Project Leaders' Assessment Tool Version

Appendix N Project Leaders' Assessment Tool – Resource Requirement Worksheet Prototype

Estimated Resource Requirements

Project Title: SAMPLE PROJECT

Description of Section

This section is designed to understand the anticipated resource requirements by organization or user group.

Directions

For each resource required (selected from drop down list) estimated the total number of people required to support the project and the level of effort need (0, 25%, 50%, 75% or 100%) for each project phase (which align to the Six Sigma Process Steps).

		Level of Effort Required During...				
Organization	Number of People Needed	DEFINE	MEASURE	ANALYZE	IMPROVE	CONTROL
Communications	1	0%	0%	25%	25%	25%
Engineering	2	25%	75%	75%	75%	50%
Facilities	2	0%	0%	50%	50%	75%
Operations	4	50%	75%	75%	75%	100%

Figure 34: Resource Requirements Worksheet Prototype - Project Leaders' Assessment Tool Version

Appendix O Project Leaders' Assessment Tool – Required Resource Report Prototype

Project Title:	SAMPLE PROJECT		
Project Leader:	JOHN DOE		
Anticipated Project Start Date:	01-Feb-10	Anticipated Project End Date	12-Jul-10
Predicted Total Labor Hours:	4,650	Equivalent Heads	5.40

Total Predicted Hours	300		1,260		920		1,610		560		4,652	
	Define		Measure		Analyze		Improve		Control		Sub Total Summary	
	Start Date	Wks	Start Date	Wks	Start Date	Wks	Start Date	Wks	Start Date	Wks		
	01-Feb-10	3	22-Feb-10	7	12-Apr-10	4	10-May-10	7	28-Jun-10	2		
Supporting Organization / User Group	Predicted Hours		Predicted Hours		Predicted Hours		Predicted Hours		Predicted Hours		Hrs	Eq Hds
Communications	0		0		40		70		40		150	0.08
Engineering	60		420		240		420		80		1,220	0.61
Facilities	0		0		160		280		120		560	0.28
Operations	240		840		480		840		320		2,720	1.37

Figure 35: Resource Output Report Prototype - Project Leaders' Assessment Tool Version

Appendix P Project Leaders' Assessment Tool – Change Management Worksheet Prototype

Change Management Assessment - *Acceptance within the Corporate Culture*

Project Title: SAMPLE PROJECT

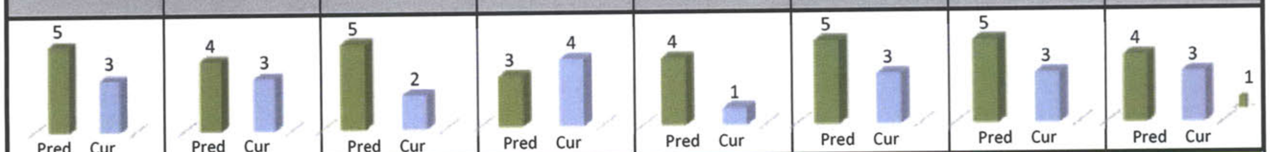
Description of Section

This section is designed to identify which areas should be prioritized during planning for implementation in order to achieve the needed level of cultural acceptance.

Directions

For each change mananagement stage rank from high (5) to low (1) the level of acceptance you anticipate needing for the targetted change(s) to be sustained long-term and the current level of acceptance you would estimate if the change(s) were to become effective today.

Provides clear rationale and sense of urgency to the change effort	Win over people who will bring credibility and support to change effort	Create purpose & direction people can relate to & see as possible	Size up the level of resistance expected; Avoidance of personal biases	Remove obstacles, make any physical changes; Take risks, think "out of the box"	Maintain change momentum after newness fades	Ensure all voices are heard; avoid vocal members unintentionally getting spotlight	Level of communication needed for information flow
Establish a Sense of Urgency	Creating the Guiding Coalition	Developing a Vision and Strategy	Communicate the Change Vision	Emplowering Broad-Based Action	Generating Short-Term Wins	Consolidating Gains and Producing More Change	Anchoring New Approaches in the Culture
PREDICTED LEVEL OF ACCEPTANCE NEEDED FOR CHANGE TO BE SUSTAINED							
5	4	5	3	4	5	5	4
CURRENT LEVEL OF ACCEPTANCE IF CHANGE WAS IMPLEMENTED TODAY							
3	3	2	4	1	3	3	3
Yellow	Green	Red	Green	Red	Yellow	Yellow	Green



SOURCE FOR CHANGE MANAGEMENT STAGES: Kotter, J. P. (1996). Leading change. Boston, MA: Harvard Business School Press.

