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Utilizing Knowledge Transfer to Promote Management of Countervailing Risks in Value Stream Analysis

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UTILIZING KNOWLEDGE TRANSFER TO PROMOTE MANAGEMENT OF

COUNTERVAILING RISKS IN VALUE STREAM ANALYSIS

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ABSTRACT

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Organizations are frequently faced with the challenges of modifying and streamlining their processes by utilizing the latest process improvement techniques such as Lean Thinking. They use these techniques to allow them to better perform their organizational purposes through the elimination of waste and non-value added steps. Personnel performing these modifications need to account for potential outcomes and risks when streamlining processes. An association of knowledge transfer and experience to the identification and handling of these countervailing or alternative risks when performing Lean Thinking value stream analysis is investigated. The elements of risk management, Lean Thinking and knowledge transfer are described.

This dissertation presents the results of a non-experimental examination to identify knowledge transfer as a means to promote management of countervailing risks that may arise when performing Value Stream Analysis and provides a foundation for future research. A research model was formulated, and a survey instrument developed with data collected from Department of the Navy personnel during Lean Thinking events. Quantitative data analysis supported the research question and showed an association between a decision-maker's knowledge from other projects and the identification and handling of countervailing risks that arise during Value Stream Analysis.

This dissertation is dedicated to my son, Sam. May you always strive to learn. Research what you are told to prove to yourself whether or not it is true.

"You may be whatever you resolve to be."

-Thomas "Stonewall" Jackson

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1. INTRODUCTION

PROBLEM STATEMENT

The process of Lean Thinking is a management activity intended to improve the quality of products or services (Womack & Jones, 2003). In the process of Lean Thinking, an assessment strategy called value stream analysis is performed to determine the value and criticality of each process. During value stream analysis, along with discussing whether the process adds value or not, it is proposed that key criteria considered in the value or non-value decision are: (a) the extent to which risks are created or imposed by eliminating, modifying or moving that process and (b) the countervailing risks that may arise from these changes. These countervailing risks need to be identified and addressed through some type of risk management process.

Risk management is defined as "a procedure to control the level of risk and to mitigate its effects" (Uher & Toakley, 1999, p. 161). Hoeft, Davey and Newsome (2007) propose using a continuous process improvement (CPI) tool called value stream mapping aimed at increasing the effectiveness of risk management by mapping the steps of risk identification to those in value stream analysis, but does not address the experience of the teams performing the analysis or knowledge transfer. The objective of this value stream analysis research is to identify and reduce risks in the key process areas identified during Lean Thinking or other CPI initiatives such as Six Sigma, Theory of Constraints, etc. Alternatively, handling identified risks may in turn pose new, countervailing risks that

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arise as a consequence of dealing with the original target risks. Risk analysis through mapping, a framework, has been proposed as a means of improving the effectiveness of process analysis (Hoeft et al., 2007); however, neither management of the alternative countervailing risks nor the implications of experience and knowledge transfer on value stream analysis teams are addressed in the current literature.

Interpretation of alternative risks is an important valuation factor in decision making, yet risk is difficult to interpret as "risk is not something that lends itself readily to objective quantification or a single definition, but rather is socially constructed...human beings have invented the concept *risk* to help them understand and cope with the dangers and uncertainties of life...based on theoretical models, whose structure is subjective and assumption-laden, and whose inputs are dependent on judgement" (Botterill & Mazur, 2004, p. 2). Alternatives, risks, and their probabilities are subject to the interpretation of the evaluator during this value stream analysis. This in turn leads to the question of the role of the evaluator's knowledge when making risk decisions, and his or her risk handling of target and countervailing risks based on prior project experience. This research investigates identifying knowledge transfer as a means to promote management of countervailing risks that arise when performing continuous process improvement during Lean Thinking's Value Stream Analysis.

RESEARCH QUESTION

Risk management and quality control methods during Lean Thinking projects may use continuous process improvement and value stream analysis as means to identify and reduce risks. However, the alternative countervailing risks are not addressed in these methods or in the current literature. This research seeks to answer the question: Is there an association between a decision-maker's knowledge from other projects and the identification and handling of countervailing risks that arise during Lean Thinking's Value Stream Analysis?

RELEVANCE OF THIS RESEARCH

The use of knowledge transfer methodologies to identify and mitigate countervailing risks when performing value stream analysis is significant to practitioners and academics to enable a better understanding of the actions being taken during these processes. It is important for engineering managers because it allows them to better perform their tasking and take into account the potential outcomes of the actions they take when streamlining their processes to eliminate waste and non-value added steps. This research will add to the existing body of knowledge to help practitioners, academics and researchers by providing knowledge of gaps in the current risk management and Lean Thinking literature concerning enhancing the managing of countervailing risks through knowledge transfer. This research may also identify areas for future research efforts enabling others to add findings to the body of knowledge.

LEAN THINKING VALUE STREAM ANALYSIS BACKGROUND

From the days of Deming and his concept of Total Quality Management aimed at increasing the quality of the product, to the Theory of Constraints for identifying and exploiting system bottlenecks, and on to Six Sigma for reducing variation and measuring defects, many methodologies have looked at the pieces and processes involved with the intent of improving the product or service. Lean Thinking is the next evolution for quality improvement. Although often combined to take advantage of each other's strengths, Lean and Six Sigma are two different philosophies. Table 1 is provided to point out the differences between Six Sigma and Lean Thinking. Primarily, Six Sigma looks at reducing variation to improve the quality of products, processes or services, whereas Lean Thinking focuses on reducing cycle time and waste in processes (Furterer, 2004, p. 1). Only Lean Thinking is evaluated since improvement of the process flow is of interest in this research.

Program	**Six Sigma**	**Lean Thinking**
View of Waste	Variation is waste	Non-value add is waste
Application	1. Define 2. Measure 3. Analyze 4. Improve 5. Control	1. Identify Value 2. Define Value Stream 3. Determine Flow 4. Define Pull 5. Improve Process
Tools	Math-Statistics	Visualization
Focus	Problem focused	Process flow focused

Table 1: Six Sigma versus Lean Thinking

(Adapted from Bizmanualz, 2006, p. 2)

The objective of this research is to understand the link between knowledge transfer and risk management methodologies to be used as functions and activities that are accomplished when performing Lean Thinking Value Stream Analysis to promote management of countervailing risks. This investigation has been conducted to determine the extent to which knowledge transfer from prior or concurrent projects is influential in managing resultant, countervailing risks that may arise when performing Value Stream Analysis during Lean Thinking events.

2. LITERATURE REVIEW

A literature review is an in-depth review of credible research literature in the field of interest conducted to determine and understand the current state of the bodies of knowledge on a given research topic. The review provides scholarly information and research from others on the given subject that is relevant to the research question. The literature review is a precursor to proposed research intended to identify current research on the topic. A study of the current literature provides the information necessary to identify the links and gaps regarding the research and provide a rationalization for the development through reasoning of hypotheses.

Literature regarding risk management and Lean Thinking was reviewed to determine the current state of both fields and to identify the links and gaps between them. The intent was to determine support for assessing the effectiveness of using risk management methodologies in Lean Thinking process analysis. After an extensive literature investigation, it was determined that there were few links and many significant gaps in the application of risk management to Lean Thinking. The identification of the alternative or countervailing risks that arise due to mitigating the initial risk by performing Lean Thinking and the utilization of knowledge transfer to promote management of those risks are only minimally addressed. However, what was discovered is included in the discussion of the gap analysis referenced in subsequent paragraphs.

CURRENT STATE OF RISK MANAGEMENT RESEARCH

Risk management is commonly categorized as identifying, assessing and responding to risks. Risk management has no agreed upon methodology in the current body of knowledge. Numerous approaches are found in literature including two-phase methods with phases of risk analysis and risk management (APM, 2000) and nine-phase methods with phases of define, process, identify, structure, ownership, estimate, evaluate, plan and manage (Chapman, 1997). There also may be different terminology that deals with the steps of each individual risk management methodology. For example, some methodologies may follow risk analysis, risk assessment and risk management (Aven & Kristensen, 2005), or risk identification, risk quantification, risk response development and risk response control (PMI, 1996), but the underlying processes of the many methodologies observed are similar. Commonality among the actual processes performed is risk identification and planning, risk assessment and analysis, and risk handling and response; risk monitoring is an iterative process that is sometimes shown separately or implied as part of the original steps in other approaches. Uher and Toakley (1999, p. 161) state the "generally recognized steps entailed are risk identification, risk analysis and risk response." This is the methodology that is implied throughout this paper where risk management is mentioned.

Currently, risk management is evolving to Team Empowerment, risk efficiency and uncertainty management. Employees have expertise and skills pertaining to their projects that enable them to successfully manage their tasks; however, empowerment is giving teams and members the latitude and authority in their work to achieve project and company goals. Williams (1997) discusses empowerment within Project Management to address project risk, where teams should not be "empowered to take actions cross-impacting other project areas. They should, however, be able to make desires known and influence project decisions." However, empowerment is allowable and desirable in terms of risk management. Robert Chapman (1998, p. 333) discusses the importance of expert judgment to the accuracy of risk management and the effectiveness and efficiency of the project management process:

> "Project management models, methods, and software provide valuable tools for project planning and design, but obtaining the right answer still depends upon specialist expertise. Judgements must be made, in some cases based upon hard data, in others based on sound conventional guidelines. In other cases creative innovation and well schooled intuition based upon a wide range of relevant experience must be used. Expertise involving an efficient blend of all of these aspects is not made less important by adopting general risk management methods: it is simply made use of more effectively" (Chapman cited in Chapman, 1998, p. 333).

In addition to empowerment for project management, Chapman and Ward (2004, p. 620) discuss a project risk management decision tool where "'risk efficiency' is simply 'the minimum risk decision choice for a given level of expected performance', 'expected performance' being a best estimate of what should happen on average, 'risk' being 'the possibility of adverse departures from expectations.'" This risk response technique is a management decision based on analysis of identified risk options. Floricel and Miller

(2001, p. 452) identified the four types of responses aimed at coping with risks or unexpected events as adapting, fighting, exiting and doing nothing. The management response would then be the one that is most efficient to the project and problem at hand.

Ward and Chapman (2003) impose the idea of updating the "risk" management terminology to "uncertainty" management. This is due to the negative connotations the term "risk" implies. Identifying "sources of uncertainty encourages a more open ended, neutral description of factors, which facilitates a less constrained consideration of response options" (Ward & Chapman, 2003, p. 102). This new look at risk management also takes into account situations such as an overabundance of resources versus the risk of not enough. Uncertainty management is a philosophical change in risk management's outlook.

Empowerment, risk efficiency decisions, and uncertainty deal with risk handling. As is implied throughout, risk management decisions are employee-based. However, people themselves introduce risk to the project: "Internally generated risks are those risks that have their origin within the project organisation or its host, arising from their rules, policies, processes, structures, actions, decisions, behaviours or cultures" (Barber, 2005, p. 584). Even though the projects are reliant on personnel expertise, these internally generated risks are due mainly to the people in the project or organization. These risks are also important and need to be managed as part of the process.

Risk management is aimed at specified projects or processes to identify, analyze and handle the risks that may arise. Risk management does not look at the overarching project and its processes as a system in terms of evaluating quality or process improvement. Uher and Toakley (1999, p. 162) state that "little information is available about (decision makers) attitudes towards the use of risk management as a systematic decision-making tool." Here is an identified need for risk management as a methodical decision-making tool.

Risk management as a science is dealing currently with uncertainty and risk efficiency. This risk management is employee-based and reliant on their knowledge and decisions and shows a distinct link between risk management and knowledge transfer. Van Donk & Riezebos (2005, p. 75) aver that "knowledge consists of truths and beliefs, perspectives and concepts, judgements and expectations, methodologies and know-how and is possessed by humans, agents, or other active entities and is used…to determine what a specific situation means and how to handle it." The phenomenon under study in this investigation is the transfer of knowledge from other projects to handle the risks and uncertainties of the decisions being made regarding the value stream analysis of the project in a Lean Thinking event. Regev, Shtub and Ben-Haim (2006, pp. 17-19) discuss a means to analyze risk based on an attempt to evaluate the gap between the information available to the project manager and the information needed, where "the knowledge gap is the gap between what we should know to guarantee project success and what we really know at a given point in time." Risk management through knowledge transfer is a means of filling the knowledge gaps and addressing the countervailing risks that may arise from performing value stream analysis to address the project's original target risks.

CURRENT STATE OF LEAN THINKING RESEARCH

Lean Thinking is a management activity with the intent of improving the quality of products or services. Poppendieck (2002, p. 7) states "the underlying principles of eliminating waste, empowering front line workers, responding immediately to customer requests, and optimizing across the value chain are fundamental to Lean Thinking." Lean Thinking research is aimed at quality improvement through project process valuation and the elimination of waste and non-value added activities.

Quality improvement philosophies have many approaches and aims. Among these approaches include improving the product itself by focusing on the elimination of variances and refining tolerances to produce a consistent product as in Total Quality Management and Six Sigma. Also included are philosophies that focus on throughput. Theory of Constraints (TOC) is a methodology for managing production planning and scheduling by identifying the system's constraints and exploiting bottlenecks (Srinivasan, Jones & Miller, 2004, p. 136). TOC deals with the Critical Chain, which the Program Evaluation and Review Technique (PERT) identifies as the Critical Path. Other philosophies deal with process improvement where the focus is to deal only with processes that add value to the system flow, as in Lean Thinking.

Lean Thinking is the current theme in quality control. "Lean Thinking is a highly evolved method of managing an organization to improve the productivity, efficiency and quality of its products or services. The core principle it uses is that no work should be done unless it is going to create customer value. Work should be performed in the simplest, most efficient way to maximize the smoothest throughput of product and services from you to the customer" (Ikovenko & Bradley, 2004, p. 1). Within Lean Thinking research, the current state of the literature addresses process valuation and improvement.

Research has also shown that TOC and Lean Thinking may be used together. The principle is to use TOC to focus on exploiting the bottleneck while Lean Thinking focuses on reducing waste in the whole process (Srinivasan et al., 2004, p. 142). This application combines two flow-based strategies with the expected result being process improvement greater than either individual strategy would produce separately.

The main course of action in Lean Thinking is that of Value Stream Analysis where all project processes are identified, assessed and treated accordingly. The first step in value stream analysis is to create a value stream map that identifies all actions required for a product (or service). These items are sorted into categories: "(1) those which actually create value as perceived by the customer; (2) those which create no value but are currently required by the product development, order filling, or production systems…and so can't be eliminated just yet; and (3) those actions which don't create value as perceived by the customer… and so can be eliminated immediately" (Womack & Jones, 2003, pp. 37-38). Appendix A is provided for supplemental information detailing the value-added mapping process with examples of the phases mentioned.

The concept of Lean Thinking and value stream analysis is simple and straightforward. The technique identifies those processes that add value and eliminates those that do not. Eliminating non-value processes may seem as though the system were being made less capable, but "lean systems are quite robust, because they don't hide unknown, lurking problems and they don't pretend they can forecast the future" (Poppendieck, 2002, p. 6). However, for risk management, since the developed system is pared down to the critical processes, it is important to assess the alternative risks and countervailing risks. Hoeft et al. (2007) propose the use of value stream mapping to perform risk analysis on project risks by utilizing a first pass mapping to identify process value and then performing a second pass mapping on the project to identify and analyze the project's risks. Identification of the risks is a subjective function performed by the team members. This paper seeks to investigate the extent to which knowledge transfer from previous projects or from team members with prior experience is used to formulate the basis for predicting how the revised, future state process may perform, and identify what new risks may arise in the revised process to promote management of these countervailing risks.

CURRENT KNOWLEDGE TRANSFER BODY OF KNOWLEDGE

Provided in this section are general discussions concerning knowledge transfer. Topics specifically address:

1. The knowledge transfer methods identified in the knowledge transfer literature;
2. The different tools that have been suggested that facilitate the execution of methods to transfer knowledge;
3. The enablers and barriers of knowledge transfer that have been suggested by researchers;
4. How knowledge management and knowledge transfer are related; and
5. How the effort and success of knowledge transfer can be measured and evaluated.

Knowledge Transfer Methods

Ladd and Ward (2002, p. 3) aver that "knowledge transfer is nominally concerned with the process of moving useful information from one individual to another person." Dixon (2000) bases the type of knowledge transfer on who needs the knowledge, how routine is the task and whether the knowledge is tacit or explicit. Expanding on this, Roth (2003, pp. 33-34) provides definitions where "tacit knowledge is the knowledge that the individual is not fully aware of and which is difficult or impossible to articulate in written documents… [and] explicit knowledge, on the other hand, is knowledge that is observable and which can be embedded in tools, processes and rules." As specific examples, Dixon (2000) gives the five types of knowledge transfer as serial, near, far, strategic and expert.

- Serial Transfer is the knowledge a team has learned from doing its task that can be transferred to the next time that team does the task in a different setting.
- Near Transfer is the explicit knowledge a team has gained from doing a frequent and repeated task that the organization would like to replicate in other teams that are doing very similar work.
- Far Transfer is the tacit knowledge a team has gained from doing a non-routine task that the organization would like to make available to other teams that are doing similar work in another part of the organization.
- Strategic Transfer is the collective knowledge of the organization needed to accomplish a strategic task that occurs infrequently but is of critical importance to the whole organization.

- Expert Transfer is the technical knowledge a team needs that is beyond the scope of its own knowledge but can be found in the special expertise of others in the organization.

These types of transfer are the means by which knowledge is moved from one individual or group to another. The knowledge transferred may be tacit or explicit.

Knowledge Transfer Tools

Knowledge transfer enables the receivers to create their own knowledge and understanding of the knowledge to be transferred. Knowledge transfer tools are the devices used to support the implementation of the knowledge transfer. The different tools investigated that facilitate the execution of knowledge transfer are applicable to both explicit and tacit knowledge.

Although there are many tools to transfer knowledge, information technology is touted as being "the fundamental tool for knowledge management, because it enables the transference of experience among employees much faster" (Yeh, Lai & Ho, 2006). Tools may be utilized to enhance knowledge transfer, but Roth (2003, p. 43) stresses the challenge for organizations to "enhance effective knowledge creation within and between different knowledge domains," and states that "four modes of knowledge creation constitute a very attractive theory on how knowledge is transformed, transferred and created in working groups."

Knowledge transfer tools facilitate the means by which a receiver can create her/his own knowledge and understanding of the knowledge being transferred. Nonaka (cited in Smith, 2001, p. 316) provides four basic patterns for creating knowledge in organizations:

(1) From tacit to tacit – learn by observing, imitating and practicing, or become "socialized" into a specific way of doing things, such as learning from mentors and peers. Knowledge is not explicit in this stage.

(2) From explicit to explicit – combines separate pieces of explicit knowledge into a new whole, such as using numerous data sources to write a financial report.

(3) From tacit to explicit – record discussions, descriptions and innovations in a manual and then use the content to create a new product. Converting tacit knowledge into explicit knowledge means finding a way to express the inexpressible. To illustrate, moving from tacit to explicit involves stating one's vision of the world – what it is and what it ought to be.

(4) From explicit to tacit – reframe or interpret explicit knowledge using a person's frame of reference so that knowledge can be understood and then internalized or accepted by others. A person's unique tacit knowledge can be applied in creative ways to broaden, extend or reframe a specific idea. Tacit knowledge does not become part of a person's knowledge base until it is articulated and internalized.

Explicit Knowledge Transfer Tools

The tools associated with explicit knowledge transfer relate to the sharing and distribution of that knowledge in a codified format verbally, in writing and electronically.

Specific tools relating to this transfer include email, electronic discussions, and forums (Smith, 2001). Information Technology (IT) utilizes databases, digital network products such as intranets and groupware, and documents (Dougherty, 1999). Benchmarking adapts or adopts good practices [best practices] and lessons learned from other organizations or professions (Leung, Chan & Lee, 2004; O'Dell, Wiig & Odem, 1999). Items such as surveys, case studies and questionnaires are also utilized to transfer knowledge from one group or individual to databases to be consolidated for further use and distribution.

Tacit Knowledge Transfer Tools

"Tacit knowledge is acquired, taught and shared through knowledge fairs, learning communities, study missions, tours, advisory boards, job rotation, stories, myths and task forces" (Smith, 2001, p. 317). The transfer of tacit knowledge is conducted through socialization, where individuals or groups meet to exchange ideas and knowledge. An example of this socialization is through 'Communities of practice' where people "capture and share knowledge and complement existing organizational structures…groups work outside the traditional organizational structure and are virtually immune to management" (Smith, 2001, p. 318). "These communities develop group knowledge and generate assets by transferring knowledge and stimulating innovation" (Pascarella cited in Smith, 2001, p. 318).

To enable the knowledge transfer, cognitive models are used to communicate an understanding and give meaning to events. Stewart (cited in Smith, 2001, p. 314) explains "people use metaphors, analogies, demonstrations and stories to convey their tacit knowledge to others, as well as taking photos and sharing these photos with colleagues. "Stories about why things happened and how information could be applied contain tacit knowledge" (Smith, 2001, p. 314).

Another means of knowledge transfer utilizes information technology. "Pioneers of the World Wide Web set out to create a forum for dialogue, for sharing and exchanging information, knowledge and ideas" (Dougherty, 1999, p. 265).

Although shown as examples under the specific headings, the different tools suggested are applicable to both explicit and tacit knowledge transfer. They are a means to facilitate knowledge transfer, but it is up to the participants to achieve the required understanding for it to have been successful.