NOTE: DATA IS FICTIONAL, FOR EXAMPLE ONLY

Figure 36: Change Management Worksheet Prototype - Project Leaders' Assessment Tool Version

Appendix Q Project Leaders' Assessment Tool – Change Management Report Prototype

Project Title: SAMPLE PROJECT
Project Leader: JOHN DOE

Delaying Change Management Stages

- Establishing a Sense of Urgency
- Generating Short-Term Wins
- Consolidating Gains and Producing More Change

Obstructing Change Management Stages

- Developing a Vision and Strategy
- Empowering Broad-Based Action

Change Management Model Tools Recommendations

RAYTHEON SIX SIGMA TOOLS

Link to any Internal Corporate Portals where Tools are located

Strongly Recommended	Highly Recommended	Recommended
Case for change worksheet	Short-term wins payoff matrix	Monitoring key organizational areas
Stakholder behavioral map	Stakholder behavioral map	

SOURCE FOR CHANGE MANAGEMENT STAGES: Kotter, J. P. (1996). Leading change. Boston, MA: Harvard Business School Press.

SOURCE FOR CHANGE MANAGEMENT TOOLS: Cohen, D. S., & Kotter, J. P. (2005). The heart of change field guide: tools and tactics for leading change in your organization. Boston, MA: Harvard Business School Press.

NOTE: RESULTS ARE BASED ON DATA IS FICTIONAL, FOR EXAMPLE ONLY

Figure 37: Change Management Report Prototype - Project Leaders' Assessment Tool Version

Appendix R Summary List of Variables

The following is a master summary of the list of variables. They are generally grouped by the element. Some variables are used in multiple groups, but are by and large listed in the group of first occurrence.

General Interpolation Variables

E_L = Lower bound of individual element scoring range

E_U = Upper bound of individual element scoring range

S_E = Individual element score (generic placeholder)

M_L = Lower bound of project evaluation matrix scoring range

M_U = Upper bound of project evaluation matrix scoring range

S_N = Individual element score (generic placeholder)

Overall Dimension Score Variables

WB_D = Impact to Businesses Dimension Score, Workshop Evaluation Tool

WE_D = Ease of Implementation Dimension Score, Workshop Evaluation Tool

LB_D = Impact to Businesses Dimension Score, Project Leaders' Assessment Tool

LE_D = Ease of Implementation Dimension Score, Project Leaders' Assessment Tool

Risk Element Variables

RL_r = Likelihood of Risk r

RM_r = Magnitude of Risk r

Where r = Individual described risk = 1,...,R

Given R = total number of described risk (number between 1 to 7)

R_E = Individual Risk Element Score

R_N = Normalized Risk Element Score

W_R = Normalized Risk Element Weight

Rewards Element Variables

B_{SY} = Single Year Reward Sub-Element Score

B_{MY} = Multiple Year (or Net Present Value, NPV) Reward Sub-Element Score

B_T = Average Time Reward Sub-Element Score

B_Q = Average Quality Reward Sub-Element Score

B_E = Individual Reward Element Score

B_N = Normalized Reward Element Score

W_B = Normalized Reward Element Weight

BL_b = Likelihood of Reward (Benefit) b

BM_b = Magnitude of Reward (Benefit) b

Where b = Individual described reward = 1,...,B

Given B = total number of described rewards (number between 1 to 7)

BL_t = Likelihood of Time Reward (Benefit) t

BM_t = Magnitude of Time Reward (Benefit) t

Where t = Individual described time reward = 1,...,T

Given T = total number of described time rewards (number between 1 to 7)

BL_q = Likelihood of Quality Reward (Benefit) q

BM_q = Magnitude of Quality Reward (Benefit) q

Where q = Individual described quality reward = 1,...,Q

Given Q = total number of described quality rewards (number between 1 to 7)

Alignment to User Defined Characteristic Element Variables

AU_a = Total number of "thumbs up" votes for user concern a

AD_a = Total number of "thumbs down" votes for user concern a

AA_a = Average Alignment Score for user concern a

Where a = user area of concern = 1,...,A

Given A = total number of areas of concern

V = Total number of workshop participants contributing input ("voting")

A_E = Individual Alignment Element Score

A_N = Normalized Alignment Element Score

W_A = Normalized Alignment Element Weight

Enterprise Business Goal Alignment Element Variables

SA_i = Answer to process identification statement i

MI_p = Magnitude of impact for business process p

MM_p= Maximum magnitude of impact for business process p

PI_p = Percentage impact for business process p

MA_a = Magnitude of applicability for area of concern a

$PA_{a,p}$= Pairing value between area of concern a and business process p

$PP_{i,p}$ = Pairing value between process identification statement I and business process p