Knowledge Transfer Enablers and Barriers

Enablers and barriers promote or inhibit identified actions. Researchers have suggested social, technological, organizational, individual and other factors that are enablers and barriers and affect the transfer of knowledge. Although the list is not all-inclusive, it is a general listing proposed by the literature.

Knowledge Transfer Enablers

Yeh et al. (2006, p. 794) believe the key factors that determine the effectiveness of executing knowledge management within the organization are knowledge management enablers, and "because enablers are the driving force in carrying out knowledge management, they do not just generate knowledge in the organization by stimulating the creation of knowledge, but they also motivate the group members to share their knowledge and experiences with one another." Yeh et al. (2006, p. 794) cite related research, which claims "knowledge management enablers include the methods of knowledge management, organizational structure, corporate culture, information technology, people, and strategies, etc."

In supporting the methods of knowledge management as an enabler, Roth (2003, p. 35) states, "different methods need to be used to enable different types of knowledge to be shared that is dependent on the context, the objectives of sharing knowledge and the type of complexity in the setting." Conjunctively, it is proposed that a framework needs to be provided for identifying, capturing, and leveraging knowledge to help a firm compete (O'Dell et al., 1999).

Organizational structure is sustained as an enabler, where the organizational factor of top management support is found to significantly influence knowledge-sharing processes (Lin, 2007). In addition, Martini and Pellegrini (2003) addressed pressures from headquarters and the internal commitment from top managers as enablers for the implementation of different knowledge management configurations. Other beliefs are that knowledge sharing and open communication "should be tied to corporate financial variables. Monetary and non-monetary (intrinsic motivators,) should be used to rewarded people for their abilities to recognize, store and share knowledge" (Smith, 2001, p. 319).

Corporate culture is maintained as an enabler, where "cultural fit, which influences communication flow and openness for sharing knowledge, may be the most important factor in all personal information exchanges" (Smith, 2001, p. 317).

Information technology is also deemed an enabler. "Technology plays a key role in collecting and codifying knowledge for distribution. It is important to have a strong information technology framework to design and implement the systematic storage and dissemination of information. IT is an enabler, but by itself will not get anything out of someone's head" (Wah cited in Smith, 2001, p. 317). In addition, Martini and Pellegrini (2003) addressed technological development and Information and Communication Technology (ICT) as enablers for the implementation of different knowledge management configurations.

Backing people as an enabler, Lin (2007) finds that the individual factors, enjoyment in helping others and knowledge of self-efficacy, significantly influence knowledge-sharing processes. "Monetary motivators are bonuses and percentages of corporate profits. Intrinsic motivators are non-financial rewards, like peer recognition and opportunities to do challenging work" (Smith, 2001, p. 319). In addition, the social interaction between employees is an enabler for the implementation of different knowledge management configurations (Martini & Pellegrini, 2003).

Utilizing strategies as an enabler is justified where "the ability to create knowledge and diffuse it throughout an organization is today recognized as a major strategic capability for gaining competitive advantage" (Roth, 2003, p. 32). Knowledge transfer is a necessary strategy to enable competitive advantage and evolve knowledge resources within the dynamics of the environment.

Knowledge Transfer Barriers

Following the structure of knowledge management enablers, key factors that are barriers to the effectiveness of executing knowledge management within the organization were also listed under the topics of the methods of knowledge management, organizational structure, corporate culture, information technology, people, and strategies.

According to some experts (Maire, Bronet & Pillet, 2005), while discussing detailing barriers to the methods of knowledge management when benchmarking it is difficult to identify what are the best practices, and competitors are not very inclined to provide their best practices. Szulanski (1996, p. 37), when relating to transfer from person to person, states "statistical findings suggest that knowledge-related barriers - lack of absorptive capacity, causal ambiguity, the arduousness of the relationship –clearly dominate motivation-related barriers" between the recipient and the source of knowledge.

Organizational structure is sustained as a barrier, where "the limitation of resources seems to be a general characteristic of [small and medium-sized enterprises]" (Leung et al., 2004, p. 601). A limited number of personnel can only bring a limited amount of knowledge to transfer, and may only be able to interact with a few others to enable the transfer.

When discussing maintaining corporate culture as a barrier, Sun and Scott (2005) performed an investigation to the barriers of learning and acknowledged, "organizational culture is a major source of barrier to transfer knowledge," where they identified barriers to learning at various levels (individual, team, organization and inter-organization) via the Delphi methodology. Results of this investigation provided the perceived barriers to learning by level. Top elements ranked by level showed:

- Barriers in the transfer from individual to team: personality differences (lack of rapport among individual members).

- Barriers in the transfer from team to individual: trust (can the individual be trusted?), and openness to ideas.
- Barriers in the transfer from team to organization: organizational culture and objectives that do not support learning, and group benefit maximization vs. organizational benefit maximization.
- Barriers in the transfer from organization to team: group value system (e.g. can the group be trusted?), and group benefit maximization vs. organizational benefit maximization.
- Barriers in the transfer from organization to inter-organizational groups: loss of the organization's competitive edge and conflicting cultures and values that exist.

"Cultural differences produce additional difficulties and challenges for managers, who must allocate more time on communication, design of compatible work routines, and development of common managerial approaches" (Simonin, 1999, p. 602). Henrie and Hedgepeth (2003, p. 2) conclude, "If the corporate culture isn't one of cooperation and sharing, then the probability of successful tacit knowledge transfer is slim."

Information technology is seen as a barrier as described by Henrie & Hedgepeth (2003), where a tacit knowledge pitfall is reliance on knowledge codification - knowledge that "is extracted from the person who developed it, then made independent of that person, and reused for various purposes...Without codification, the ability to allow explicit knowledge transfer is severely limited," resulting in either underutilization of the corporate asset, or over utilization where everything gets stored in the database resulting in information overload and people start avoiding use of the system (Henrie & Hedgepeth 2003, pp. 2-3).

People may be barriers when "employees hesitate to contribute out of fear of criticism, or of misleading the community members (not being sure that their contributions are important, or completely accurate, or relevant to a specific discussion)" (Ardichvili, Page & Wentling, 2003, p. 64).

When dealing with strategies, the barriers are "the profound questions about what knowledge matters; who needs it; and how those people can get it, use it, and renew it" (O'Dell et al., 1999, p. 204). This can be compounded by the "inability of competitors to comprehend the competencies that are sources of competitive advantages" (Simonin, 1999, p. 597), where not knowing what others know (such as insider knowledge and subject matter expertise) makes it difficult to compete in that market.

Relationship between Knowledge Management and Knowledge Transfer

Knowledge management and knowledge transfer are closely related. Davies (cited in Landaeta, 2003) defines knowledge management (KM) as the tools, techniques and processes for the most effective and efficient management of an organization's intellectual assets aimed at addressing the challenge faced by modern organizations. In concert with this, Nonaka and Konno (cited in Hicks, Dattero & Galup, 2007, p. 6) define knowledge management as "a method for simplifying and improving the process of sharing, distributing, creating, and understanding company knowledge."

Davenport and Prusak (cited in Ladd & Ward 2002, p. 3) state, "Knowledge transfer is nominally concerned with the process of moving useful information from one individual to another person." In addition, Daghfous (2003, p. 145) cites Davenport and Prusak as arguing that the knowledge transfer process consists of transmission and absorption, culminating in a behavioral change in the recipient firm.

Numerous references to the link of knowledge transfer and knowledge management exist. Davenport and Prusak (cited in Ladd & Ward, 2002, p. 3) avow, "Knowledge transfer is an important component of knowledge management, [although] knowledge transfer predates the study of knowledge management by several decades." Dougherty (1999, p. 263) depicts the phrase "knowledge sharing" or "knowledge transfer" as the "human aspect of knowledge management." Described are two mechanisms for transfer: those that are formalized, "such as documents, databases, intranets and groupware; and informal exchanges which are more casual events that take place face to face i.e. in conversation" (Dougherty, 1999, p. 263). "Distribution of the knowledge is a critical enabler of KM and may take many forms, including software applications, web sites, e-mail, and books" (Hicks et al., 2007, p. 8). Daghfous (2003, p. 145) explains that knowledge transfer has not only been a conceptual extension of technology transfer, but it has also emerged as one of the most important and most researched activities and processes in knowledge management.

Knowledge management subsumes the entirety of knowledge events within an organization, from identifying, collecting and assimilating, to validating, applying and transferring. Knowledge transfer is the transference of that knowledge and "depends on how easily that knowledge can be transported, interpreted, and absorbed" (Simonin, 1999, p. 597). Knowledge transfer includes dependencies on the knowledge management enablers and barriers.

Knowledge Transfer Measurement and Evaluation

The effort and success of knowledge transfer may be measured and evaluated through various methods. "Ultimate judges of success are supervisors, team members, partners, shareholders and many others in the value chain" (Smith, 2001, p. 319).

Benefits may also be used to evaluate the success of the knowledge transfer. Knowledge transfer may be measured by determining if "(1) the system helps new people to more quickly integrate themselves into their new place of work and become productive faster; and, (2) the system provides various geographically dispersed units with a place to work together, and to communicate better. Two additional benefits, 'Access to Best Practices', and 'Access to a Lessons Learned Database'" were also mentioned (Ardichvili et al., 2003, p. 71).

Smith (2001, p. 314) expresses the idea that explicit knowledge evaluation is based on tangible work accomplishments, whereas tacit knowledge evaluation is based on demonstrated performance. Of course, the basic factor enabling knowledge transfer is in understanding, and "understanding is said to be able to occur if the information presented is relevant and somewhat familiar to the listener" (Herschel, Nemati & Steiger, 2001, p. 109).

O'Dell et al. (1999, p. 209) discuss knowledge as a product where evaluation may be seen as revenue enhancement, cycle-time reduction, and reuse of knowledge as the business variables. Also included were ideas pursuing "an intellectual asset management strategy focused on attaching financial measures to organizational knowledge assets and linking them to the enterprise's current and future performance" where measurement and evaluation could be performed as benchmarks studied longitudinally (O'Dell et al., 1999, p. 209).

Transfer success may also be evaluated quantitatively. Cummings and Teng (2003) opine that the objective of any knowledge transfer is to transfer source knowledge successfully to a recipient and define transfer success as a dependent variable. Multiple techniques defined transfer success as: the number of knowledge transfers engaged in during a certain period of time; a transfer that is on time, on budget, and produces a satisfied recipient; a transfer that is focused on the degree to which knowledge is re-created in the recipient; and as a degree to which a recipient obtains ownership of, commitment to, and satisfaction with the transferred knowledge (determined by the transferability of meaning and value) (Cummings & Teng, 2003, pp. 41-44).

Roth (2003) shows the success of establishing a sharing culture, where knowledge is created through knowledge sharing processes, as projects that approach the knowledge facilitators instead of vice versa. Otterson (2005) describes how to measure and evaluate knowledge transfer by utilizing benchmarks to establish objectives and show results. "This is the key to demonstrating the success of the knowledge transfer program and the value of similar employee learning initiatives. Always establish knowledge benchmarks before employees begin the learning experience...for you cannot measure improvement without a baseline," and test after the learning experience to evaluate (their catastrophic) risk management knowledge and skill (Otterson, 2005, p. 46).

The effort and success of knowledge transfer can be measured and evaluated through various methods. As discussed, the success of the transfer is dependent on the understanding of the receiver (Cummings & Teng, 2003) and must take into account the different forms and levels of knowledge. A successful transfer also addresses the relational and contextual factors of knowledge (Roth, 2003).

TRANSFER METHODS IN PROJECT MANAGEMENT LITERATURE

Project Management and Research & Development literature identify numerous knowledge transfer methods. Literature acknowledges Dixon's (2000) five types of knowledge transfer as serial, near, far, strategic and expert, and provides a multitude of ways for allowing the transfer to occur (Leung et al., 2004). Numerous knowledge transfer methods may be performed to achieve knowledge transfer.

Dixon (2000) points out that the type of knowledge to be transferred determines the method of transfer. Knowledge may be explicit or tacit. "Explicit knowledge is described as knowledge that can be easily expressed or codified" (Fernie, Green, Weller & Newcomb, 2003, p. 179) and can be "embodied in a code or a language, as a consequence, it can be communicated easily" (Koskinen, 2004, p.15). The literature describes the theme of tacit knowledge as being experience-based, having personal meaning, and being difficult to convey or put in written form (Simonin, 1999). Determination of the type of knowledge, or combination of the types, leads to options for how to transfer the knowledge. Knowledge transfer may utilize any method, but the success of the transfer is dependent on the understanding of the receiver (Cummings & Teng, 2003).

Eskerod & Skriver (2007) reproduce Nonaka and Takeuchi's typology defining four modes of knowledge transfer processes shown in Table 2. Paraphrasing the interpretation of these modes results in a description where socialization requires a physical proximity for execution in action, observation and imitation; externalization is making tacit knowledge explicit; internalization is making explicit knowledge tacit within an individual; and a combination is explicit knowledge being transferred from one explicit form to another explicit form (Eskerod & Skriver, 2007, pp. 114-115).

	To	Tacit knowledge	Explicit knowledge
From	Tacit knowledge	Socialization	Externalization
	Explicit knowledge	Internalization	Combination

Table 2: Types of knowledge and knowledge transfer processes

(Adapted from Eskerod & Skriver, 2007, p. 113)

Methods describing means of transferring knowledge are provided in the following paragraphs. Although listed under specific headings, these methods are applicable methods for either knowledge type provided the required understanding is affiliated with the individuals receiving the knowledge.

Explicit Knowledge Transfer Methods

Explicit knowledge transfer methods are by means of procedures, steps and standards. Eskerod and Skriver (2007, p. 113) utilize Nonaka and Takeuchi's explanation where "explicit or codified knowledge is knowledge that is transferable in a formal and systematic language." Methods for transfer of explicit knowledge include tangible, codified sources where written documentation may be stored or disseminated, electronically, in writing or verbally. Cummings and Teng (2003, p. 49) focus knowledge transfer methods on "activity context" as important information in knowledge transfer, saying the "literature identifies three independent types of knowledge transfer activities, including those focused on assessing the form and embeddedness of the knowledge; those focused on establishing and managing an administrative structure through which differences and issues between the parties can be accommodated and reduced, and those focused on transferring the knowledge." Transferring explicit knowledge relies on a "codification strategy" implying "explicit experiences should be gathered, and then create information that others can utilize later…to make use of an already explicit knowledge or make a tacit knowledge explicit. Knowledge is transferred from a person to a document or another media from which the knowledge may be retrieved at any point in time" (Eskerod & Skriver, 2007,.pp. 113-114). Internet applications for project management may also be used as a method to transfer knowledge where tools such as email, websites and discussion applications meet 'the project management function of disseminating information or providing reference material" (Giffin, 2002, pp. 40-41). Transfer of explicit knowledge relies on activities with methods that focus on codifying specific areas related to the knowledge being transferred.

Zack (cited in Yeh et al., 2006, p. 799) contends that information technology methods play a role in knowledge management via collecting, defining, storing, categorizing, indexing, linking, seeking and identifying related content. E-mail is an example of a communication tool, as well as internet technologies such as file transfer and static websites. Informational communication technology influences the sharing of knowledge by providing channels to "obtain information, correct flow processes, and identify the location of knowledge carrier and knowledge seeker" (Yeh et al., 2006, p.

799). These transfer methods are accomplished through data searches or benchmarking (pulling the information) or distribution (pushing the information), where interpretation of the information's content is dependent on the context of the recipient. The specifics for the means of knowledge transfer accomplishment in these methods occur via knowledge transfer tools.

Data mining may also be used as means of finding and transferring knowledge. Data mining is a process referenced in R&D literature to extract knowledge from large-scale databases where an analysis of data "leads to information, which in turn can be used to produce knowledge" (Studt, 2002, p. 39). Data mining utilizes models and algorithms as mathematical search tools and often as optimization tools to find data of interest from databases that contain explicit or implicit temporal information for research (Studt, 2002). Other methods of transferring information include best practice documents, lessons learned, video nuggets of experts on a web site, and a repository of documents for projects to see what others have done, which may be set up in a framework and linked to each stage of project development with the object being a knowledge management system created to ensure a better sharing of best practice documents and methodologies (Liebowitz & Megbolugbe, 2003, pp. 193-195).

Explicit knowledge transfer occurs via formalized methods "such as documents, databases, intranets and groupware" (Davenport and Prusak cited in Dougherty, 1999, p. 263). A summary of the mentioned explicit knowledge transfer methods includes documentation (procedures, steps and standards), verbal exchanges (discussions, teaching, forums), people-to-documents, and information technology (information communication technology, data searches, benchmarking, and electronic methods).

However, Fernie et al. (2003, p. 179) provide "attempts to capture and manage only explicit knowledge are the most recent and frequently cited criticisms of knowledge management within the literature" for they do not take into account the context and personal understanding of the individual.

Tacit Knowledge Transfer Methods

Tacit knowledge is, by and large, learned experience that is difficult to express. Eskerod and Skriver (2007, pp. 113-114) describe tacit knowledge as personal and context specific and, therefore, difficult to formalize and communicate. To transfer knowledge that is tacit and unconscious requires physical proximity between individuals, where "the situation requires execution in action, observation and imitation."

Tacit knowledge may be transferred via informal methods as "exchanges which are more casual events that take place face to face" (Davenport and Prusak cited in Dougherty, 1999, p. 263) such as talk rooms and knowledge fairs (Dougherty, 1999, p. 263). This may also be accomplished based on interactions between individuals "like in a master and apprentice relationship" by linking individuals who need knowledge with those that possess that knowledge, entitled "personalization strategy" (Eskerod & Skriver 2007, p. 114). It is also claimed that "tacit knowledge is gained and exchanged through interpersonal contacts…[and] the notion of 'knowledge' cannot be separated from the knower...whereby knowledge is essentially personal. Any approach at knowledge sharing must be predicated on engaging the *individual*…Knowledge is frequently embedded in context such that an understanding of the 'host' and 'receiving' contexts becomes central to any knowledge-sharing" endeavor (Fernie et al., 2003, pp. 179-185).

Tacit knowledge transfer requires socialization and an interaction between the individuals or groups performing the transfer. In order for the transfer to be successful, there has to be an understanding by the recipient of the knowledge, and the knowledge has to make sense. Reich (2007) discusses numerous means by which to transfer complex and tacit knowledge from brainstorming sessions and visiting experts to methodology workshops, estimation exercises, lessons learned, stories and experiences. Simulations are also valuable for hypothetical events and may create knowledge through causal reasoning, which is working forward from doing something to its result, and diagnostic reasoning, which involves working back from some result to the action that caused it (Busby, 1999, p. 25). Utilizing post-project reviews to disseminate knowledge, Busby (1999, p. 23) points out that people "do not automatically learn from their own experience, even as isolated individuals. They have to test new experiences against their existing knowledge and revise that knowledge in order to learn."

O'Dell et al. (1999) provide numerous knowledge transfer methods, which include informal sharing of knowledge and organized knowledge sharing. They may be one-on-one or reach broader populations with greater value to the enterprise. Approaches include the learning organization, networking, practice centers and communities of practice, lessons learned, spreading of best practices, and feedback systems. Byosiere and Luethge (2007, p. 19) describe the utilization of Project Management as a strategic tool to "dissolve rigid boundaries and enhance the flow of knowledge" by neutralizing the intradepartmental rivalries between functional silos and "enhancing the creation and dissemination of knowledge and the exchange of other critical resources." For transferring knowledge from one group to another, or to another organization, Cummings and Teng (2003, p. 43) cite literature showing that "whether tacit or explicit, such knowledge can be transferred by transferring individuals."

A socialization action for knowledge transfer is through a method called Communities of Practice (COPs). COPs are where community members bond in smaller groups to capture and share knowledge (O'Dell et al., 1999). According to Sense (2003, pp. 7-8), a COP "focuses around a domain of knowledge…that creates a sense of common identity as opposed to focusing on a specific and unique task achievement…[where] the project team serves as a knowledge exchange venue for these COPs – not a COP in its own right." Bishop (1999, p. 6) similarly employs the tactic of cross-functional teams for a joint decision-making process, "reducing sequential knowledge transfer activities, reducing work, improving the flow of communication, and increasing knowledge at lower levels of the organization." To "appropriate knowledge from someone else means having a shared mental model or system of meaning that enables the other to understand and accept that knowledge…some level of shared meaning that allows one group to understand and apply another's insights to their own context…In communities of practice, knowledge is constructed as individuals share ideas through collaborative mechanisms such as narration and joint work" (Bresnen, Edelman, Scarbrough & Swan, 2003).

Similar to COPs is the concept of self managing teams (SMTs) (Ayas, 1996) that utilize project management to improve the ability to generate knowledge and make it explicit and capable of being shared. In SMTs, a core team is built with the desired mix of skills and specialties to cover the whole aspect of a project. Members transmit their learning to others and project improvement depends mainly on the ability to learn from experience. Job rotation is encouraged through a project network structure, which enables members to be absorbed back into the organization or assigned to new teams allowing them to transmit their learning to another group of individuals that were not in the original group (Ayas, 1996).

To allow knowledge transfer, numerous knowledge transfer methods may be performed. The cliché, "it's not what you know, but who you know that matters" applies well to tacit knowledge transfer. The primary theme for transfer of tacit knowledge is that "processes of knowledge capture, transfer and learning in project settings rely very heavily upon social patterns, practices and processes in ways which [emphasize] the value and importance of adopting a community-based approach" (Bresnen et al., 2003, p. 165). The underlying methods of tacit knowledge transfer rely on transfer through socialization techniques since knowledge is acquired not collected, and these methods are dependent on interactive strategies that develop understanding.

GAP ANALYSIS

As shown in the previous discussions, there is a gap in the current literature between the process evaluation steps of Lean Thinking and the risk steps of risk management in managing countervailing risks. A literature review was performed to analyze the gap between Lean Thinking's value stream analysis and risk management. The criteria used during the review of the literature for risk management steps as distinguished by Klein and Cork (1998, p. 345) was the extent to which the material discusses:

1. The identification of possible risks and their consequences (risk identification);

2. The articulation of risks in terms of their likelihood and seriousness (risk analysis); and
3. The process of dealing with the identified and assessed risks (risk response).

Additional criteria assessed for Lean Thinking steps as presented in Womack and Jones (2003) was whether the literature discussed:

1. Identifying the processes required to accomplish a project along with the value of each process and eliminating the non-value added processes (identifying process value);
2. Grouping the value added activities or processes efficiently (determining process flow); and
3. Moving towards process perfection by reapplying the methodology to the project and applying it to new projects at the outset (improving process).

Also identified were if the articles discussed a risk trade-off analysis of the risks that arise from addressing the target risks (countervailing risks) and if knowledge from prior projects/experience was used to address identifying or managing these risks (knowledge transfer). Table 3 highlights this gap and supports the investigation of the research question.

	Risk Identification	Risk Analysis	Risk Response	Identifying Process Value	Determining Process Flow	Improving Process	Countervailing Risks	Knowledge Transfer
Aase, Karina; Nybo, Geir 2005								X
APM 2000	X	X	X					
Aven, T.; Kristensen, V. 2005	X	X	X					
Baldry, David 1998	X	X	X					
Bier, Vicki 1999		X						
Bryant, Michael; Chervony, Anne; Wojdula, Joseph; et al. 1992	X			X	X	X		
Certified Six Sigma Black Belt Primer 2001				X	X	X		
Chapman, Chris 1997	X	X	X					
Chapman, Chris; Ward, Stephen 2004	X		X	X				
Chapman, Robert J. 1998	X	X						
Conrow, Edmund 2005	X	X	X					
Cooper, Lynne 2003			X					X
Currie, Wendy 2003		X						X
DoD DAU 2003	X	X	X					
Floricel, Serghei; Miller, Roger 2001	X	X	X					
Gabriel, Eric 1997	X	X		X	X			
George, Michael 2002				X	X	X		
George, Michael 2003				X		X		
George, Michael; Rowlands, David; Price, Mark; Maxey, John 2005					X	X		
Goldratt, Eliyahu 1990				X	X			
Hoeft, Steve 2007	X	X	X	X	X	X		
Hofstetter, 2002		X					X	
Huthwaite, Bart 2004				X	X	X		
Ikovenko, Sergei; Bradley, Jim 2004				X	X	X		
Isaac, Ian 1995	X	X	X					
Jaafari, Ali 1996	X	X	X					
Jaafari, Ali 2001	X		X					
Klein, Jonathan; Cork, Robin 1998	X	X						

	Risk Identification	Risk Analysis	Risk Response	Identifying Process Value	Determining Process Flow	Improving Process	Countervailing Risks	Knowledge Transfer
Kristensen, V.; Aven, T.; Ford, D. 2006		X	X					
Lengyel, Dave 2007	X							X
Milis, Koen; Mercken, Roger 2004	X			X				
Miller, Roger; Lessard, Donald 2001	X	X	X					
Miller, William; Schenk, Vicki 2004				X	X	X		
Muller, Ralph; Turner, J. Rodney 2005		X	X					
PMI 1996	X	X	X					
Poppendieck, Mary 2002				X	X	X		
Poppendieck, Mary; Poppendieck, Tom 2003				X	X	X		
Regev, Sary; Shtub, Avraham; Ben-Haim, Yakov 2006	X	X	X					X
Stewart, Roger; Fortune, Joyce 1995	X	X	X					
Ward, Stephen 1999	X	X	X					
Ward, Stephen; Chapman, Chris 2003	X	X						
Williams, Richard; Thompson, Kimberly 2004		X	X				X	
Womack, James; Jones, Daniel 2003				X	X	X		

Table 3: Gap Analysis of Risk Management and Lean Thinking Literature

As is shown in the gap analysis table, with few exceptions the literature portrays processes that are associated either with risk management or with Lean Thinking. Although there are risk management articles that do discuss value (Chapman & Ward, 2004; Milis & Mercken, 2004), these references only lightly touch on how a particular strategy may add value to a project or goal but do not discuss utilizing risk management to increase the effectiveness of process valuation. The same holds for Lean Thinking articles where risk is mentioned as possible during project management (Gabriel, 1997) but is not discussed in any detail or in relation to risk management methodologies in the value analysis process. It was not until Hoeft et al. (2007) that both risk management and Value Stream Analysis were discussed as potentially complementary processes, yet no trade-off analysis or comparison of risks was discussed. The literature does not discuss utilizing knowledge transfer to promote the management of countervailing risks during the activities of risk management and Lean Thinking.

Methodology discussions maintain the phases for risk management and Lean Thinking individually. Rarely does literature in one discipline refer to any step associated with the other discipline, and very rarely is knowledge from previous projects or experience or risk trade-off analyses mentioned. As has been shown, the literature does not address the concept of utilizing knowledge transfer to promote the management of countervailing risks when determining process value and criticality during a Lean Thinking value stream analysis project.

RESEARCH HYPOTHESES

The literature search revealed "little information is available about (decision makers') attitudes towards the use of risk management as a systematic decision-making tool" (Uher & Toakley, 1999, p. 162). Also shown in the literature is that risk management is aimed at specified projects or processes to identify, analyze and handle the risks that may arise, leaving unaccounted the countervailing risks from decision making events.

Lean Thinking processes focus on "new team-oriented organizations which are centered on the flow of value, not on functional expertise" (Poppendieck, 2002, p. 5), but in risk management, "obtaining the right answer still depends upon specialist expertise" (Chapman, 1998, p. 333). In addition, Lean Thinking empowers the workers whereas risk management is implementing oversight for the empowerment to ensure decisions do not overstep boundaries. Knowledge transfer is hypothesized to enable the decision makers to promote management of the countervailing risks obtained during value stream analysis projects based on their knowledge and expertise. This approach assumes value stream analysis is being performed to mitigate project risks (such as excessive cost or prolonged schedules) identified in the previous process by eliminating or modifying, where applicable, the non-value added processes.

It is assumed that when determining the future state process during the value stream analysis continuous process improvement method of Lean Thinking, the greater the amount of experience a decision maker has in the type of work being changed, the better the decision maker will be able to identify the alternative risks that may occur. In addition, knowledge transfer across projects supports management of the identified countervailing risks. In support of the research question, "is there an association between a decision-maker's knowledge from other projects and the management of countervailing risks that arise during Lean Thinking's Value Stream Analysis?" the hypotheses to be investigated are:

Hypothesis 1: There is significant correlation between experience and identification of countervailing risks.

Hypothesis 2: There is significant correlation between experience (i.e., previous occurrences; lessons learned) from other projects and the handling of countervailing risks in the current project.

Hypothesis 3: There is no significant correlation between education and the identification of countervailing risks.

Hypothesis 4: There is no significant correlation between education and the handling of countervailing risks.

Hypothesis 5: There is significant correlation between utilizing knowledge transfer across projects and identification of countervailing risks.

Hypothesis 6: There is significant correlation between utilizing knowledge transfer across projects and handling of countervailing risks.

Hypothesis 7: There is no significant correlation between project roles (manager, administrative, engineer, etc.) and identification of countervailing risks.

Hypothesis 8: There is no significant correlation between project roles (engineer, manager, administrative, etc.) and the handling of countervailing risks.

Figure 1 depicts the research model correlating the hypotheses to be tested. The resultant premise being tested is if the decision maker is experienced in the area of work, then they will be better able to identify countervailing risks that may arise as a result of proposed changes to the process in the future state of a Lean Thinking event. Also, if personnel have knowledge from other projects regarding risks that may arise when changing how a process is performed, then their experience may be utilized to support assessment and handling of the new, countervailing risks through expert transfer.

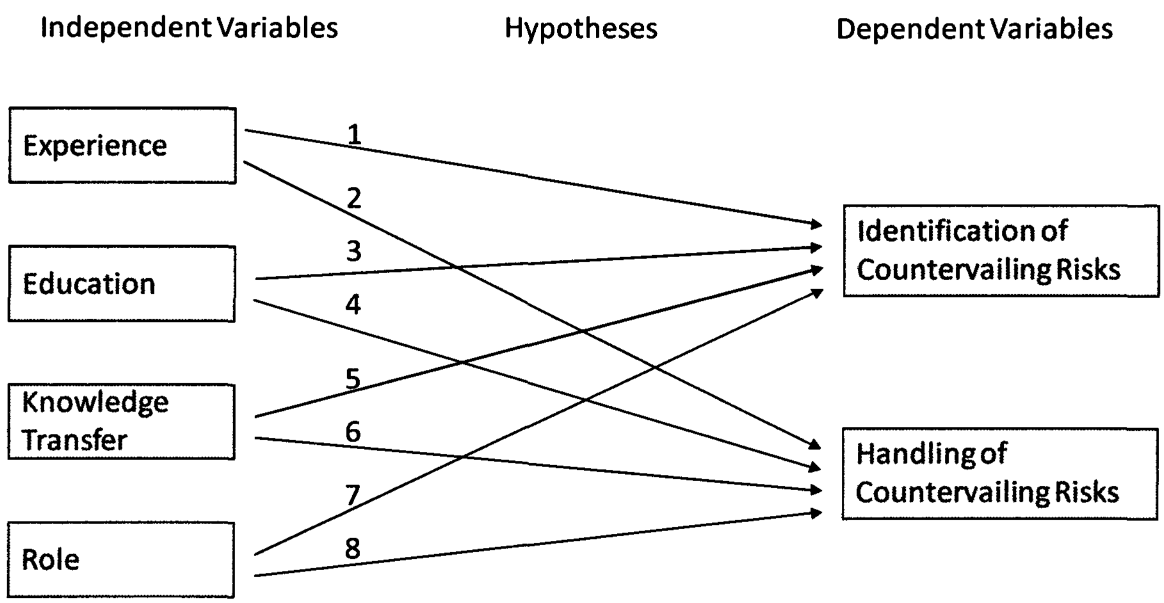


Figure 1: Research Model

3. METHODOLOGY

INTRODUCTION

A research methodology consists of the practices, procedures and rules used in an inquiry utilizing established methods and procedures. A "research method is a strategy of inquiry which moves from the underlying philosophical assumptions to research design and data collection" (Myers, 1997) as an approach designed to answer a researcher's questions. The proposed methodology utilized in this research is quantitative in nature and designed to investigate whether:

1. An association exists between the decision-maker's experience and the identification and handling of countervailing risks;
2. An association exists between knowledge transfer and the identification and handling of countervailing risks.

The environment in which this association is to be tested is development of the future state process in Department of the Navy Lean Thinking Value Stream Analysis events. Simple statistical correlation will be used to analyze the quantitative data as no causality between the variables is to be studied within the scope of this investigation.

QUANTITATIVE RESEARCH

The strategy of inquiry determines the approach the research will take. Quantitative research is a deductive method of reasoning moving from theory to confirmation by hypothesizing, then trying to prove the hypothesis through observation using empirical data and techniques.

"Quantitative research methods were originally developed in the natural sciences to study natural phenomena. Examples of quantitative methods now well accepted in the social sciences include survey methods, laboratory experiments, formal methods (e.g. econometrics) and numerical methods such as mathematical modeling" (Myers, 2006). Creswell (2003, p. 18) provides the notion that "a quantitative approach is one in which the investigator primarily uses postpositivist claims for developing knowledge (i.e., cause and effect thinking, reduction to specific variables and hypotheses and questions, use of measurement and observation, and the test of theories), employs strategies of inquiry such as experiments and surveys, and collects data on predetermined instruments that yield statistical data." Following Creswell's (2003, p. 19) distinctions when choosing an approach, quantitative approaches generally have post-positivist knowledge claims as their philosophic assumptions and employ surveys and experiments as strategies of inquiry; methods are: close-ended questions, predetermined approaches, and numeric data, and the practices of research:

- Test or verify theories or explanations, identify variables to study;
- Relate variables in questions or hypotheses;
- Use standards of validity and reliability;
- Observe and measure information numerically;
- Use unbiased approaches
- Employ statistical procedures

Quantitative methods are designed to take an unbiased approach to test and verify theories via observation. The observed results are interpreted in a quantifiable manner.

Quantitative research enables the testing of hypotheses based on the collection and analysis of statistical data. The theory and hypothesis testing proposed follows a quantitative approach utilizing a deductive process and statistical data. Data collection in quantitative research, and for this study, will be in the form of surveys designed around the theory regarding risk management in decision making when implementing a Lean Thinking event.

SURVEYS

A quantitative approach requires testing of research questions and hypotheses using statistical data. "Research questions are interrogative statements or questions that the investigator seeks to answer. They are used frequently in social science research and especially in survey studies. Hypotheses, on the other hand, are predictions the researcher holds about the relationship among variables. They are numeric estimates of population values based on data collected from samples. Testing of hypotheses employs statistical procedures in which the investigator draws inferences about the population from a study sample" (Creswell, 2003, p. 108). Data is required for statistical analysis in order to test theories and hypotheses in a quantitative approach.

One method to collect data in quantitative studies is the field study. In a field study, data can be collected using different tools; a survey or questionnaire is an effective tool to collect data about several variables from a relatively large number of potential respondents. Bowen (1995, p. 32) shows that surveys provide an opportunity to study a large number of groups providing the strength of high external validity, assuming the data samples include multiple organizations, settings, etc. "The word 'survey' is used most often to describe a method of gathering information from a sample of individuals...(whereby) surveys gather information from only a portion of a population of interest...Information is collected by means of standardized procedures so that every individual is asked the same questions in more or less the same way" (Scheuren, 2004, p. 9). Surveys are data collection techniques for gathering information to validate quantitative research.

"Surveys include cross-sectional and longitudinal studies using questionnaires or structure interviews for data collection, with the intent of generalizing from a sample to a population" (Babbie as cited in Cresswell, 2003, p. 14). Cross-sectional studies are performed at a point in time and are a snapshot as opposed to longitudinal studies that make observations over time. For this study, the intent is to perform a cross-sectional study to collect data, with the population sample (i.e., unit of analysis) being projects in the Department of the Navy that have performed Lean Thinking implementation events.

Surveys are designed to present data in a quantitative, objective fashion. "A survey design provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population" (Creswell, 2003, p. 153). Anonymity is required to dissociate social aspects from the data. Quantitative data is only concerned with the statistical analysis and trends. "All of the survey's results should be presented in completely anonymous summaries, such as statistical tables and charts" (Scheuren, 2004, p. 10). Surveys are not to be directed at any individual but are to be anonymous and random in order to represent the sample population for generalizeability.

Surveys will be constructed to get data that answers the research questions. Questions themselves may be asked in different ways to validate the results. Textual responses need to be converted to numeric answers for a quantitative analysis. Surveys are designed to collect specific information, which may be accomplished in a variety of ways and for a variety of reasons.

Surveys are performed to collect data that is quantifiable for analysis. "Surveys should be carried out solely to develop statistical information about a subject" (Scheuren, 2004, p. 14). Structuring the survey around the purpose helps maintain its internal and external validity, not to mention other canons of ethics, bias and data context for analysis and interpretation. Surveys are therefore designed with a specific purpose in mind, comprised of questions directed to get data that answers the research questions and are asked in different ways to validate the results, are objective in nature and randomly cover a sample of the population for later generalization.

The survey is the intended technique for collecting data to answer the research questions, with statistical methods utilized to perform the analyses on acquired quantitative data. For this study, the data will be collected through a survey with questions designed to obtain information that may be portrayed in a quantifiable manner.

RESEARCH METHODOLOGY

The practices, procedures and rules used in this inquiry are provided to describe the methodology and to ensure validity of the research. The steps used in this methodology establish the introduction to the study with background data and what is to be accomplished, as well as an overview of the research design and methods used to describe the participants, instruments, analysis, interpretation and presentation of findings.

This research investigates the existence of an association between independent and dependent variables utilizing established practices, methods and procedures. A quantitative research method was followed to study how experience and knowledge transfer apply to risk management analysis decisions in the government regarding countervailing risk identification and promoting the management of countervailing risks, specifically when implementing continuous process improvement methodologies such as Lean Thinking.

A quantitative method utilizes an empirical approach to collect and analyze data. The procedure follows steps designed to objectively gather information to answer the research question:

1. Define the research area;
2. Review the literature;
3. Define research design and methods;
4. Collect data;
5. Analyze data;
6. Interpret and present results.

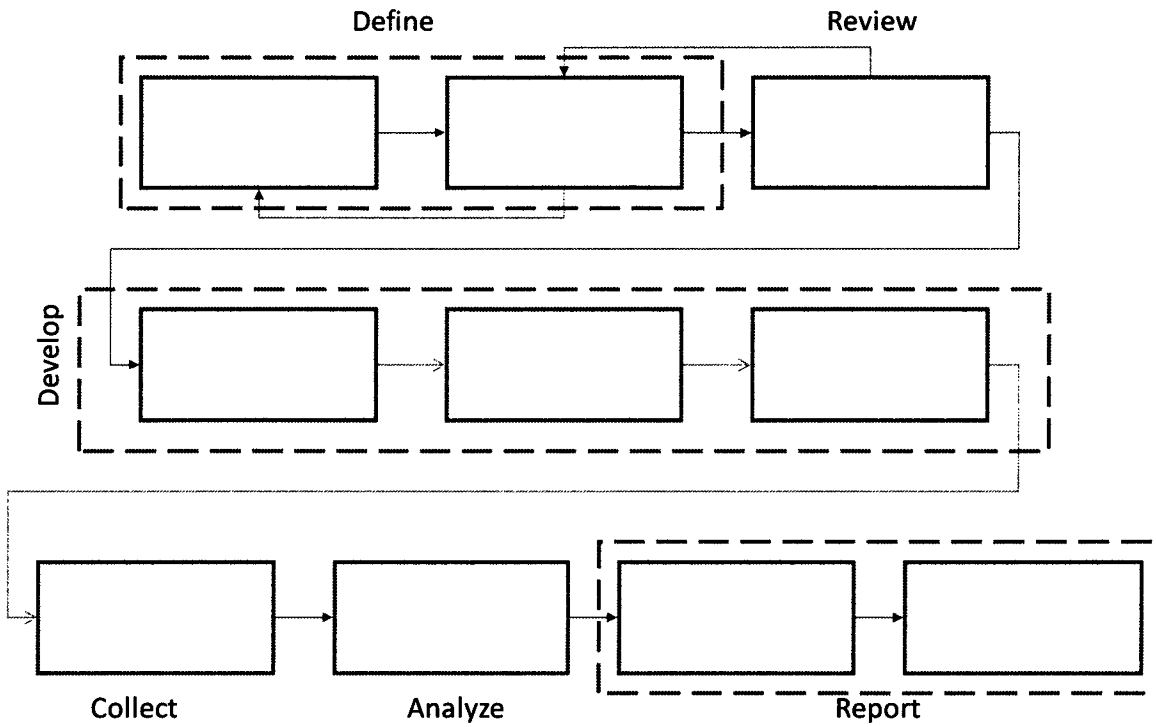


Figure 2: Research Methodology

The quantitative method followed allows for an objective approach to this research and is graphically represented as Figure 2. The methods and procedures of each step are provided in greater detail in subsequent paragraphs.

RESEARCH AREA DEFINITION

Development of research questions and generation of hypotheses may evolve in multiple ways. An underlying characteristic for the researcher to enable success is to delve into areas in which he or she is interested and to postulate new ideas and investigate ideas that others have theorized. The research question poses the broad problem theorized about the objectives and purpose of the research and facilitates building the body of knowledge with answers and facts through research and experimentation, not just with opinion. Hypotheses are propositions or suggested explanations of a phenomenon based on observation. In Organizational Behavior literature, it was stated "when a question put to nature is formalized by specification of constructs or concepts and their supposed relationship, this conjecture is called a hypothesis" (Lundberg, 1976, p. 8). Hypotheses are statements that can be disproven but cannot be proven, as it is not possible to evaluate every situation and circumstance, only samples that may be generalized based on results.

Lundberg (1976, p. 8) discusses hypothesis creation as having four prerequisites: "acquiring a 'knowledge of acquaintance' of the phenomenon, really knowing the subject, possessing an ingrained paradigm, and the ability to 'galumph.'" He goes on to describe this as having firsthand familiarity, a thorough knowledge of the subject area, the ability to think unconsciously in a structured manner or in accordance with a fundamental model, and voluntarily placing obstacles to deliberately complicate a process.

There are numerous ways to generate hypotheses. The onset of this research stemmed from an approach termed 'hypothetico-deductive,' which involves an intentional search by "putting together two or more common sense principles or empirical findings and deriving from their conjunction some predictions of interest" (Lundberg, 1976, p. 9). Risk management is the underlying field of study for this research, which raised ideas of interest during Lean Thinking events when postulating the criticality of value and non-value added processes and the repercussions of the decisions made during these events. Investigations into the juncture of these two areas did not yield scholarly results as was shown in the gap analysis of the current literature. The research question and hypotheses were the culmination of observation and postulation during Lean Thinking events as to how the decision makers were arriving at a changed process and the criteria they took into account to change from their current way of doing business to the new state.