$PG_{a,g}$= Pairing value between area of concern a and corporate business goal g

W_a = Weight for area of concern a

W_g = Weight for corporate business goal g

$A_{a,g}$ = Alignment score between area of concern a and corporate business goal g

Where a = user area of concern = 1,...,A

Given A = total number of areas of concern

p = business process = 1,...,P

Given P = total number of business processes

g = user area of concern = 1,...,G

Given G = total number of enterprise or corporate business goals

i = process identification statement = 1,...,I

Given I = total number of process identification statements

AG_E = Individual Enterprise Business Goal Alignment Element Score

AG_N = Normalized Enterprise Business Goal Alignment Element Score

W_{AG} = Normalized Enterprise Business Goal Alignment Element Weight

Key Metric Impact Element Variables

KI_p = Key metric influence score for business process p

$PK_{k,p}$ = Pairing value between key metric k and business process p

$II_{k,p}$ = Impact indicator between key metric k and business process p

KA_k = Average impact score for key metric k

Where k = key metric = 1,…,K

Given K = total number of key metrics

K_E = Individual Key Metric Impact Element Score

K_N = Normalized Key Metric Impact Element Score

W_K = Normalized Key Metric Impact Element Weight

Project Duration Element Variables

D_s = Indicator if project duration qualitative category s is selected

Where s = project duration qualitative category s = 1, 2, 3 (representing low, medium and high respectively)

SF = 'Medium' Qualitative Scaling Factor Scaling Factor = 0.33

WD_N = Normalized Project Duration Element Score, Workshop Evaluation Tool Version

W_{WD} = Normalized Project Duration Element Weight, Workshop Evaluation Tool Version

Resource Requirement Element Variables

L_s = Indicator if organization or labor skill s is selected

Where s = organization or labor skill s = 1,…,S

Given S = total number of organizations or labor skills

WL_E = Individual Resource Requirements Element Score, Workshop Evaluation Tool Version

WL_N = Normalized Resource Requirements Element Score, Workshop Evaluation Tool Version

W_{WL} = Normalized Resource Requirements Element Weight, Workshop Evaluation Tool Version

L_n = Number of people required for support from organization n

I_d = Number of weeks estimated duration for implementation phase d

$LE_{n,d}$ = Level of effort (%) for organization n during implementation phase d

Where n = organization or labor skill = 1,…,N

Given N = total number of organizations or labor skills

d = implementation phase = 1,…,D

Given D = total number of implementation phases

LL_E = Individual Resource Requirements Element Score, Project Leaders' Assessment Tool Version

LL_N = Normalized Resource Requirements Element Score, Project Leaders' Assessment Tool Version

W_{LL} = Normalized Resource Requirements Element Weight, Project Leaders' Assessment Tool Version

Change Management Element Variables

C_s = Indicator if change management qualitative category s is selected

Where s = change management qualitative category s = 1, 2, 3 (representing low, medium and high respectively)

SF = 'Medium' Qualitative Scaling Factor Scaling Factor = 0.33

WC_N = Normalized Change Management Element Score, Workshop Evaluation Tool Version

W_{WC} = Normalized Change Management Element Weight, Workshop Evaluation Tool Version

CP_m = Predicted level of acceptance needed for change management stage m

CC_m = Current level of acceptance for change management stage m

CG_m = Gap score between predicted and current level of acceptance for change management stage m

CD_m = Indicator for which level (predicted or current) is dominate for change management stage m

CS_m = Assessment gap score for change management stage m

$PC_{x,m}$= Pairing value between change management tool x and change management stage m

CI_x = Influence score for change management tool x

CM_x = Maximum potential influence for change management tool x

CR_x = Rank of change management tool x (based on a highest to lowest sort of CI_x)

Where m = change management stage = 1,...,M

Given M = total number of change management stages

x = change management tool = 1,...,X

Given X = total number of change management tools

LC_E = Individual Change Management Element Score, Project Leaders' Assessment Tool Version

LC_N = Normalized Change Management Element Score, Project Leaders' Assessment Tool Version

W_{LC} = Normalized Change Management Element Weight, Project Leaders' Assessment Tool Version

Business Complexity Element Variables

$PX_{p,f}$ = Business complexity rating for business process p in relation to complexity factor f

XA_p = Average complexity score for business process p

XI_p = Indicator if business process p has the potential for impact by the project