UNDERSTANDING CURRENT BODIES OF KNOWLEDGE

The purpose of the literature review is to compare the research question against what is currently known about the subject to determine if that question has already been answered in previous investigations. This step is essential to a scientific process as it defines through a systematic and refined search what has already been accomplished. The search is conducted by including definition of the research area, identification of the publications related to the research area, and the selection of articles based on searching for the subject matter experts and key words related to the research question and topic. Broader and narrower searches are conducted based on results of the original search and investigation into those articles, their references and refinement of the research search questioning and criteria. Results of the literature review provide knowledge relevant to the research topic based on what is already known and how it is related to the research question.

RESEARCH DESIGN AND METHODS

The purpose of the research design is to define the objectives and variables of the research and the methods utilized during the research to collect and analyze data to establish the procedures and basis for validation. The objective of this research is to express the theory in terms of measurable activities. These activities are based on analysis of data obtained from quantifiable interpretations of empirical observations obtained through surveys. The scope of this research shall cover the variables identified in the hypotheses. These variables are separated into independent, dependent and control. Independent variables are not dependent on other factors and influence the outcome of the dependent variable; dependent variables are affected by changes in the independent variables; and control variables set the specific parameters of the experiment establishing the criteria or categories for data sampling and analysis and do not change.

Methods utilized during the research to collect and analyze data are detailed through the generation of a data plan. A data plan is designed to ensure successful analysis of the research question and hypotheses by collecting useful data. It is intended to answer the questions of the research to include but not be limited to: what knowledge is desired; what is to be measured; what data will be collected; how will the data be collected; when, where, how often and by whom will the data be collected; what are the limitations of the data; how will the data be analyzed; and how will the methods and their procedures be validated. Properly documented, a data plan details the metrics, methods, and validation processes for the data collection and data analysis portions of the research methodology.

Knowledge Desired

What knowledge is desired from the research determines the methods to be utilized for data collection and analysis. The quantitative methodology utilized in this research is designed to investigate whether during a Lean Thinking event an association exists between the decision-maker's experience and the identification of countervailing risks and if an association exists between knowledge transfer and promoting management of countervailing risks. These variables, identified in the hypotheses, are the basis of the questions asked in the survey instrument to obtain the data necessary for correlation analysis. The knowledge desired from this research is the determination of a statistically significant association between the dependent and independent variables of the hypothesis; mainly, is there an association between experience and the identification of countervailing risks, and is there an association between knowledge transfer and promoting the management of countervailing risks.

Metric

The metric of desire is statistical significance validating the research hypotheses. Statistical significance is to be determined through measurement of the data obtained via statistical analysis to determine if there is a consistent and reliable correlation of the questions to their respective constructs, and through analysis to determine if there is a correlation between the independent and dependent variables. The data related to the variables from the hypotheses are the data to be collected from the Lean Thinking events based on the decision making utilized when determining the future state process. This data will be measured in accordance with the data analysis process to validate the research hypotheses.

Data will be collected for each of the independent and dependent variables. The hypotheses to be investigated are:

Hypothesis 1: There is significant correlation between experience and identification of countervailing risks.

Independent Variable: experience.

Dependent Variable: identification of countervailing risks.

Hypothesis 2: There is significant correlation between experience (i.e., previous occurrences; lessons learned) from other projects and the handling of countervailing risks in the current project.

Independent Variable: experience.

Dependent Variable: handling of countervailing risks.

Hypothesis 3: There is no significant correlation between education and the identification of countervailing risks.

Independent Variable: education.

Dependent Variable: identification of countervailing risks.

Hypothesis 4: There is no significant correlation between education and the handling of countervailing risks.

Independent Variable: education.

Dependent Variable: handling of countervailing risks.

Hypothesis 5: There is significant correlation between utilizing knowledge transfer across projects and identification of countervailing risks.

Independent Variable: knowledge transfer.

Dependent Variable: identification of countervailing risks.

Hypothesis 6: There is significant correlation between utilizing knowledge transfer across projects and handling of countervailing risks.

Independent Variable: knowledge transfer.

Dependent Variable: handling of countervailing risks.

Hypothesis 7: There is no significant correlation between project roles (manager, administrative, engineer, etc.) and identification of countervailing risks.

Independent Variable: roles.

Dependent Variable: identification of countervailing risks.

Hypothesis 8: There is no significant correlation between project roles (engineer, manager, administrative, etc.) and the handling of countervailing risks.

Independent Variable: roles.

Dependent Variable: handling of countervailing risks.

Control Variables for each of the stated hypotheses: (1) when determining the future state process; (2) during the value stream analysis continuous process improvement method of Lean Thinking.

Operational definitions of the established variables in these hypotheses were identified in the literature, the dictionary and common usage and shown below. Operational definitions of variables and terms used throughout this research are provided in Appendix B. Interpretations and meanings for the variables used in the hypotheses are defined as:

Experience: the knowledge and know-how gained through a person's involvement or exposure.

Education: formal attainment of scholastic degrees.

Identification of countervailing risks: the ability to find or identify alternative risks that may arise as a result of mitigating an original risk.

Project roles: titles and/or positions held during the running of a project; functions performed by personnel during the running of the project.

Knowledge transfer: moving or utilizing information/knowledge (either tacit or explicit) from one individual or group to another; transferring the experience gained from one project to be utilized in another.

Handling of countervailing risks: the handling and mitigation efforts associated with alternative (countervailing) risks - including transferring, reducing, accepting and avoiding.

Future State Process: the resultant stream of processes followed to achieve the goals of a project after undergoing value stream analysis. The result of improvements made to the current state process during a Lean Thinking event.

Value Stream Analysis: the continuous process improvement method utilized to determine which of a project's processes add value or which are waste and may be deleted or modified to achieve a more efficient future state process. Technique used in Lean Thinking events.

A statistical analysis is to be performed to determine whether the questions consistently and reliably correlate to their variables and to determine whether there is a correlation between the independent and dependent variables. Objective data relevant to each of the variables will be collected from the sample population regarding their assessments of these factors. Interactions among the questions, independent variables and dependent variables as well as the control variables shall be factored to measure correlation.

Data Collection Instrument

Once it has been determined what data will be collected, the next decision is how the data will be collected. To meet the requirements of this quantitative study, a cross-sectional survey will be utilized to gather data. The survey generation method used for this research is shown in Figure 3.

When generating a survey, the questions must be representative of the variables, hypotheses and the research question. Generation of the survey questions is based on the variables identified in the hypotheses. These questions will be developed by determining what information is necessary to define the variable in the context of the research question and hypotheses. The questions will be developed and discussed with/reviewed by personnel with knowledge of the subject to refine the question to the area of interest and remove ambiguity from the phrasing and response categories. The number of questions per variable allows for internal validity of the research. Nunally and Bernstein provided the "optimal number of survey questions per variable is between three and five" (Parsons, 2004, p. 42). Hatcher (cited in Parsons, 2004, p. 42) "maintained that surveys should include at least five questions per variable in order to increase the probability of retaining at least three after verification of internal consistency." The resultant survey will be administered to a pilot group in order to obtain results to run against metrics and compare to the theoretical response. Based on the results of the pilot survey, the questions may or may not be modified dependent on the determination that they are representative of the intended question. The resultant survey will be distributed to the sample population for data collection after it has been cleared by an ethics review.

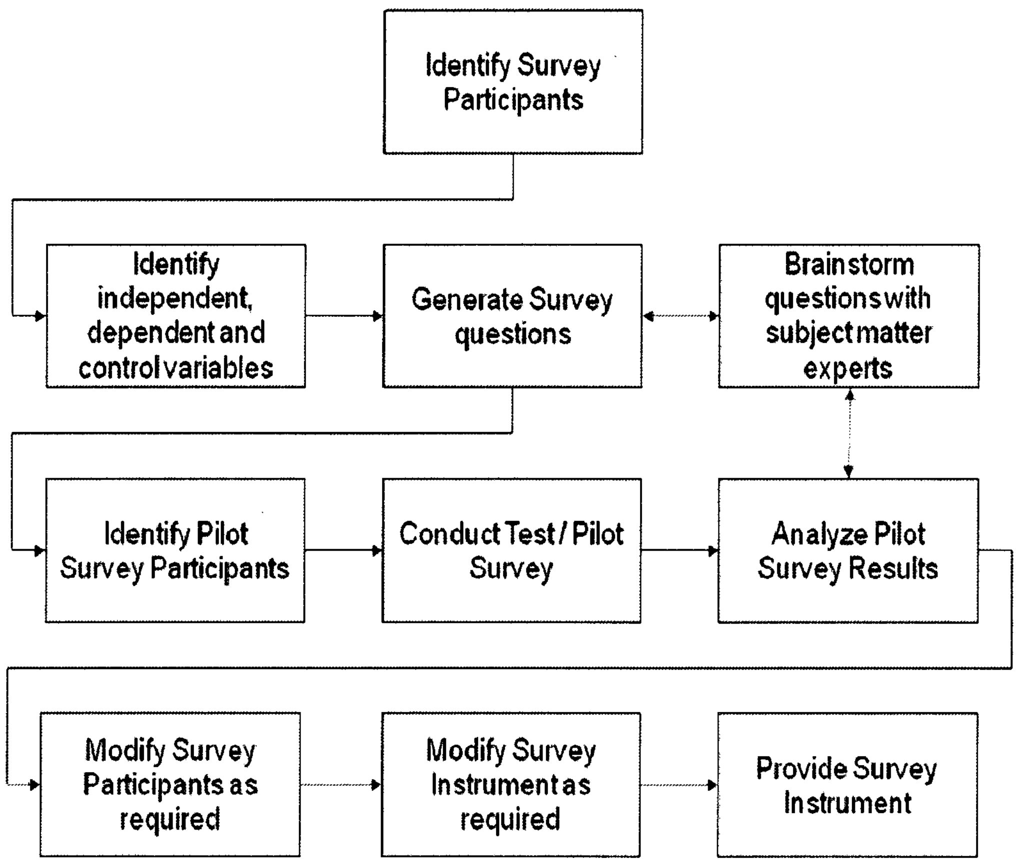


Figure 3: Survey Generation Method

When dealing with multiple response possibilities for questions in a survey, a Likert scale provides the means of obtaining a quantitative response utilizing closed inquiry vice requiring a subjective interpretation of an open-ended question. McKelvie

(1978, p. 185) investigated five, seven and 11 rating scales through empirical research and determined "a relatively small number of categories (five or six) should generally be used," where "the five-category scale was most reliable" (for attitude judgment tasks), and confidence judgments using a continuous scale essentially operated with five or six categories. As such, this research utilizes five-category scales such as the Likert scale to provide the necessary levels of reporting variation of the judgment questions portrayed in the survey instrument.

When discussing quantitative analysis of survey data, Sage (1998) discusses the implications of grouping questions and a causal sequence of variables. The intent of the survey instrument in this study is independent evaluation of the variables and is not intended to lead the surveyor to build on previous responses, nor to perform causal or recursive modeling. To avoid causal inference or path analysis of the questions related to each construct or variable, after the questions are developed for each variable they shall be interspaced throughout the survey to ensure they are not correlated by proximity.

Data Collected

The variables in the hypotheses drive what data will be collected. Theories and hypotheses are validated through analysis of the acquired data. Data collected for analysis is designed to validate the dependent and independent variables and provide the means for a statistical comparison to determine if a correlation exists between the variables. Data obtained to measure each of the independent and dependent variables are shown in Tables 4 and 5 respectively.

Variable	Operational Definition	Information Obtained by Survey Questions
Experience	Knowledge and know-how gained through a person's involvement or exposure	10. Approximate number of years in role/function 11. Approximate number of years in type of work 12. Approximate number of years on this project 13. Approximate number of years in this organization 14. I considered what I have experienced and learned 17. Based on my familiarity, I reviewed the current process to evaluate areas that could/should change 20. I know what tasks/processes can or cannot change in my area of responsibility 23. I have considerable knowledge and know-how in my current field and role 34. I have in-depth knowledge of my area of responsibilities
Knowledge Transfer	Moving useful information/knowledge (either tacit or explicit) from one individual to another; transferring the experience gained from one project to be utilized in another	3. Percentage of changes based on knowledge gained from other projects 16. I used knowledge from other projects when evaluating the future state 22. I used knowledge gained from decisions made on other projects to influence similar decisions during this lean event 25. I identified actions I needed to execute during this event through experiences gained from other projects 27. I utilized information provided by others to make decisions during this event 28. As a group, made decisions based on information exchanged between team 32. I used information and lessons learned from other projects during this event
Education	Formal attainment of scholastic degrees	6. Highest level of education
Project Role	Titles and/or positions held during the running of a project	9. Primary role/function on this project

Table 4: Independent Variable Measurement

Variable	Operational Definition	Information Obtained by Survey Questions
Identification of Countervailing Risks	The ability to find or identify alternative risks that may arise as a result of mitigating an original risk	15. I identified the repercussions that may occur as a result of changing the current process when developing the future state process 24. I identified impacts that may occur as a result of changes from the current state to the future state 29. I identified the problems, benefits and consequences associated with each of the changes presented during this lean event 31. When considering change, I identify risks that may occur as related to my job 33. If a process or task was recommended to be changed or eliminated in the future state, I identified the risks associated with the idea
Handling of Countervailing Risks	Assessment, handling and mitigation efforts - including transferring, reducing, accepting and avoiding - that are associated with alternative (countervailing) risks	18. I considered ways to avoid, mitigate or handle repercussions in the future state that may occur as a result of changing the current process 19. I identified alternatives so the identified risks should not occur 21. I identified risk handling methods to shift the impact to another organization or area 26. I identified ways to lessen the impact if the risk was to occur 30. I assessed whether the impact was acceptable or not if the risk was to occur

Table 5: Dependent Variable Measurement

Questions generated reflect a decision makers experience, education, knowledge transfer occurrences, and roles as related to her/his abilities to identify risks that may arise, types of risk, and management of those risks, all as related to the future state process being developed during a Lean Thinking event. These questions were generated as part of the measurement instrument portion of this research and portrayed utilizing category scales to reflect confidence judgments to obtain the requisite data for analysis and collected in accordance with the data collection model shown in Figure 4 to obtain the data required to analyze the hypotheses. This data consists of objective, quantified responses obtained from surveys where questions regarding each of the variables are constructed to answer the research question and hypotheses.

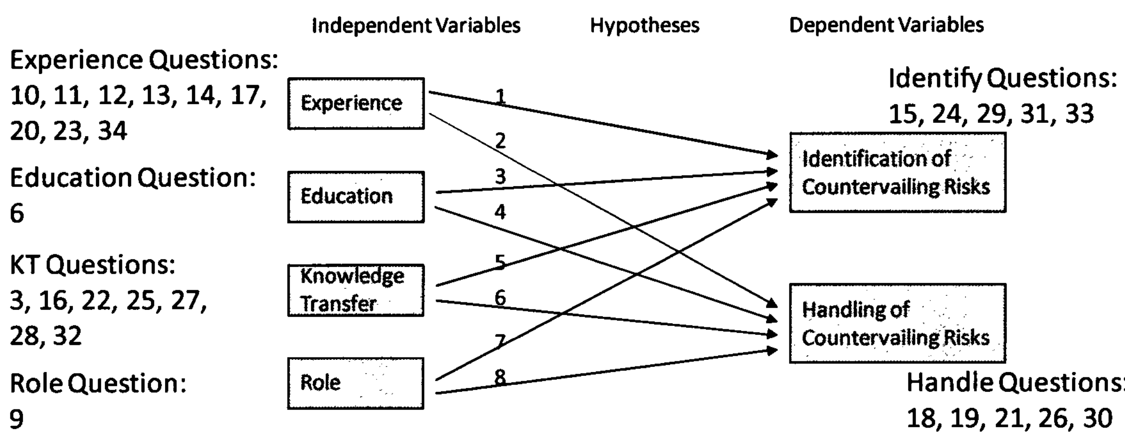


Figure 4: Measurement Data Collection Model

Population and Sample Size

Along with what data will be collected, it is also necessary to know when, where, how often and by whom the data will be collected. The survey generated must also take into account the population for which it is to be administered. The population from which samples shall be utilized for data collection to test this correlation is the Department of the Navy research laboratories conducting Lean Thinking events. The survey participants will be identified based on the population of interest but asked to participate voluntarily and anonymously. The objective of this study will be to apply the research from specific Navy research and development laboratory projects as a sample for later generalizeability to a larger population – first to a larger Navy organizational account and with potential transferability of the results to all Lean Thinking events.

Lean events occur frequently throughout the year. The intent is to provide the survey questionnaire to the event facilitators (Lean Office personnel) for disbursement and collection and obtain data from the personnel participating in each of these events. The survey is to be administered after the event has been completed but before the results are briefed to the stakeholders of the event. The facilitators will then collect the surveys and return them to the Lean Office where they will be acquired by the researcher and the data analyzed. In preparation for obtaining approval for survey distribution and data collection, a web-based training course was taken by the researcher regarding "Protecting Human Subject Research Participants." A Certificate of Completion was obtained from The National Institutes of Health (NIH) Office of Extramural Research certifying successful completion of the NIH web-based training course "Protecting Human Research Participants." The certificate is provided in Appendix C.

Regarding sample size, there is a wide range of recommendations in the literature. These ranges include calculations for sample size to variables being analyzed, N:p ranging from 3 to 6, to at least 10 with an argument for a minimum of 5 (MacCallum, Widaman, Zhang & Hong, 1999). Hair, Anderson, Tatham and Black (1998) suggest the ratio never fall below 5 to 1 and recommend using "between 15 to 20 observations for each independent variable" when discussing generalizability and would not use fewer than 50 observations when performing factor analysis. Larger samples increase statistical significance, which may lead to substituting for accurate measurement, whereas "with relatively small samples, researchers must pay close attention to construct validity ... Statistical significance does not necessarily signal good measurement in a large-sample study" (Combs 2010, pp. 10-11). MacCallum et al. (1999) state "there is considerable divergence of opinion and evidence about the question of how large a sample is necessary to adequately achieve these objectives" (regarding factor analysis results) and that "sample size is dependent on several aspects of any given study, including the level of communality of the variables and the level of overdetermination of the factors."

The number of surveys required to adequately reflect the population may be calculated mathematically. Sample Size (ss) = [Z^2 * (p) * (1-p)]/c^2, where Z = Z value (e.g. 1.96 for 95% confidence level); p = percentage picking a choice, expressed as decimal (.5 used for sample size needed); and c = confidence interval, expressed as decimal (e.g., .04 = ±4) (Synar, 2009). "Having an adequate sample is obviously important, but the long-term impact of our research will be judged more by whether we can show strong evidence that our theories are correct and of real benefit to managers" (Combs 2010, p. 13). The object is to ensure good measurement with valid constructs.

Placing these factors into practice and planning for later generalizability, 4 independent variables times 15 to 20 samples each (per the previously mentioned recommendation) equate to 60 to 80 surveys required. Utilizing the above shown mathematical equation, the goal sample size is calculated to = [1.96^2 * (.5) * (1-

.5)]/.05^2 = 384.16 = 385 surveys for a 95% confidence level and 5% confidence interval. Consequently, the resultant sample size falls within a range of 60 to 385 observations dependent on the quality of the factor analysis. The determinate of this analysis is where "communalities must be high [greater than 0.6], factors must be well determined, and computations must converge to a proper solution" (MacCallum et al., 1999, p. 96).

Data Limitations

With any research, there are limitations regarding the data collected and the manner and environment from which it was obtained. One of the limitations pointed out in literature regarding measurement devices is that not much time or effort has been spent "delineating what method constructs exist and how they might affect our research and measurements in different settings using different measuring devices" (Schmitt, 1994, p. 394). The data obtained is applicable to the setting and environment in which the instrument was provided and as such may have an influence on the generalizability of the results, though "the tendency to overgeneralize and overinterpret results, however, is not limited to questionnaire researchers" (Spector, 1994, p. 391). To account for this situation, the survey generation and data collection methods have provided the means to minimize or eliminate this influence through the validation procedures. The data analyzed is obtained from Department of the Navy personnel during Lean Thinking events utilizing a survey as the data collection instrument. To account for the limitation of measurement error associated with survey questions, multi-item scales or factor scores are utilized to reduce the effect, where it is assumed "that the survey questions are valid measures of the concepts they appear to measure" (Sage, 1998, p. 98). Appendix D is provided as a means of validating that the survey questions represent the variables they are intended to measure.

This research also assumes value stream analysis is being performed to mitigate risks identified in the current process primarily due to cost, schedule or inefficiency issues and may be either internally or externally/customer driven. This limitation is to account for the research analyzing the identification of alternative, countervailing risks that may arise in the new process and promoting the management of those risks. This premise is accounted for in the survey instrument for validation.

The research presented is evaluated for the context in which the data was collected. Efforts have been taken to eliminate research bias and provide valid results commensurate with the applicable justifications provided. However, "surveys rarely measure a number of systematic and plausible causes of attainment" of the underlying contributors [to explain the causes of social phenomenon and effects] to the answers in the questionnaire (Sage, 1998, p. 93) and the results and conclusions of the study.

Data Analysis

Once data is collected, it needs to be analyzed in a manner that brings significance to the research. Data analysis shall be performed on the collected data utilizing statistical methods in an objective, quantitative evaluation as shown in Figure 5. The analysis will be conducted against the pilot surveys where the instrument will be validated or modified as appropriate and rerun, and then against all data collected with the finalized surveys. Exploratory Factor Analysis (EFA) will be used at the beginning of the research when collecting sample data to extract factors or constructs. Alternatively, when validating the measurement instrument, Confirmatory Factor Analysis (CFA) will be used to confirm the validity between the indicators and the constructs utilizing data collected (Ahire & Devaraj, 2001).

All aspects of the data will be analyzed against each of the independent and dependent criteria where the multiple areas of data will be treated as "a separate estimate for each 'group' in statistical terms" (Sage, 1998, p. 100). The object of the research shall be to statistically support or reject the research question and hypotheses.

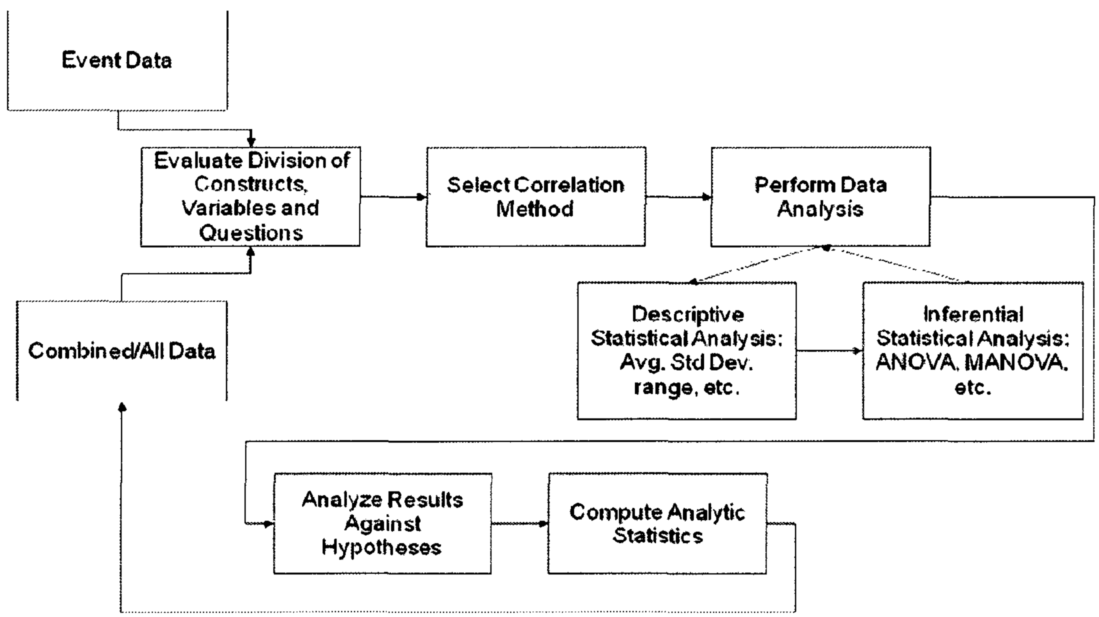


Figure 5: Data Analysis Diagram

Analysis to be performed is dependent on the questions themselves and how the researcher wants them portrayed, where "statistical analysis is the manipulation, summarization, and interpretation of quantitative data" (GAO, 1992, p. 13). "Successful data analysis, whether quantitative or qualitative, requires (1) understanding a variety of data analysis methods, (2) planning data analysis early in a project and making revisions in the plan as the work develops; (3) understanding which methods will best answer the study questions posed, given the data that have been collected; and (4) once the analysis is finished, recognizing how weaknesses in the data or the analysis affect the conclusions that can properly be drawn. The study questions govern the overall analysis. But the form and quality of the data determine what analyses can be performed and what can be inferred from them" (GAO, 1992, p. 10). Understanding the research and its purpose are required to adequately interpret and convey the meaning of the data.

Data analysis for quantitative research involves numerical estimates and statistical procedures. These quantitative methods utilize statistical methods to maintain validity. Descriptive statistics that are calculated for observations and measures such as means, standard deviations, and ranges will be used. When examining the hypotheses in the study, inferential statistical tests are used as categorized for the independent or dependent variable through "t tests or univariate analysis of variance (ANOVA), analysis of covariance (ANCOVA), or multivariate analysis of variance (MANOVA – multiple dependent measures)" (Creswell, 2003, pp. 172-173). Depiction of the statistic communicates the researcher's interpretation of the data.

Interpretation of the quantitative data will provide significance to the research. Analysis of the categories to obtain validation through consistency and reliability may be obtained through Cronbach's alpha and Pearson product moment *r* measures (McKelvie, 1978). Cronbach's alpha is an indication of the reliability and consistency of how well the items (survey questions in this research) measure the construct for which they were devised. "Cronbach's alpha can be written as a function of the number of test items AND the average inter-correlation among the items" where increasing the items and increasing the average inter-item correlation will increase alpha as well (Landaeta, 2003, p. 270). A high value for Cronbach's alpha provides good reliability that the items are measuring the same construct and is an indicator of a high correlation between the associated items. "Researchers have often used a 0.60 for emerging construct scales and 0.70 for established scales," though 0.50 has been recommended for exploratory work and there is no strict limit established for a high value concerning scale reliability (Ahire & Devaraj, 2001, p. 322). In this research, the measurement instrument was developed for this study and therefore establishes alpha of 0.60 as the measure for good reliability, with 0.50 being the minimum value.

Pearson Product-Moment correlation coefficient (Pearson's *r*) obtains the correlation between the variables being measured by showing a linear dependency between the variables. The statistical significance of this correlation lies in the relationship between the compared variables, where a value of 1 equates to a perfect positive correlation between the variables, -1 being a perfect negative correlation, and 0 showing no correlation or relationship. Therefore, given a correlation, it is feasible to estimate the value of one variable given the value of the other correlated variable.

Quantitative data analysis will be used to interpret collected data. Means of depicting the quantitative data analysis utilizing descriptive statistics include: averages, standard deviations, ranges, and test significance (t test). Also included are summaries, statistical tables and charts, frequency distributions, histograms, and probability distributions. Listing variables and the number of times each appears, and showing central tendency, averages and variability, mean, median and mode are also forms of descriptive statistical analysis to be used where applicable during the analysis. Utilizing data collected by the measurement instrument, Confirmatory Factor Analysis (CFA) will be used to confirm the validity of the variable relationships utilizing "statistics that can assess the overall goodness of fit," Cronbach's alpha for reliability, and with content validity judging the extent to which factors are associated with each with a goodness of fit index of 0.80 being a minimum threshold (Ahire & Devaraj, 2001, pp. 321-322).

Data shall be handled appropriately when evaluating the survey data and analyzed with the appropriate statistical means. Interpreting responses to the survey instrument is performed by assigning a scaled value to the responses as "evidence supported the premise that raters assume a normal distribution across options within a Likert-like scale (Ramsey cited in Parsons, 2004, p. 56). "However, since there is no method to verify that individuals consider the differences between adjacent numbers on the scale to be uniform, the raw survey data [should be] considered ordinal and not numerical" (Parsons, 2004, p. 56). Validation of the scale shall also be performed where "Cronbach's scale reliability coefficient alpha is used for assessing the internal consistency of a scale" (Ahire & Devaraj, 2001, p. 319). Non-response questions in the surveys will utilize the mean of all data responses for that variable without affecting the remaining survey questions; the remaining answered questions will be utilized, which "makes use of all the non-missing responses from the survey that are relevant to each statistical calculation," and where for correlation questions if the respondent answered the questions for both variables being correlated, the data may be used (Sage, 1998, p. 102).

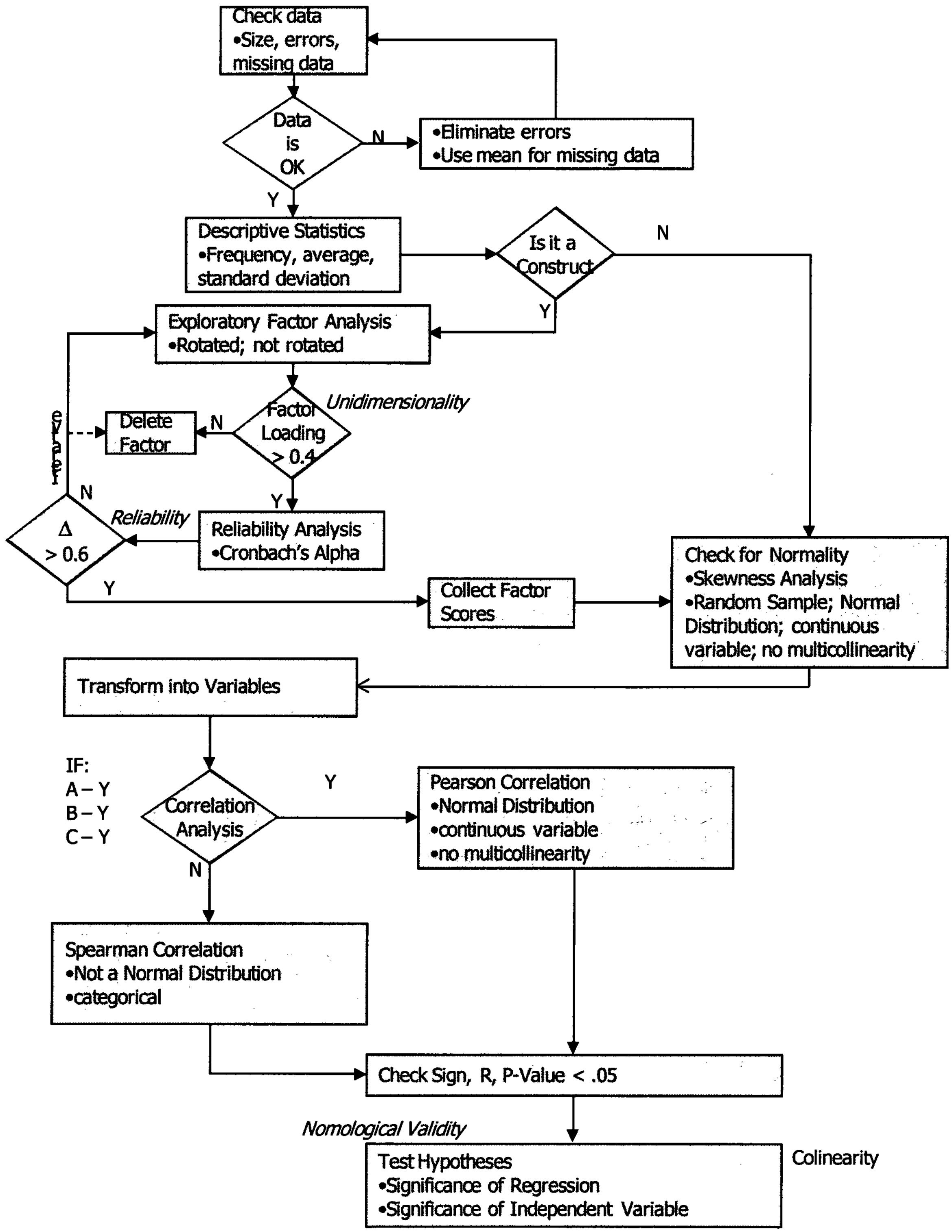


Figure 6: Data Analysis Flowchart

The objective of the data analysis is to perform an objective, quantitative evaluation of the data to statistically support or reject the research question and hypotheses. Statistical analysis will be used to interpret and convey the meaning of the quantitatively derived analytic data to support evaluation of the hypotheses and generalizability of the results from the sample to the population. Figure 6 depicts the steps involved to perform the data analysis procedures and the evaluation criteria detailed throughout the methodology described.

Research results will be tabulated from the validated data and provided using research results models as shown in Figure 7 for correlation. Applicable analysis data will be provided showing the relationships between the independent and dependent variables in accordance with the hypotheses.

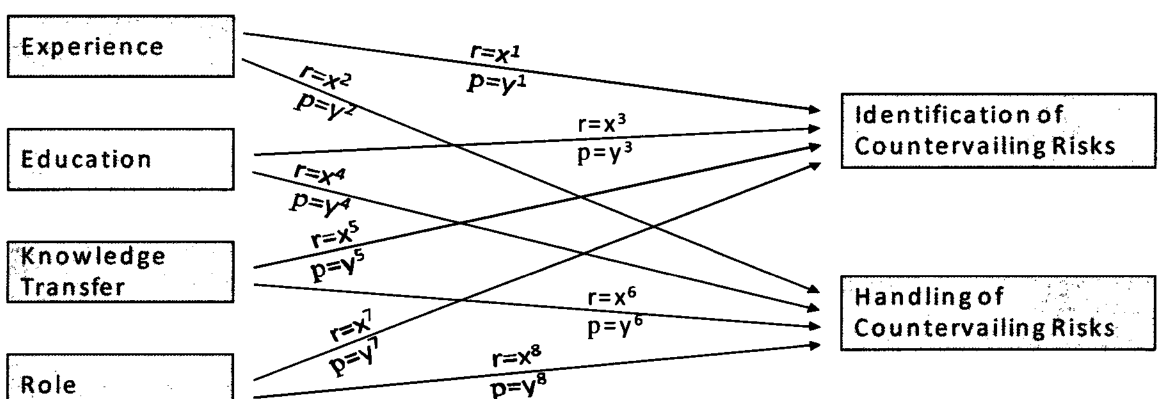


Figure 7: Research Results Model

Research Validity

Regarding research and method bias, Schmitt (1994, p. 394) remarks, the "relevant question is whether the method(s) of measurement and the research design allow one to derive appropriate conclusions." Methods and their procedures will be validated in accordance with canons of science for quantitative methods providing the traditional (positivist) approach. The canons and research methodology will account for significance, applicability, consistency and neutrality in the research and data analysis.

Significance and credibility of the research findings is supported through internal validity. The check is for control of the research by providing randomization, a data collection instrument, and data to perform deductive testing. Internal validity checks to see if the correlation being tested is between the independent and dependent variables and not affected by an outside factor. The survey instrument provides research credibility where "internal validity may be slightly easier to obtain in survey and experimental research, where pre-testing and iterative designs are practicable" (Bowen, 1995, p. 32). The questions in the survey instrument must be un-biased and objective to obtain valid results. Table 6 provides a measurement instrument validation process describing the applicable methods and tests to be utilized in this research.

To ensure empirical implementation and validation of the survey, the survey resulting from the question validation process provided as Appendix D was administered with analysis of the responses to validate the questions and their target variables in accordance with the data analysis flowchart. The resultant survey was used throughout the data collection period; no modifications were permitted and the same measurements and analysis were performed on all of the data so as to maintain internal validity. Internal validity is being checked where the "primary strategy for strengthening the experimental methodology is replication" (Bowen 1995, p. 32). The survey administered is provided as Appendix E.

Validity Check	Definition	Methods/Tests
Content Validity	The degree to which the measurement instrument spans the domain of the concept	•Prior literature on the domain and use of experts •Expert Knowledge
Face Validity	The extent to which the measurement instrument (after it has been developed) "looks like" it measures what it is intended to measure	•Validation surveys •Pilot studies
Unidimensionality	The extent to which indicators are associated with each other and represent a single concept	•Principle Component Factor Analysis of a construct •Confirmatory Factor Analysis of a construct's measurement model or that of a set of constructs
Reliability	The degree of consistency between different measures of a construct	•Internal Consistency using Cronbach's Alpha
Nomological Validity	The extent to which constructs of a framework relate to each other in a manner consistent with theory and/or prior research	•Assessment of relationships through correlation, regression or other multivariate analysis procedures
Internal Validity	The extent to which the correlation being tested is between the independent and dependent variables and not affected by an outside factor	•Descriptive Statistics •Data collection from different samples (different organizations and within the same organization) using a developed survey
External Validity	The extent to which the findings may be generalized to the population or other populations or contexts	•Inferential Statistics

Table 6: Measurement Instrument Validation Process

(Adapted from Ahire & Devaraj, 2001, p. 321)

Applicability of the research findings is substantiated through external validity. External validity checks the results to see if the findings may be generalized to the population or other populations or contexts instead of just the sample. This check is performed by randomizing the samples and performing statistical inference. Bowen (1995, p. 32) shows that surveys provide an opportunity to study a large number of groups providing the strength of high external validity, assuming the data samples include multiple organizations, settings, etc. Selection of participants must be random and not target particular groups or traits to prevent biasing the data collected. Participants in the survey must also be from the target population of interest. In addition, "possible method bias explanations and research design limitations might affect the generalizability of the results" (Schmitt, 1994, p. 396). To provide external validity in this research, the survey was provided to a Department of the Navy Lean office for distribution to all groups under their cognizance performing Lean Events. All participants were asked to voluntarily and anonymously participate with no exclusions, and the number of actual respondents was reported. This approach should ensure data is obtained from a diverse sample and from multiple organizations.

Consistency of the research findings checks for assurance and reliability that the findings may be replicated. This check provides for repeatability and control. Reliability and consistency of this research is obtained through collecting multiple sources of data and canvassing multiple, diverse groups with different objectives. The intent of this research is to "expand the confidence with which conclusions can be drawn from a set of data" by using multiple sources of data (Spector, 1994, p. 387).

Neutrality of the research findings is obtained through objectivity. The check ensures the results obtained are from inquiry and not from bias, prejudice or design on the part of the researcher. Objectivity is designed to achieve separation of the researcher from the research and ensure control of the data obtained. This separation needs to account for how the methods might influence the measurement of the constructs of interest; the motivational context for the data being collected; and assessment or minimization of method effects to provide valid interpretations (Schmitt, 1994). Objectivity in this research is obtained through an instrumented survey validated through analysis and provided independently by different personnel so as not to inject an influential bias.

4. RESULTS

The main objective of this research is to explore the strength and direction of a hypothesized correlation between a decision-maker's knowledge from other projects and the identification and handling of countervailing risks that may arise when performing Value Stream Analysis. This dissertation presents the results of a non-experimental examination and provides a foundation for future research. A research model was formulated and a survey instrument was developed with data collected from Department of the Navy personnel during Lean Thinking events. Quantitative data analysis supported the research question and showed an association between a decision-maker's knowledge from other projects and the identification and handling of countervailing risks that arise during Value Stream Analysis. Results of this analysis are shown in subsequent paragraphs.

SURVEY VALIDATION

Survey validation was performed through limited interviews and surveys for data collection. During development of the measurement instrument, to ensure internal validity in this research, the survey generation method developed for this inquiry utilized brainstorming of questions to develop applicable choices and reduce ambiguity as a means of content validity. The questions developed were distributed in a survey to a diverse group of individuals to analyze the category in which they believed the question fell (face validity). Results were analyzed, and the questions that acquired multiple responses were refined and a subsequent revised validation survey distributed. Results of the revised instrument were analyzed and discussed with the respondents individually asking their thought processes on why they marked a specific category based on specific words in the question. A supplemental survey consisting of only the questions that had outliers from the previous survey was then provided with updated questions or a revised operational definition to resolve ambiguity. The validation surveys with results are provided as Appendix D. Results of the question validation were combined with the background and demographic questions to obtain the final survey utilized for data collection. The final survey distributed is provided in Appendix E.

Survey approval was obtained by submission of the final survey to the local government labor employee relations board and the Old Dominion University Institutional Review Board (IRB). The final survey was provided with the applicable IRB package requesting an exemption from Human Subject Research requirements was submitted to determine if the study can be classified as exempt under Federal Regulations. The submission met the requirements for: research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation. The submitted justification stated the research involves obtaining data through a survey instrument (questionnaire). There is no identifiable private information - all surveys are anonymous and none of the information can be traced back to any individual directly or through identifiers. No individual survey responses will be reported, only the analyzed results. The IRB response granting the exemption is provided as Appendix F. The final survey was also submitted to the local government labor employee relations board to obtain authorization to distribute the survey during government Lean events by showing no personal data would be gathered that could distinguish any individual, and that data collected would be obtained voluntarily and anonymously. Labor employee relations had no issues with the survey and their response is provided in Appendix G.

The approved survey was distributed to Lean event personnel as their events occurred. Initial surveys were tabulated to obtain factor scores as a means to validate the survey instrument. Based on initial findings, no changes were made to the survey and all data collected was provided for data analysis.

DATA COLLECTION

Surveys were distributed and collected at each participating Lean event. The surveys were obtained, and the question responses translated to numeric values with the resultant data consolidated into a master spreadsheet for later analysis. The object of data collection is to ensure good measurement with valid constructs. The required number of surveys was determined by 4 independent variables times 15 to 20 per variable, equating to 60 to 80 surveys required. The determinate was in the analysis where "communalities must be high [greater than 0.6], factors must be well determined, and computations must converge to a proper solution" (MacCallum et al, 1999, p. 96). Sample Size (ss) = [Z^2 * (p) * (1-p)]/c^2, where Z = Z value (e.g. 1.28 for 80% confidence level); p = percentage picking a choice, expressed as decimal (.5 used for sample size needed); and c =

confidence interval, expressed as decimal (e.g., .04 = ±4) (Synar, 2009). The goal sample size is calculated to = $[1.28^2 * (.5) * (1-.5)]/.05^2$ = 164 surveys for a 80% confidence level and 5% confidence interval, with a minimum of 60 surveys with high communality in construct factors that are well determined and converge to a proper solution.

DATA ANALYSIS

Data analysis was performed in accordance with the prescribed methodology shown by the data analysis flowchart in Figure 6. SPSS version 18 software was utilized as the tool to perform the data analysis. Analysis results are provided in Appendix H with applicable tables shown throughout the data analysis areas depicted in the methodology as formulated from the applicable analyses.

Data Check

Data was compiled from the submitted surveys and translated into the applicable spreadsheets and consolidated. Results maintained anonymity where neither the event nor an individuals' specific data could be gleaned from the spreadsheet. The first check was size of the dataset where a minimum of 60 surveys were required to validate the analysis. 73 surveys were obtained with a minimum of 66 values per question observed. Descriptive statistics were used to determine valid data, the frequency response for each variable, the mean and standard deviations. Variables were checked for normality and skewness, and the SPSS tool used the mean to replace the missing data points where applicable when analysis was performed. Results are provided in Appendix H.