Where f = business complexity factor = 1,...,F

Given F = total number of business complexity factors

X_E = Individual Business Complexity Element Score, Project Leaders' Assessment Tool Version

X_N = Normalized Business Complexity Element Score, Project Leaders' Assessment Tool Version

W_X = Normalized Business Complexity Element Weight, Project Leaders' Assessment Tool Version

PM Process Impact Element Variables

SI_p = PM stage influence score for business process p

$PS_{y,p}$ = Pairing value between PM stage y and business process p

$II_{y,p}$ = Impact indicator between PM stage y and business process p

SA_y = Average impact score for PM stage y

Where y = PM stage = 1,...,Y

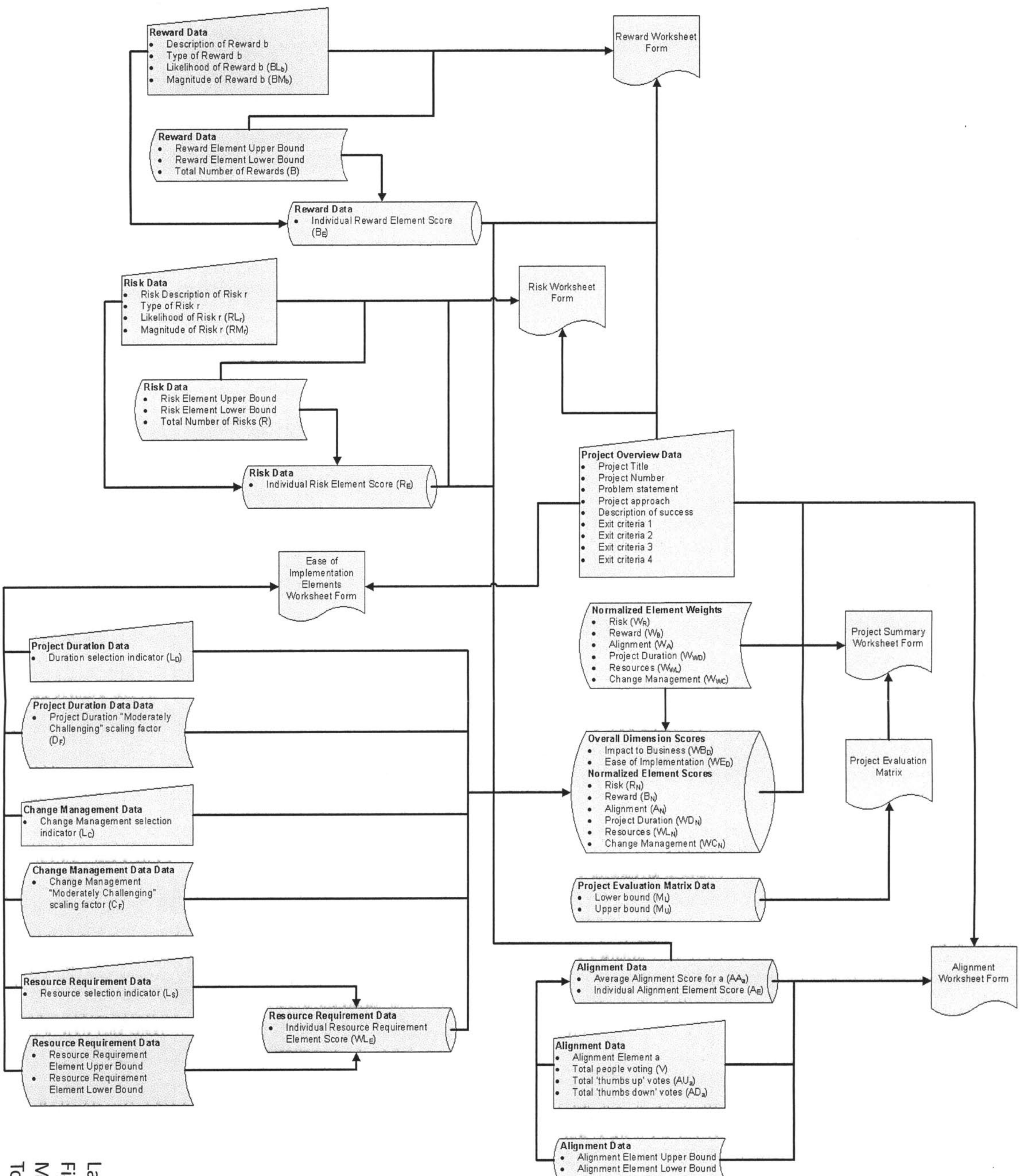
Given K = total number of key metrics

Y_E = Individual PM Process Impact Element Score, Project Leaders' Assessment Tool Version