Construct Determination

Variables were checked to see if they were part of a construct in accordance with Tables 4 and 5, which detail the questions asked to obtain data for each independent and dependent variable. Exploratory Factor Analysis was performed on each construct. All variables associated with the construct to be tested were analyzed to determine the factor loading through principal component analysis. Variables with factors greater than 0.4 determined the variable to be associated with that construct (Unidimensionality). If all variables explain the same construct, there will be only one component.

The construct for experience had nine questions associated with factor analysis shown in Table 7. Results showed the questions were associated with two components.

Experience

Component Matrix[a]

	Component	
	1	2
V10	.278	.822
V11	.223	.836
V12	.231	.479
V13	.392	.523
V14	.706	-.313
V17	.484	-.606
V20	.822	-.214
V23	.785	.126
V34	.838	-.167

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 7: Experience Construct Exploratory Factor Analysis

Analysis of the two experience components and the associated questions resulted in splitting the factor into two separate constructs; one for the questions that were related to experience in years, and the other for questions that related experience to an individual's self-assessment. Exploratory Factor Analysis was then performed on each of these constructs resulting in one component for each construct as shown in Table 8. Four questions were associated with one component in a construct related to years of experience, and the other five questions were associated with one component in a construct related to a self-assessment of experience.

Experience - Years

Component Matrix[a]

	Component
	1
V10	.869
V11	.868
V12	.539
V13	.676

Extraction Method: Principal Component Analysis.
a. 1 components extracted.

Experience - Self Assessment

Component Matrix[a]

	Component
	1
V14	.771
V17	.627
V20	.843
V23	.731
V34	.852

Extraction Method: Principal Component Analysis.
a. 1 components extracted.

Table 8: Experience Constructs

Knowledge Transfer exploratory analysis also resulted in two components for the original 7 questions as shown in Table 9. Question 28 did not meet the 0.4 factor loading criteria, so it was eliminated and the exploratory factor analysis was re-run.

Knowledge Transfer

Component Matrix[a]

	Component	
	1	2
V3	.435	-.568
V16	.880	-.067
V22	.903	-.150
V25	.853	-.199
V27	.543	.694
V28	.345	.810
V32	.941	-.047

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Table 9: Knowledge Transfer Construct Exploratory Factor Analysis

Analysis was run with the remaining six questions, and once again, analysis associated the questions with two components, where question 3 was designated as being more strongly associated with the second component. In accordance with the analysis flowchart and the iterative factor loading step, question 3 was deleted and the analysis was run again. This resulted in the remaining five questions explaining one component and being associated with the Knowledge Transfer construct. Table 10 shows this iteration and subsequent analysis results.

Exploratory Factor Analysis was also performed on the remaining constructs for the dependent variables regarding the identification of countervailing risks and the handling of countervailing risks. Each of these analyses resulted in one component to explain the construct, showing all of the questions were associated with that construct with a factor score greater than 0.4. Results of these analyses are shown in Table 11.

Knowledge Transfer without 28

Component Matrix[a]

	Component	
	1	2
V3	.470	.735
V16	.885	-.050
V22	.917	-.009
V25	.869	.095
V27	.485	-.709
V32	.941	-.033

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Knowledge Transfer without 3, 28

Component Matrix[a]

	Component
	1
V16	.888
V22	.924
V25	.859
V27	.527
V32	.944

Extraction Method: Principal

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Table 10: Knowledge Transfer Construct Analysis

Identification of Countervailing Risks

Component Matrix[a]

	Component
	1
V15	.861
V24	.858
V29	.843
V31	.777
V33	.886

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Handling of Countervailing Risks

Component Matrix[a]

	Component
	1
V18	.775
V19	.806
V21	.492
V26	.744
V30	.837

Extraction Method: Principal Component Analysis.

a. 1 components extracted

Table 11: Dependent Variable Constructs

Confirmatory Factor Analysis was performed on all resultant constructs with analysis outputs fixed to one component. No rotation was performed, and the scores were added into the data sheet for subsequent analysis. Analysis results for the Confirmatory Factor Analysis supplied the same factor scores for each question of the construct as each of the Exploratory Factor Analyses that resulted in one component. These are shown in Appendix H.

Exp Years	Exp Self	KT	ID	Handling
Extraction	Extraction	Extraction	Extraction	Extraction
.755	.595	.788	.742	.600
.753	.394	.853	.735	.649
.290	.711	.739	.710	.243
.457	.535	.278	.604	.554
	.726	.891	.786	.700
.564	.592	.710	.715	.549

Table 12: Average Communalities

Factors were also analyzed to evaluate communality in construct factors and whether they are well determined and converge to a proper solution. Table 12 provides the average communalities for construct factors, where "it is desirable for the mean level of communality to be at least .7, preferably higher" (MacCallum et al, 1999). The communalities for Knowledge Transfer and Identification of Countervailing Risks meet this criterion; however, Experience and Handling of Countervailing Risks average slightly lower in the moderate range. "With communalities in the range of .5, it is still not difficult to achieve good recovery of population factors, but one must have well-determined factors (not a large number of factors with only a few indicators each), and possibly a somewhat larger sample" (MacCallum et al, 1999, p. 96). The factors converging to a proper solution were determined by achieving high reliability scores for the constructs as discussed under reliability analysis.

Independent Variables	Survey Instrument Data Collection Questions
Years of Experience	10, 11, 12, 13
Self Assessment of Experience	14, 17, 20, 23, 34
Knowledge Transfer	16, 22, 25, 27, 32
Education	6
Project Role	9
Dependent Variables	
Identification of Countervailing Risks	15, 24, 29, 31, 33
Handling of Countervailing Risks	18, 19, 21, 26, 30

Table 13: Summary of Survey Analysis Data Questions

Analysis was performed on the survey instrument to assess the extent to which the indicators are associated with each other and represent a single concept in support of the validity check for unidimensionality. The resultant questions utilized to obtain analysis data are shown in Table 13. The summary of constructs after validation is provided along with the independent variables for role and education, which are collected from a single survey question.

Reliability Analysis

At the completion of the factor analysis, reliability analysis was performed on the resultant construct data. The object of reliability analysis is to test the construct quality. Cronbach's alpha is used to determine reliability statistics. "Researchers have often used a 0.60 for emerging construct scales," though 0.50 has been recommended for exploratory work (Ahire & Devaraj, 2001, p. 322). Results of the reliability analysis are shown in Table 14. Analysis was run as an emerging construct scale with alpha of 0.6 being the requirement criteria. As shown, all constructs exceed this requirement.

Construct	Cronbach's Alpha	N Questions	Survey Questions
Experience in Years	0.746	4	10, 11, 12, 13
Experience Self Assessment	0.824	5	14, 17, 20, 23, 34
Knowledge Transfer	0.900	5	16, 22, 25, 27, 32
Identification of Countervailing Risks	0.900	5	15, 24, 29, 31, 33
Handling of Countervailing Risks	0.776	5	18, 19, 21, 26, 30

Table 14: Cronbach's Alpha Reliability Results

Reliability shows the degree of consistency between the different measures of a construct. The internal consistency provided by the Cronbach's Alpha results show a high reliability measure for this emerging construct scale.

Check for Normality

Factor scores from reliability analysis and the non-construct variables were analyzed for normality. Skewness analysis was performed with the results shown in Table 15. Distribution of the data was verified "through a skewness analysis in which values over 1.0 suggest a non-normal distribution" (Decker, Landaeta & Kotnour, 2009). Data analyzed showed non-normal distributions where all variables had either positive or negative skew from the mean.

Statistics

		EducationDegree	Role	ExpYrsConfirm	ExpSelfConfirm	KTConfirm	IDConfirm	HandleConfirm
N	Valid	71	71	72	72	72	72	72
	Missing	1	1	0	0	0	0	0
Skewness		.429	-.188	.702	-2.101	-1.446	-1.787	-1.437
Std. Error of Skewness		.285	.285	.283	.283	.283	.283	.283

Table 15: Skewness Analysis

Multicollinearity was also checked during this phase. Multicollinearity testing is required if there is more than one component for a construct. The construct for Experience resulted in two components, which were analyzed to determine if they were correlated. As the variables are not a normal distribution, a Spearman correlation was run for a two-tailed response to determine if a relationship existed between the two constructs. Correlation results of less than 0.3 are not related/correlated and significance values over 0.05 for a two-tailed response are deemed not significant.

Table 16 provides the multicollinearity test results, showing the constructs are not related and not significant. Since the separated experience factors of years of experience and self assessment of experience are not correlated (neither is predictive of the other), they may be used in further analysis as independent variables.

Correlations

			ExpYrsConfirm	ExpSelfConfirm
Spearman's rho	ExpYrsConfirm	Correlation Coefficient	1.000	.012
		Sig. (2-tailed)	.	.919
		N	72	72
	ExpSelfConfirm	Correlation Coefficient	.012	1.000
		Sig. (2-tailed)	.919	.
		N	72	72

Table 16: Multicollinearity Analysis

Correlation Analysis

Assessment of relationships between the variables was performed through correlation analysis. Variables analyzed are not normally distributed; consequently, a Spearman correlation was run for a two-tailed response to determine if a relationship existed between the variables. Correlation results of greater than 0.3 signify variables being related and significance values less than 0.05 for a two-tailed response are deemed significant. Results of the correlation analysis are shown in Table 17.

Correlations

			Education Degree	Role	ExpYrsConfirm	ExpSelfConfirm	KTConfirm	IDConfirm	HandleConfirm
Spearman's rho	EducationDegree	Correlation Coefficient	1.000	.057	.076	-.168	.035	-.241*	-.151
		Sig. (2-tailed)	.	.642	.527	.161	.770	.043	.208
		N	71	70	71	71	71	71	71
	Role	Correlation Coefficient	.057	1.000	.206	-.295*	-.050	-.301*	-.162
		Sig. (2-tailed)	.642	.	.086	.012	.681	.011	.178
		N	70	71	71	71	71	71	71
	ExpYrsConfirm	Correlation Coefficient	.076	.206	1.000	.012	.098	-.061	-.144
		Sig. (2-tailed)	.527	.086	.	.919	.411	.612	.226
		N	71	71	72	72	72	72	72
	ExpSelfConfirm	Correlation Coefficient	-.168	-.295*	.012	1.000	.468**	.688**	.494**
		Sig. (2-tailed)	.161	.012	.919	.	.000	.000	.000
		N	71	71	72	72	72	72	72
	KTConfirm	Correlation Coefficient	.035	-.050	.098	.468**	1.000	.590**	.430**
		Sig. (2-tailed)	.770	.681	.411	.000	.	.000	.000
		N	71	71	72	72	72	72	72
	IDConfirm	Correlation Coefficient	-.241*	-.301*	-.061	.688**	.590**	1.000	.614**
		Sig. (2-tailed)	.043	.011	.612	.000	.000	.	.000
		N	71	71	72	72	72	72	72
	HandleConfirm	Correlation Coefficient	-.151	-.162	-.144	.494**	.430**	.614**	1.000
		Sig. (2-tailed)	.208	.178	.226	.000	.000	.000	.
		N	71	71	72	72	72	72	72

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 17: Correlation Analysis

The analysis table shows that self assessment of experience is very significant and highly correlated with knowledge transfer, identification of countervailing risks and handling of countervailing risks. Also, knowledge transfer is very significant and highly correlated with identification of countervailing risks and handling of countervailing risks. The table also shows a significance and negative correlation between role and the identification of countervailing risks as well as significance between role and self assessment of experience and between education and identification of countervailing risks, although neither of these last two pairings show a correlation.

Linear Regression

The predictive power of the model is found through linear regression analysis and the resultant R Square value. Linear regression provides for hypotheses tests through the significance of regression and significance of independent variables as validated through nomological validity and colinearity. Analysis is performed between the dependent and independent variables with statistics providing results in model summary, ANOVA and coefficient tables. The predictive power of the model is shown by the R Square value of the regression analysis. R Square values over 0.3 signify valid relations where the R Square is a percentage of how well the variables explain each other. In addition, from the ANOVA tables, the regression significance provides the predictive significance where a value of 0 is excellent. Values less than 0.3 should not be used as data points to test the hypotheses as they do not explain how the independent variable impacts the dependent variable; hypotheses with a low R Square will be shown through correlation analysis to determine if they are associated (e.g., as one increases, the other increases or decreases). Table 18 summarizes the values from the regression. As an example from the table, experience predicts nearly 67% of the identification of countervailing risks dependent variable and is very significant, whereas role and education are not predictors of the identification of countervailing risks.

		Model		Regression	
	Hypothesis	R	R Square	F	Sig
Experience - Identification	1	0.817	0.667	69.133	0.000
Experience - Handling	2	0.710	0.504	35.064	0.000
Education - Identification	3	0.203	0.041	3.023	0.086
Education - Handling	4	0.099	0.010	0.689	0.409
Knowledge Transfer - Identification	5	0.607	0.368	40.825	0.000
Knowledge Transfer - Handling	6	0.589	0.347	37.156	0.000
Role - identification	7	0.246	0.060	4.492	0.038
Role - Handling	8	0.216	0.047	3.416	0.069

Table 18: Linear Regression Results

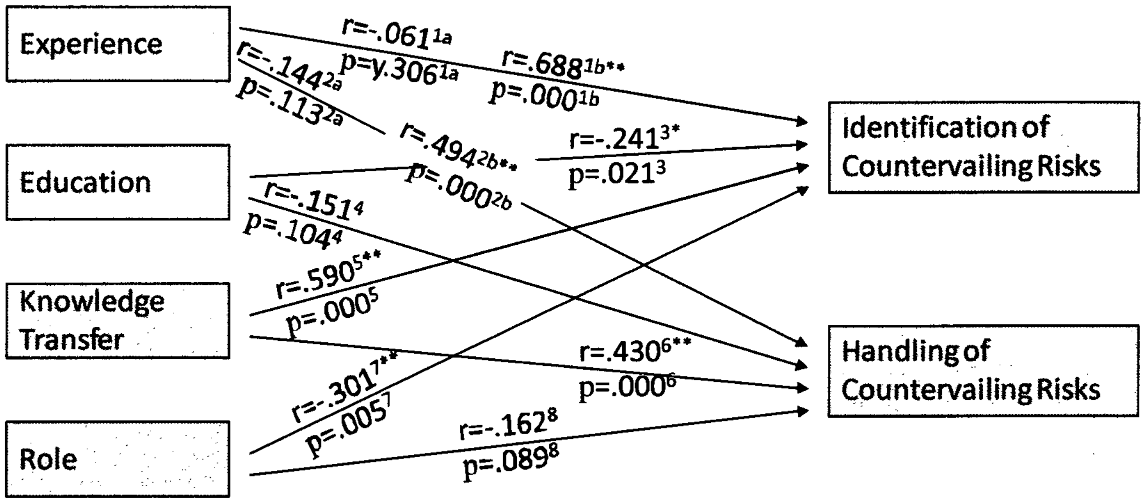
The power of a test is calculated through the use of beta and provides the probability of correctly rejecting the null hypothesis. Beta is an indicator of the association between the independent and dependent variables. A beta of 0 means there is no association. A positive beta means that the dependent variable generally follows the independent. A negative beta shows the dependent inversely follows the independent; the dependent generally decreases if the independent goes up and vice versa. Table 19 provides results from the regression analysis and details the standardized coefficients of beta. As shown in the analysis, when breaking the variable experience into its two components, self assessment of experience provides a very strong positive association with the identification of countervailing risks. When analyzing the handling of countervailing risks, the experience component of self assessment again provides the strong association. Knowledge transfer has a strong positive association with both the identification and handling of countervailing risk variables.

	Hypothesis	Coefficients		
		Beta	t	sig
Yrs Exp - Identification	1a	-0.124	-1.778	0.080
Self Exp - Identification	1b	0.818	11.730	0.000
Yrs Exp - Handling	2a	-0.190	-2.233	0.029
Self Exp - Handling	2b	0.700	8.227	0.000
Education - Identification	3	-0.203	-1.739	0.086
Education - Handling	4	-0.099	-0.830	0.409
Knowledge Transfer - Identification	5	0.607	6.389	0.000
Knowledge Transfer - Handling	6	0.589	6.096	0.000
Role - identification	7	-0.246	-2.119	0.038
Role - Handling	8	-0.216	-1.848	0.069

Table 19: Standardized Coefficients

The R Square values from the regression show data associated with both independent variables education and role are not predictive of the dependent variables (values are below the 0.3 threshold). Although they may not show as predictive, they may still be correlated. Correlation analysis was performed on the data utilizing a Spearman Correlation. Figure 8 represents the associations between the independent and dependent variables discovered through a 1-tailed Spearman's Correlation analysis.

Correlation results provide the tendency for response between the analyzed variables. Although not predictive from the regression analysis, the independent variable for education shows a significant association with the identification of countervailing risks but still no association with the handling of countervailing risks. The same results apply for the independent variable of role, which is very significantly associated with the identification of countervailing risks, though it too has no association with the handling of countervailing risks.



* Correlation is significant at the 0.05 level (1-tailed)

** Correlation is significant at the 0.01 level (1-tailed)

Figure 8: Correlation Results

HYPOTHESIS TESTING

Hypotheses are statements that can be disproven but cannot be proven, as it is not possible to evaluate every situation and circumstance, only samples that may be generalized based on results. The object is to not disprove the hypotheses formulated utilizing the data collected from the measurement instrument. Results of the hypothesis testing are provided for this investigation based on the data obtained through analysis with full data analysis results shown in Appendix H.

Hypothesis 1: There is significant correlation between experience and identification of countervailing risks.

Independent Variable: experience.

Dependent Variable: identification of countervailing risks.

Through exploratory analysis, it was determined experience had two components associated with the experience variable – years of experience and self assessment of experience. The reliability of years of experience showed a Cronbach's Alpha of .746, and the Cronbach's Alpha for self assessment of experience was .824, showing a high construct quality.

The results of the regression analysis demonstrate a positive prediction correlation between the predictors of experience and the identification of countervailing risks. An R Square value of .667 shows experience predicts nearly 67% of the identification of countervailing risks dependent variable and is very significant with a regression significance of 0.000. Through correlation analysis, it was shown that the component for the self assessment of experience was the major factor in this prediction value where it was highly significant at the 0.01 level for a 1-tailed analysis with a correlation coefficient of .688, whereas years of experience was not associated to the identification of countervailing risks and demonstrated a -.061 correlation coefficient and significance of .306.

Results of this analysis support the hypothesis. The data provided demonstrate a positive correlation between experience and the identification of countervailing risks.

Hypothesis 2: There is significant correlation between experience (i.e., previous occurrences; lessons learned) from other projects and the handling of countervailing risks in the current project.

Independent Variable: experience.

Dependent Variable: handling of countervailing risks.

Through exploratory analysis, it was determined experience had two components associated with the experience variable – years of experience and self assessment of experience. The reliability of years of experience showed a Cronbach's Alpha of .746, and the Cronbach's Alpha for self assessment of experience was .824, showing a high construct quality.

The results of the regression analysis demonstrate a positive prediction correlation between the predictors of experience and the handling of countervailing risks. An R Square value of .490 shows experience predicts nearly 49% of the handling of countervailing risks dependent variable and is very significant with a regression significance of 0.000. Through correlation analysis, it was shown the component for the self assessment of experience was the major factor in this prediction value where it was highly significant at the 0.01 level for a 1-tailed analysis with a correlation coefficient of .494, whereas years of experience was not associated to the identification of countervailing risks and demonstrated a -.144 correlation coefficient and significance of .113.

Results of this analysis support the hypothesis. The data provided demonstrate a positive correlation between experience and the handling of countervailing risks.

Hypothesis 3: There is no significant correlation between education and the identification of countervailing risks.

Independent Variable: education.

Dependent Variable: identification of countervailing risks.

Utilizing the statistical results provided through linear regression and correlation, the data showed no significant relationship between education and the identification of countervailing risks. The regression testing provides an R square value of .041, saying it does not explain Identifying Countervailing Risks; however, the correlation coefficient of -.241 is significant at the .05 level with a value of .021 indicating a negative correlation between education and identification – meaning, for example, that personnel with less formal education are more related to explaining identification of countervailing risks than those with graduate degrees.

Results of this analysis do not support the hypothesis. The data provided demonstrate no predictive correlation between education and the identification of countervailing risks; however, there does appear to be a negative association.

Hypothesis 4: There is no significant correlation between education and the handling of countervailing risks.

Independent Variable: education.

Dependent Variable: handling of countervailing risks.

Utilizing the statistical results provided through linear regression and correlation, the data showed no significant relationship between education and the handling of countervailing risks. The regression testing provides an R square value of .010, saying it does not explain the Handling of Countervailing Risks; in addition, the correlation coefficient of -.151 showed no significance with a value of 0.104.

Results of this analysis support the hypothesis. The data provided demonstrate no correlation between the predictors of education and the handling of countervailing risks.

Hypothesis 5: There is significant correlation between utilizing knowledge transfer across projects and identification of countervailing risks.

Independent Variable: knowledge transfer.

Dependent Variable: identification of countervailing risks.

Through exploratory analysis, it was determined knowledge transfer had two components associated with the variable, which could not be separated into different components. Through iterative factor analysis, two questions were deleted that were not associated with the construct, resulting in one component with five explaining questions. The reliability analysis of the resultant knowledge transfer showed a Cronbach's Alpha of .900 showing a high construct quality.

The results of the regression analysis demonstrate a positive prediction correlation between the predictors of knowledge transfer and the identification of countervailing risks. An R Square value of .359 shows knowledge transfer predicts nearly 36% of the identification of countervailing risks dependent variable and is very significant with a regression significance of 0.000. Through correlation analysis, it was shown the component for knowledge transfer had a highly significant prediction value at the 0.01 level for a 1-tailed analysis with a correlation coefficient of .590.

Results of this analysis support the hypothesis. The data provided demonstrate a positive correlation between the predictors of knowledge transfer and the identification of countervailing risks.

Hypothesis 6: There is significant correlation between utilizing knowledge transfer across projects and handling of countervailing risks.

Independent Variable: knowledge transfer.

Dependent Variable: handling of countervailing risks.

Through exploratory analysis, it was determined knowledge transfer had two components associated with the variable, which could not be separated into different components. Through iterative factor analysis, two questions were deleted that were not associated with the construct, resulting in one component with five explaining questions. The reliability analysis of the resultant knowledge transfer showed a Cronbach's Alpha of .900 showing a high construct quality.

The results of the regression analysis demonstrate a positive prediction correlation between the predictors of knowledge transfer and the handling of countervailing risks. An R Square value of .347 shows knowledge transfer predicts nearly 35% of the handling of countervailing risks dependent variable and is very significant with a regression significance of 0.000. Through correlation analysis, it was shown the component for knowledge transfer had a highly significant prediction value at the 0.01 level for a 1-tailed analysis with a correlation coefficient of .430.

Results of this analysis support the hypothesis. The data provided demonstrate a positive correlation between the predictors of knowledge transfer and the handling of countervailing risks.

Hypothesis 7: There is no significant correlation between project roles (manager, administrative, engineer, etc.) and identification of countervailing risks.

Independent Variable: roles.

Dependent Variable: identification of countervailing risks.

Utilizing the statistical results provided through linear regression and correlation, the data showed no significant relationship between role and the identification of countervailing risks. The regression testing provides an R square value of .06, saying it does not explain Identifying Countervailing Risks; however, the correlation coefficient of -.301 is significant at the .01 level with a value of .005 indicating a negative correlation between role and identification – meaning, for example, that managers are more related to explaining identification of countervailing risks than test and evaluation personnel.

Results of this analysis do not support the hypothesis. The data provided demonstrate no predictive correlation between role and the identification of countervailing risks; however, there does appear to be a negative association.

Hypothesis 8: There is no significant correlation between project roles (engineer, manager, administrative, etc.) and the handling of countervailing risks.

Independent Variable: roles.

Dependent Variable: handling of countervailing risks.

Utilizing the statistical results provided through linear regression and correlation, the data showed no significant relationship between role and the handling of countervailing risks. The regression testing provides an R square value of .01, saying it does not explain Identifying Countervailing Risks; in addition, the correlation coefficient of -.162 does not demonstrate significance with a value of .089 indicating no association between role and handling of countervailing risks.

Results of this analysis support the hypothesis. The data provided demonstrate no correlation between the predictors of role and the handling of countervailing risks.

HYPOTHESIS SUMMARY AND GENERALIZABILITY

In all cases the linear regression analysis supported the hypotheses; however, in two cases correlation analysis showed a negative association where it was hypothesized no association would be evident. The case where role is negatively associated with the identification of countervailing risks may be postulated that managers are more experienced at identifying risks as part of their tasking and test and evaluation personnel, for example, do not normally account risk identification as part of their normal duties; however, the association will be left for future determination. The negative association between education and the identification of countervailing risks implies the higher the degree achievement, the less personnel think about risks; this association will also be left to future analysis to determine if the higher degree is associated with certain roles or other determinate factors.

Analysis of the independent variable knowledge transfer and the dependent variables of identification and handling of countervailing risks fully supported the research question. Data showed there is an association between a decision-maker's knowledge from other projects and the identification and handling of countervailing risks that arise during Lean Thinking's Value Stream Analysis.

Inference from these results based on the sample given high reliability of the constructs implies similar results would prevail in the larger population of Naval Research and Development laboratories. Generalizability to a different type of organization could be attained in a future study by performing a similar study with the same measurement instrument and data analysis methodology.

RESEARCH VALIDATION

Research validation is provided in terms of the validity checks described in the methodology. Schmitt (1994, p. 394) remarks, the "relevant question is whether the method(s) of measurement and the research design allow one to derive appropriate conclusions." Methods and their procedures were validated in accordance with canons of science for quantitative methods providing the traditional (positivist) approach. The canons and research methodology account for significance, applicability, consistency and neutrality in the research and data analysis. A measurement instrument validation process demonstrating the applicable methods and tests utilized in this research adapted from Ahire and Davaraj (2001) was followed. Results of the data collection and analysis were provided empirically and in accordance with the proposed validation processes.

Content Validity

Prior literature and subject matter experts were utilized to develop the measurement instrument concepts for data to be collected. As this was the development of an emergent scale, the instrument questions were provided to independent assessors to validate whether the question asked fell into the variable category being measured. Outliers were discussed with the respondents, and the resultant questions validated as written or updated as appropriate and the test re-run. The resultant tested questions were incorporated into the measurement instrument for data collection.

Face Validity

Validation of the survey instrument and pilot study of the results for its continued use was performed to validate the measurement instrument "looks like" it measures what it is intended to measure. Survey question formulation utilized subject matter experts to develop requisite questions and a test group of diverse persons was utilized to categorize these questions into the construct areas identified in the hypotheses. Results of this iterative survey question development process are provided in Appendix D with the final questions being utilized in the measurement instrument provided for data collection.

Unidimensionality

Component factor analysis and confirmatory factor analysis of the constructs were performed to measure the extent indicators are associated with each other and represent a single concept. Analysis results validated the constructs with high factor loadings indicating the questions were representing the variable being tested.

Reliability

Internal consistency provides the reliability describing the degree of consistency between the measures of a construct using Cronbach's Alpha. Hatcher "maintained that surveys should include at least five questions per variable in order to increase the probability of retaining at least three after verification of internal consistency" (Parsons, 2004, p. 42). Confirmatory factor analysis verified the resultant survey questions for each construct as pertaining to one component. All constructs were explained by at least four questions per construct with three of the four constructs being explained by five questions each.

Cronbach's alpha is an indication of the reliability and consistency of how well the items (survey questions in this research) measure the construct for which they were devised. A high value for Cronbach's alpha provides good reliability that the items are measuring the same construct and is an indicator of a high correlation between the associated items. An alpha value greater than 0.60 establishes the measure for good reliability for emerging construct scales, and there is no strict limit established for a high value concerning scale reliability (Ahire & Devaraj, 2001, p. 322). All constructs returned values between .746 and .900. Reliability indicators provide the items are measuring the same construct with high correlation.

Nomological Validity

The assessment of relationships through correlation, regression and multivariate analysis procedures provide the extent to which constructs relate to each other in accordance with the theory. Analysis results provided the construct relations in accordance with theory except as noted as described in hypothesis testing. Nomological validity was maintained utilizing statistical analysis techniques.

Internal Validity

Internal validity was checked where the "primary strategy for strengthening the experimental methodology is replication" (Bowen 1995, p. 32). The resultant survey was used throughout the data collection period; no modifications were permitted and the same measurements and analysis were performed on all of the data collected to maintain internal validity.

Descriptive statistics were performed utilizing data collection from different samples (separate organizations with different facilitators within the target population) via a survey developed to obtain data related to theories provided with the purpose being to test that the correlation between the independent and dependent variables is not affected by an outside factor. Methods used in this process are shown in Table 20.

Data Collection	▪ Interview (limited) ▪ Survey
Data Analysis	▪ Correlation ▪ Regression Analysis
Subject Sample Data (Source)	▪ Different Events ▪ Different Organizations

Table 20: Internal Validity

External Validity

Applicability of the research findings is substantiated through external validity. External validity checks the results to see if the findings may be generalized to the population or other populations or contexts instead of just the sample. Bowen (1995, p. 32) shows that surveys provide an opportunity to study a large number of groups providing the strength of high external validity, assuming the data samples include multiple organizations, settings, etc. To achieve these criteria, multiple departments and events were used to collect data. Selection of participants was random and did not target particular groups or traits so as to not bias the data collected. Participants in the survey were from the target population of interest, and all participants were asked to voluntarily and anonymously participate with no exclusions. This approach should ensure data was obtained from a diverse sample and from multiple organizations. A search for similar results in the literature show no studies exist that externally validate the results of this investigation independently. To increase external validity, investigation results were reviewed by coworkers to discuss conclusions and implications.

5. DISCUSSION AND CONCLUSIONS

A research investigation was proposed to identify knowledge transfer as a means to promote the management of countervailing risks that arise when performing the continuous process improvement method of Lean Thinking Value Stream Analysis. This is important to enable a better understanding of the actions being taken when performing Lean Thinking value stream analysis and to provide knowledge for the identified gaps in the current risk management and Lean Thinking literature. Literature regarding risk management and Lean Thinking was reviewed to determine the current state of both fields and to identify the links and gaps between the two. The purpose was to determine support for using knowledge transfer methodologies to identify and mitigate countervailing risks when performing Lean Thinking value stream analysis during projects to enable a better understanding of the actions being taken during these processes. This study proposed the need for further research and development to link knowledge transfer methodologies as functions and activities accomplished to promote the management of countervailing risks when performing Lean Thinking Value Stream Analysis during projects.

A quantitative research method was proposed to study how knowledge transfer applies to promoting the management of countervailing risks to analyze decisions made during projects that are implementing continuous process improvement methodologies such as Lean Thinking. A survey was the technique used for collecting data to answer the research questions, with statistical analysis performed on the quantitative data. It is the object of this research to express the theory in terms of measurable activities based on analysis of data obtained from quantifiable interpretations of empirical observations obtained through surveys. The actual data collected was determined during the investigative stage of the proposal. The intent was to perform a cross-sectional study with the population sample being projects in the Department of the Navy that have performed Lean Thinking implementation events.

Results of the analysis fully supported the research hypotheses. Analysis of the independent variable knowledge transfer and the dependent variables of identification and handling of countervailing risks provided predictive associations. Data showed an association between a decision-maker's knowledge from other projects and the identification and handling of countervailing risks that arise during Lean Thinking's Value Stream Analysis.

IMPLICATIONS TO ENGINEERING MANAGERS

One of the goals of this research was to provide engineering managers additional information regarding risk identification and handling so they may better perform their tasking and take into account the potential outcomes of the actions they take when streamlining their processes to eliminate waste and non-value added steps. The data collected and analysis performed provides valuable information regarding the correlations and associations between risk identification and handling and the independent variables studied.

The highly significant correlation between experience and both the identification and handling of countervailing risks (hypotheses 1 and 2) enables managers to identify team members not only for lean events that will potentially modify programmatic processes but also for project teams and their associated tasking. Implications are that teams with highly experienced personnel in that focus area will be able to manage project risks and transfer that knowledge to other team members without having to experience the risk during the project.

The highly significant correlation between knowledge transfer and both the identification and handling of countervailing risks (hypotheses 5 and 6) enables managers to establish projects with the means and methods for transferring knowledge regarding areas of concern. Implications may include the use of communities of practice or subject matter experts to handle areas of interest or risk versus having duplicative teams in each of the organization's projects, resulting in cost savings, common processes and an easier implementation of lessons learned and other knowledge management techniques.

Regarding the impact of formal education and project roles on identifying and handling countervailing risks (hypotheses 3, 4, 7 and 8), implications for engineering managers provide insight into team make-up and applicable tasking assignments. This insight enables managers to develop teams by skill set and assign applicable tasking versus traditional performance by tasks assigned to roles or with prerequisite educational requirements (e.g., the risk manager may be the foreman with 25 years of experience versus the new hire with a master's degree).

The results of the study are valuable to engineering managers as well as practitioners, researchers and academics to further their understanding in the areas of knowledge transfer and risk management and the correlation between these fields. This research will add to the existing body of knowledge by providing knowledge of the gaps in the current risk management and Lean Thinking literature concerning enhancing the management of countervailing risks through knowledge transfer.

LIMITATIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

An important area to be discussed involves the limitations of this study. The data analysis did not fully support the hypotheses in all cases; the sample respondents were from a target population, and some of the analysis results could provide greater support of the recommended criteria. Limitations may be due to sample size, the population of interest and potentially the use of an emerging measurement scale to obtain data.

To address these limitations and enhance the current body of knowledge, future research is recommended. One area of research would address potential reasoning behind the hypotheses that were not fully supported by the data. In the case where role is negatively associated with the identification of countervailing risks it may be postulated that managers are more experienced at identifying risks as part of their tasking; however, the association will be left for future determination. The negative association between education and the identification of countervailing risks implies the higher the degree achievement, the less personnel think about risks; this association will also be left to future analysis to determine if the higher degree is associated with certain roles or other determinate factors.

Another area of future research would be to address generalizability of the results to a different type of organization. Generalizability could be attained in a future study by performing a similar study with the same measurement instrument and data analysis methodology to obtain a larger sample size or performing a similar study with a different population. The resultant larger sample size could also contribute to higher statistical analysis results with increased confidence and validity and provide greater statistical significance for unidimensionality by countering the lower communality scores in a couple of the constructs.

The purpose of this investigation was to determine support for using knowledge transfer methodologies to identify and mitigate countervailing risks when performing Lean Thinking value stream analysis, which was empirically supported. A final recommended research area would be in the investigation of specific knowledge transfer techniques that could be used in value stream analysis to identify and mitigate countervailing risks.

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APPENDICES

APPENDIX A: FIGURES FOR VALUE STREAM ANALYSIS

"The value-added flow chart is a mechanism to improve cycle times and productivity by visually separating value-adding from non-value-adding activities. The process is very straightforward, as outlined below:

1. List all of the steps in a process from beginning to end.
2. Create a diagram with a box for every step, in sequence.
3. Calculate the time currently required to complete each step of the process, and add that time to the box… [see figure 9].
4. Add the time in each box to yield the Total Cycle Time.
5. Identify those steps that do not add value to the process. Non value-added operations include: inspection, test, rework, set-up, inventory buffers, product movement other than customer delivery - any activity that does not improve the form, fit, or function of the product on the first pass through the process.
6. Move the boxes representing non-value-added processes to the right of the value-adding steps… [see figure 9].
7. Add the time in each of the non-value-added processes to yield the Non-Value-Added Cycle Time. This is the waste that could be eliminated if only value-added steps were performed.
8. Add the time in each of the value-added process to yield the Value-Added Cycle Time.

9. Calculate the percentage of the Total Cycle Time that is a function of Non-Value-Added operations. You may wish to construct a pie chart to communicate the analysis… [see figure 10].
10. Identify the target process configuration using benchmarking and best-in-class analysis.
11. Diagram the target process and determine the Total Target Cycle Time.
12. Analyze the Non-Value-Added steps to identify actions to reduce or eliminate these operations… [see figure 11].
13. Analyze the Value-Added steps to identify improvement opportunities and implement actions to reduce the cycle time.
14. Diagram the improved process, compare to the target process, and identify gaps for further improvement actions on an ongoing basis until the target is achieved."

(Moresteam, 2006)

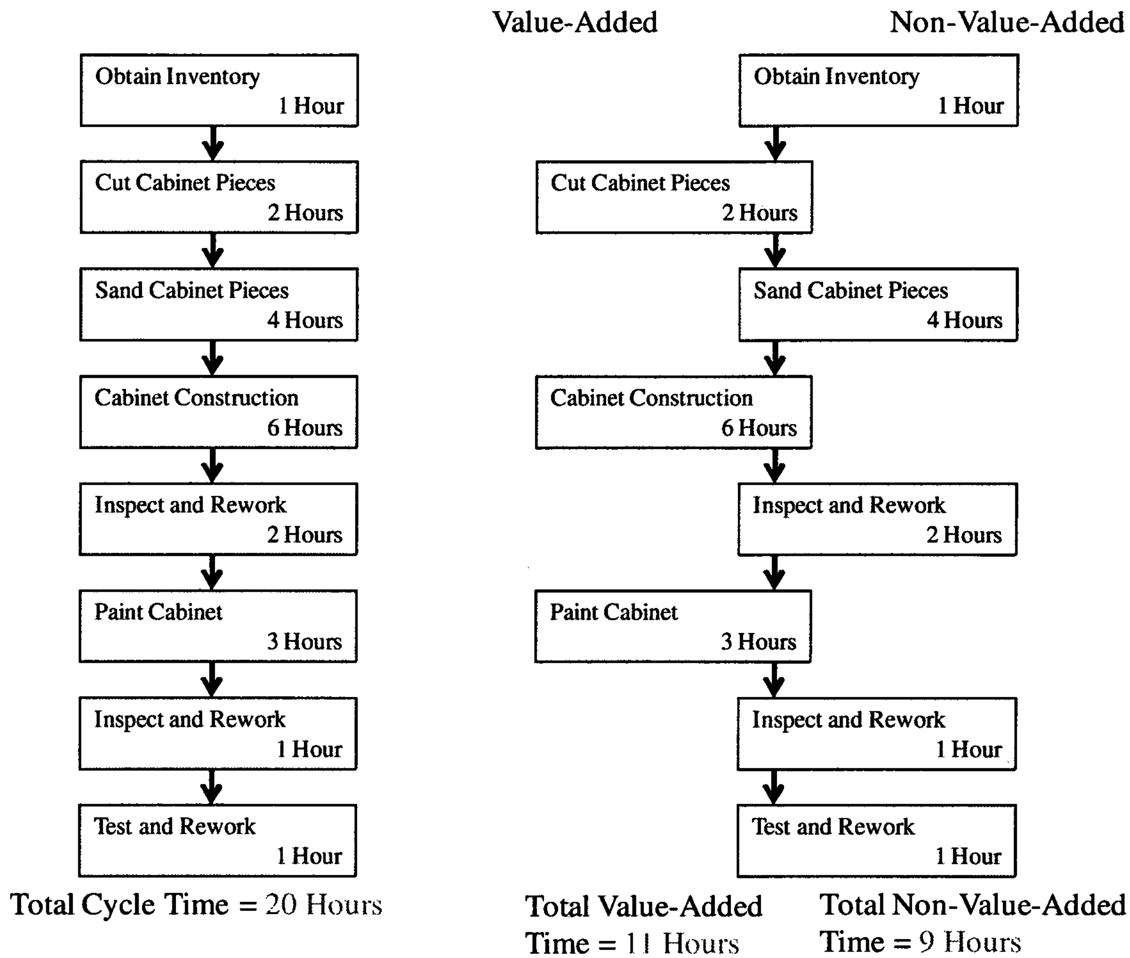


Figure 9: Value-Added Process Steps

(Adapted from Moresteam, 2006)

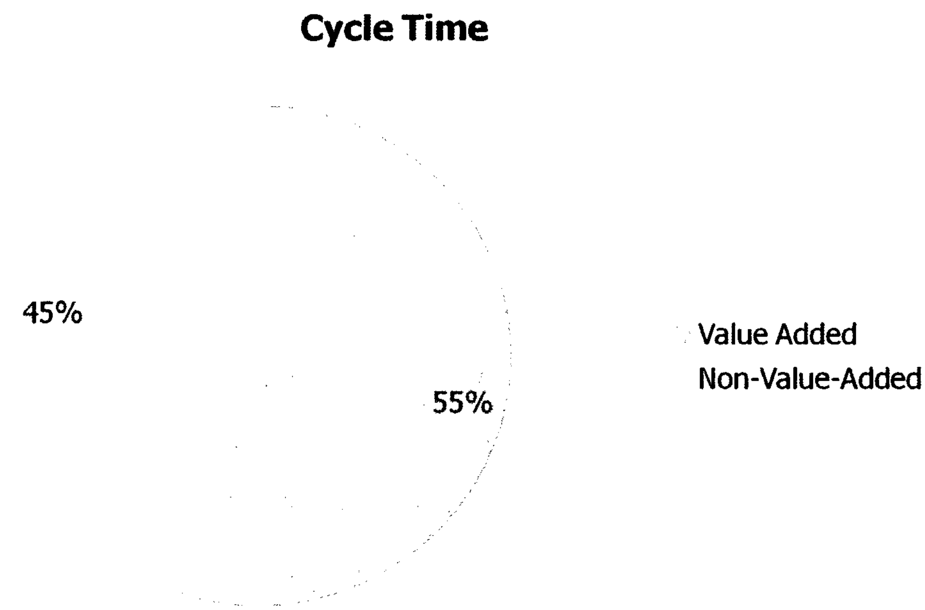


Figure 10: Total Cycle Time

(Adapted from Moresteam, 2006)

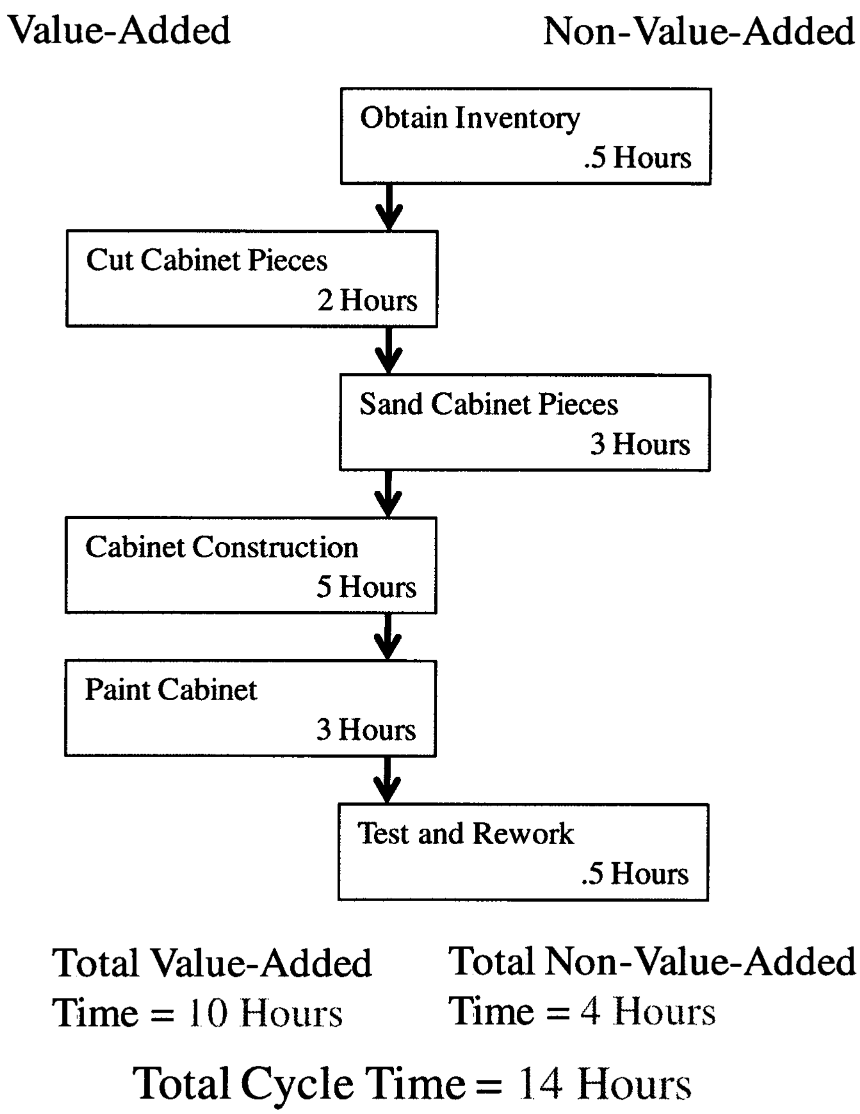


Figure 11: Total Target Cycle Time

(Adapted from Moresteam, 2006)

APPENDIX B: OPERATIONAL DEFINITIONS

Operational definitions of the established variables were identified by way of the literature, the dictionary and common usage. Interpretations and meanings for the following variables used in this research are defined below.