Y_N = Normalized PM Process Impact Element Score, Project Leaders' Assessment Tool Version

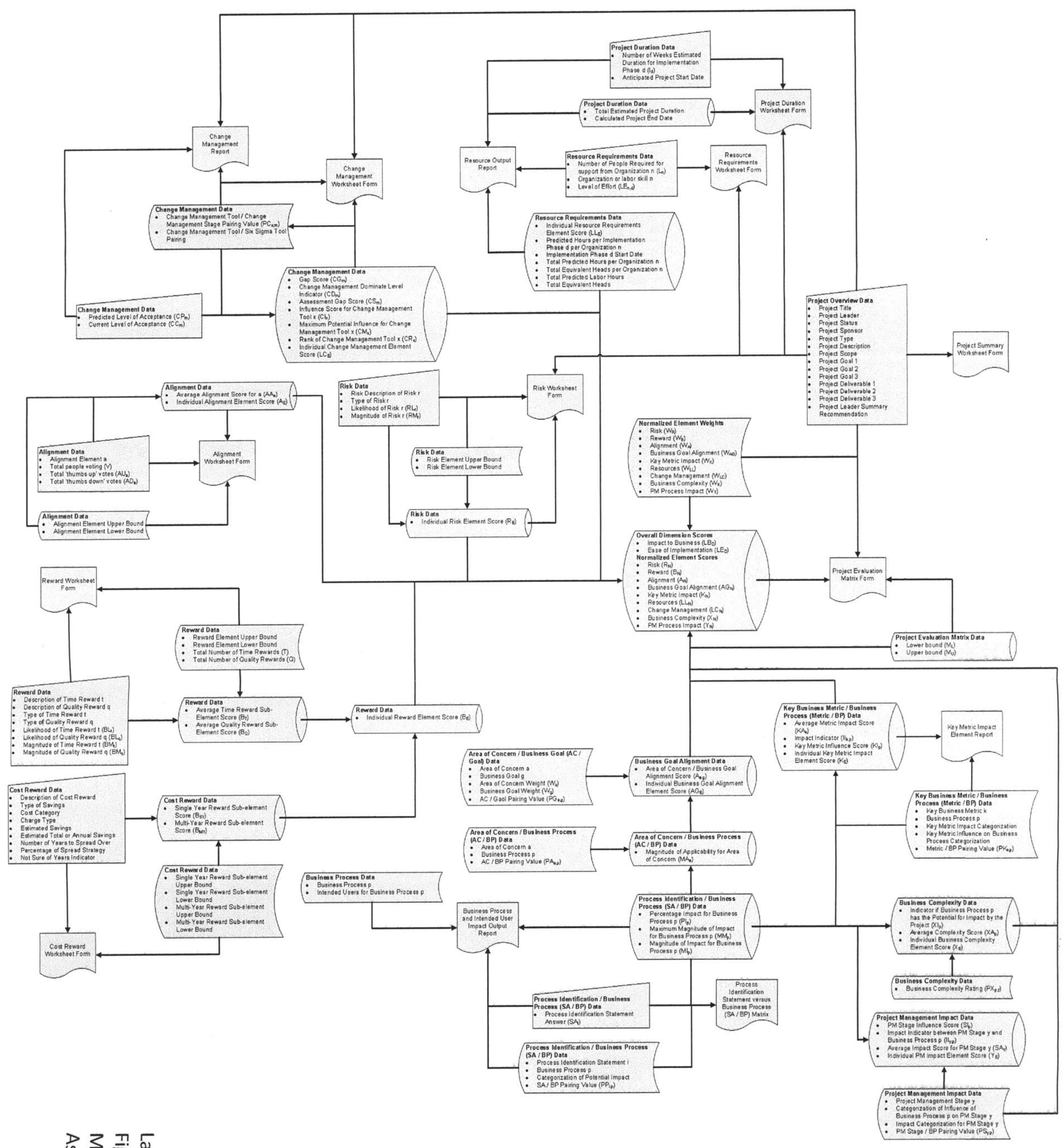
W_Y = Normalized PM Process Impact Element Weight, Project Leaders' Assessment Tool Version

WORKSHOP EVALUATION TOOL – DATA MAPPING



Large scale version of Figure 16: Data Relationship Map – Workshop Evaluation Tool Version

PROJECT LEADER'S ASSESSMENT TOOL – DATA MAPPING



Large scale version of Figure 17: Data Relationship Map – Project Leader's Assessment Tool Version