Countervailing risks: alternative risks that may arise as the result of handling the original risk.

Education: formal attainment of scholastic degrees.

Experience: the knowledge and know-how gained through a person's involvement or exposure.

Future State: process between the current state and the ideal state. Process that may be achieved by implementing Lean Thinking and eliminating non-value added processes (waste) where possible. The resultant stream of processes followed to achieve the goals of a project after undergoing value stream analysis. The result of improvements made to the current state process during a Lean Thinking event.

Handling of countervailing risks: the handling and mitigation efforts associated with alternative (countervailing) risks - including transferring, reducing, accepting and avoiding.

Identification of countervailing risks: the ability to find or identify alternative risks that may arise as a result of mitigating an original risk.

Knowledge transfer: moving useful information/knowledge (either tacit or explicit) from one individual or group to another; transferring the experience gained from one project to be utilized in another.

Lean Thinking: process focused on reducing cycle time and waste in processes.

Management of countervailing risks: the identification, assessment, handling and mitigation efforts including transferring, reducing, accepting and avoiding, that are associated with alternative (countervailing) risks.

Method: strategy of inquiry utilizing established procedures, which moves from the underlying philosophical assumptions to research design and data collection.

Methodology: the practices, procedures and rules used in the inquiry utilizing established methods and their procedures.

Project roles: titles and/or positions held during the running of a project; functions performed by personnel during the running of the project.

Risk Management: the activities involved in dealing with risks, primarily - risk identification, risk analysis and risk response.

Six Sigma: process focused on reducing variation to improve the quality of products, processes or services.

Value Stream Analysis (VSA): project analysis where all project processes are identified, assessed and acted upon accordingly. The continuous process improvement method utilized to determine which of a project's processes add value or which are waste and may be deleted or modified to achieve a more efficient future state process. Technique used in Lean Thinking events.

Value Stream Map (VSM): the step in VSA that lays out all actions required for a product or service identifying each action as value or non-value added.

APPENDIX C: HUMAN SUBJECT RESEARCH CERTIFICATE

Figure 12 details the successful completion of the National Institutes of Health "Protecting Human Research Participants."

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Jeff Temple** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 04/23/2009

Certification Number: 220541

Figure 12: Protecting Human Research Participants Certificate of Completion

APPENDIX D: QUESTIONNAIRE CATEGORY VALIDATION

The following instrument was provided to validate whether the question asked fell into the variable category being measured. "X" marks the intended category for the question, with a "1" entered for individual marks for each response; "1/2" meant the respondent marked two different responses for the same question.

Name______Consolidation/Validation: tabulation of responses received_______
Please evaluate into which category you feel each question falls according to the following definitions:

Experience: the knowledge and know-how gained through a person's involvement or exposure.

Risk Identification: finding or identifying risks or repercussions/impacts that may occur.

Knowledge transfer: moving useful information/knowledge from one individual to another; transferring the experience gained from one project to be utilized in another.

Risk Management: the assessment, handling and mitigation efforts associated with the identified risks including transferring, reducing, accepting and avoiding.

	Experience	Risk Identification	Knowledge Transfer	Risk Management
1. I considered what I have experienced and learned when determining value added for each of the current process steps during this lean event.	X 111111 ½		½	
2. When developing the future state process during this lean event, I considered the repercussions that may occur as a result of changing the current process.	½	X 11111 ½	½	1 ½

	Experience	Risk Identification	Knowledge Transfer	Risk Management
3. I used knowledge gained from other projects when evaluating the future state process during this lean event.	1		X 111111	
4. To prepare for this lean event I reviewed my experiences with the current process to identify what processes, steps or areas could/should change.	X 11111		11	
5. When developing the future state process during this lean event, I considered ways to avoid or handle the repercussions that may occur as a result of changing the current process.				X 1111111
6. Based on the risks identified in my area of responsibility when implementing the future state, I identified alternatives so those risks should not occur.				X 1111111
7. I know what tasks/processes can or cannot change in the future state in my area of responsibility.	X 1111 ½ ½		½ ½	1

	Experience	Risk Identification	Knowledge Transfer	Risk Management
8. Based on the risks identified in my area of responsibility when implementing the future state, I identified ways to transfer the impact to another organization or area if the risk was to occur.			111	X 1111
9. I used the decisions made for other projects to influence similar decisions during this lean event.	½ ½		X 11111 ½ ½	
10. I have considerable experience in my current field and others may consider me an expert.	X 111111		1	
11. Based on changes from the current state to the future state, I identified the probability or likelihood of a negative impact and the severity or consequence if that impact were to occur.		X 111111		1
12. I identified actions I needed to execute during this event through experiences from other projects.	½		X 11111 ½	1

	Experience	Risk Identification	Knowledge Transfer	Risk Management
13. Based on the risks identified in my area of responsibility when implementing the future state, I identified ways to lessen the impact if the risk was to occur.				X 1111111
14. I utilized information provided by others/another to make my decisions during this lean event.			X 1111111	
15. As a group, our team discussed why a process should stay or be changed in the future state and made the decision based on the information exchanged between team members.			X 1111111	
16. When evaluating processes in the future state during this lean event, I evaluated the problems and benefits and the consequences associated with each of the options presented.	½	X 1111	½	11

	Experience	Risk Identification	Knowledge Transfer	Risk Management
17. Based on the risks identified in my area of responsibility when implementing the future state, I evaluated the impact as acceptable if the risk was to occur.				X 1111111
18. When I am considering changing a process, I think about the risks that may occur as related to my job and tasking.		X 1111111		
19. I used information and lessons learned from other projects when making decisions during this lean event.	1		X 111111	
20. If a process or task was recommended to be changed or eliminated in the future state, I identified the risks associated with that idea.		X 1111111		
21. I have in-depth knowledge of my area of responsibilities on this project.	X 111111 ½		½	

Revised questionnaire category validation.

The following instrument was provided to validate whether the question asked fell into the variable category being measured. "X" marks the intended category for the question, with a "1" entered for individual marks for each response.

Outliers were discussed with the respondents and the resultant questions validated as written or updated as appropriate.

Name______Consolidation/Validation: tabulation of responses received_______

Please evaluate the single, best category you feel each question falls into according to the following definitions:

Experience: the knowledge and know-how learned through a person's involvement or exposure that is not specifically gained from another person or project.

Risk Identification: finding or identifying risks or repercussions/impacts that may occur.

Knowledge transfer: moving or utilizing information/knowledge from one individual to another; transferring the experience gained from one project to be utilized in another.

Risk Management: the assessment, handling and mitigation efforts associated with the identified risks, to include: risk transfer, risk reduction, risk acceptance and risk avoidance.

	Experience	Risk Identification	Knowledge Transfer	Risk Management
1. I considered what I have experienced and learned when determining value added for each of the current process steps.	X 11111			
2. I identified the repercussions that may occur as a result of changing the current process when developing the future state process.		X 11111		

	Experience	Risk Identification	Knowledge Transfer	Risk Management
3. I used knowledge gained from other projects when evaluating the future state process.			X 11111	
4. I reviewed my involvement and exposure with the current process to evaluate areas that could/should change to prepare for this lean event.	X 111		1	1
5. I considered ways to avoid or handle the repercussions in the future state that may occur as a result of changing the current process.		11		X 111
6. Based on the risks identified in my area of responsibility when implementing the future state, I identified alternatives so those risks should not occur.				X 11111
7. I know what tasks/processes can or cannot change in my area of responsibility.	X 1111			1

	Experience	Risk Identification	Knowledge Transfer	Risk Management
8. Based on the risks identified in my area of responsibility when implementing the future state, I identified risk transfer methods to shift the impact to another organization or area.			1	X 1111
9. I used knowledge gained from decisions made on other projects to influence similar decisions during this lean event.			X 11111	
10. I have considerable knowledge and know-how in my current field and role.	X 11111			
11. I identified impacts that may occur as a result of changes from the current state to the future state.		X 11111		
12. I identified actions I needed to execute during this event through experiences gained from other projects.			X 11111	
13. Based on the risks identified in my area of responsibility when implementing the future state, I identified ways to lessen the impact if the risk was to occur.				X 11111

	Experience	Risk Identification	Knowledge Transfer	Risk Management
14. I utilized information provided by others/another to make my decisions during this lean event.			X 11111	
15. As a group, our team discussed why a process should stay or be changed in the future state and made the decision based on the information exchanged between team members.	1	1	X 111	
16. I identified the problems, benefits and consequences associated with each of the changes presented during this lean event.		X 11111		
17. Based on the risks identified in my area of responsibility when implementing the future state, I evaluated the impact as acceptable if the risk was to occur.	1			X 1111
18. When I am considering changing a process, I think about the risks that may occur as related to my job and tasking.	1	X 1111		

	Experience	Risk Identification	Knowledge Transfer	Risk Management
19. I used information and lessons learned that were gained from other projects when making decisions during this lean event.			X 11111	
20. If a process or task was recommended to be changed or eliminated in the future state, I identified the risks associated with that idea.		X 11111		
21. I have in-depth knowledge of my area of responsibilities.	X 11111			

Supplemental questionnaire category validation.

The following instrument was provided to validate the remaining outlying questions. Results of the previous instrument were discussed with the respondents, individually asking their thoughts on why they marked a specific category based on specific words in the question. The supplemental questionnaire consisting of only the questions that had outliers from the previous questionnaire was then provided with updated questions or a revised operational definition. Once again they were asked to mark the variable category where they believed the question being asked fell. "X" marks the intended category for the question, with a "1" entered for individual marks for each response.

Name______Consolidation/Validation: tabulation of responses received_______
Please evaluate the single, best category you feel each question falls into according to the following definitions:

Experience: an individual's knowledge and know-how learned through involvement or exposure that is not specifically gained from another person or project.

Risk Identification: finding or identifying risks or repercussions/impacts that may occur.

Knowledge transfer: moving or utilizing information/knowledge from one individual or group to another; transferring the experience gained from one project to be utilized in another.

Risk Response: the assessment, handling and mitigation efforts dealing with the identified risks, to include: risk transfer, risk reduction, risk acceptance and risk avoidance.

	Experience	Risk Identification	Knowledge Transfer	Risk Response
4. Based on my familiarity, I reviewed the current process to evaluate areas that could/should change to prepare for this lean event.	X 1111			
5. I considered ways to avoid, mitigate or handle the repercussions in the future state that may occur as a result of changing the current process.				X 1111
7. I know what tasks/processes can or cannot change in my area of responsibility.	X 1111			

	Experience	Risk Identification	Knowledge Transfer	Risk Response
8. Based on the risks identified in my area of responsibility when implementing the future state, I identified risk handling methods to shift the impact to another organization or area.		1	1	X 11
15. As a group, our team discussed why a process should stay or be changed in the future state and made the decision based on the information exchanged between team members.			X 1111	
17. Based on the risks identified in my area of responsibility when implementing the future state, I assessed whether the impact was acceptable or not if the risk was to occur.				X 1111
18. When I am considering changing a process, I identify the risks that may occur as related to my job and tasking.		X 1111		

APPENDIX E: SURVEY QUESTIONNAIRE

Survey questionnaire –validated and approved.

Survey questionnaire

The information being requested will help future Lean event teams. Analysis results will be based on a combination of events and cannot be traced to any individual or event. Individual responses will remain anonymous and not be reported to any person nor be traced to any specific event or person. Participation in this survey is voluntary, with no penalties or reprisals for not participating or completing.

Please provide a single, best answer to each of the following questions based on the LEAN Event just held:

1. What was the Team's primary purpose for conducting this LEAN Event?
    - o Documenting the current process
    - o Modifying an inefficient process or changing due to new requirements
    - o Finding ways to reduce the cost of the current process
    - o Finding ways to reduce the schedule of the current process
    - o Eliminating poor quality or rework
    - o Other ______________________________

2. What was your primary purpose in attending this LEAN Event?
    - o Understand the current process or Organization's goals
    - o Have a say in the new process/provide opinion
    - o Reduce risk of poor decisions that would be made if I did not attend
    - o Reduce my current "pain" by providing alternatives
    - o Required to meet "quota"
    - o Other ______________________________

3. Based on all of the changes discussed during this lean event, what percentage of your inputs to the process were based on knowledge gained from other projects:
    - o __________ percent (0 through 100)

4. Based on all of the changes discussed during this lean event, which changes are you most confident in having the desired outcome:
    - o Changes made based on past results/lessons learned
    - o Changes made that would have the greatest cost savings
    - o Changes made that would have the greatest schedule savings
    - o Changes that deleted non-value added processes
    - o Changes that modified or added requirements
    - o Other ______________________________

5. How confident are you that risks were identified and adequately handled for the new, future state process:
    - Positive they were addressed
    - Sure the majority were identified and addressed
    - Don't know
    - Don't think the majority were identified or addressed
    - Other ____
    - N/A

6. What is your highest level of education?
    - High school
    - Associates Degree or some college
    - Bachelor's Degree
    - Some graduate work
    - Master's Degree
    - Some post-graduate work
    - Doctoral Degree

7. What is your gender?
    - Male
    - Female

8. What is your age?
    - __________ years

9. What is your primary role/function on this project?
    - Management
    - Administrative
    - Engineering
    - Test and evaluation
    - Other ____

10. What is your approximate number of years in this type of role/function?
    - __________ years

11. What is your approximate number of years in this type of work regardless of role/function?
    - __________ years

12. What is your approximate number of years on this project?

- ___________ years

13. What is your approximate number of years in this organization?
    - ___________ years

For Questions 14-37:
Please respond to the following questions rating your agreement with the statement from strongly disagree to strongly agree.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
14. I considered what I have experienced and learned when determining value added for each of the current process steps.					
15. I identified the repercussions that may occur as a result of changing the current process when developing the future state process.					
16. I used knowledge gained from other projects when evaluating the future state process.					
17. Based on my familiarity, I reviewed the current process to evaluate areas that could/should change to prepare for this lean event.					
18. I considered ways to avoid, mitigate or handle the repercussions in the future state that may occur as a result of changing the current process.					

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
19. Based on the risks identified in my area of responsibility when implementing the future state, I identified alternatives so those risks should not occur.					
20. I know what tasks/processes can or cannot change in my area of responsibility.					
21. Based on the risks identified in my area of responsibility when implementing the future state, I identified risk handling methods to shift the impact to another organization or area.					
22. I used knowledge gained from decisions made on other projects to influence similar decisions during this lean event.					
23. I have considerable knowledge and know-how in my current field and role.					
24. I identified impacts that may occur as a result of changes from the current state to the future state.					
25. I identified actions I needed to execute during this event through experiences gained from other projects.					

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
26. Based on the risks identified in my area of responsibility when implementing the future state, I identified ways to lessen the impact if the risk was to occur.					
27. I utilized information provided by others/another to make my decisions during this lean event.					
28. As a group, our team discussed why a process should stay or be changed in the future state and made the decision based on the information exchanged between team members.					
29. I identified the problems, benefits and consequences associated with each of the changes presented during this lean event.					
30. Based on the risks identified in my area of responsibility when implementing the future state, I assessed whether the impact was acceptable or not if the risk was to occur.					
31. When I am considering changing a process, I identify the risks that may occur as related to my job and tasking.					
32. I used information and lessons learned that were gained from other projects when making decisions during this lean event.					

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
33. If a process or task was recommended to be changed or eliminated in the future state, I identified the risks associated with that idea.					
34. I have in-depth knowledge of my area of responsibilities.					
35. Our team had sufficient time to cover what was required during this Lean event.					
36. Most of my actions in this value stream analysis project were physically demanding.					
37. Most of my actions in this value stream analysis project were psychologically demanding.					

APPENDIX F: INSTITUTIONAL REVIEW BOARD APPROVAL

No.: 09-058

OLD DOMINION UNIVERSITY
HUMAN SUBJECTS INSTITUTIONAL REVIEW BOARD
RESEARCH PROPOSAL REVIEW NOTIFICATION FORM

TO: Rafael E Landaeta
Responsible Project Investigator

DATE: May 21, 2009
IRB Decision Date

RE: Utilizing Knowledge Transfer to Promote Management of Countervailing Risks in Value Stream Analysis
Name of Project

Please be informed that your research protocol has received approval by the Institutional Review Board. Your research protocol is:

_X_ Approved (as exempt)
___ Tabled/Disapproved
___ Approved, contingent on making the changes below*

George C. Maihafer — May 21, 2009
IRB Chairperson's Signature — *date*

Contact the IRB for clarification of the terms of your research, or if you wish to make ANY change to your research protocol.

The approval expires one year from the IRB decision date. You must submit a Progress Report and seek re-approval if you wish to continue data collection or analysis beyond that date, or a Close-out report. You must report adverse events experienced by subjects to the IRB chair in a timely manner (see university policy).

---

* Approval of your research is CONTINGENT upon the satisfactory completion of the following changes and attestation to those changes by the chairperson of the Institutional Review Board. Research may not begin until after this attestation.

Attestation

As directed by the Institutional Review Board, the Responsible Project Investigator made the above changes. Research may begin.

George C. Maihafer — May 21, 2009
IRB Chairperson's Signature — *date*

APPENDIX G: LABOR EMPLOYEE RELATIONS RESPONSE

-----Original Message-----
From: Heiler, Philip A CIV NSWCDD, CXP
Sent: Wednesday, May 27, 2009 8:55
To: Schneider, Julie A CIV NSWCDD, CXPL; Temple, Jeffery A CIV NSWCDD, K90
Cc: Manley, Lisa G CIV NSWCDD, CD1L
Subject: RE: Survey
Importance: High

Nor do I.
Phil Heiler

-----Original Message-----
From: Schneider, Julie A CIV NSWCDD, CXPL
Sent: Tuesday, May 26, 2009 9:50
To: Temple, Jeffery A CIV NSWCDD, K90
Cc: Heiler, Philip A CIV NSWCDD, CXP; Manley, Lisa G CIV NSWCDD, CD1L
Subject: RE: Survey

Jeff,

I have no issues with the survey from the LER perspective.

Thanks,
Julie

APPENDIX H: ANALYSIS DATA

Survey Question Frequency and Skewness

Statistics

		V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16	V17	V18	V19
N	Valid	69	72	67	70	72	71	70	69	71	71	71	65	67	70	70	69	70	71	69
	Missing	3	0	5	2	0	1	2	3	1	1	1	7	5	2	2	3	2	1	3
Skewness		.521	.920	-.063	.800	1.620	.429	.818	-.134	-.188	.795	.311	1.783	1.105	-1.753	-1.315	-1.258	-1.035	-1.440	-.862
Std. Error of Skewness		.289	.283	.293	.287	.283	.285	.287	.289	.285	.285	.285	.297	.293	.287	.287	.289	.287	.285	.289

Statistics

		V20	V21	V22	V23	V24	V25	V26	V27	V28	V29	V30	V31	V32	V33	V34	V35	V36	V37
N	Valid	71	70	69	71	71	71	71	69	70	70	69	70	71	71	71	71	70	70
	Missing	1	2	3	1	1	1	1	3	2	2	3	2	1	1	1	1	2	2
Skewness		-1.131	-.232	-1.123	-1.522	-1.487	-.860	-1.185	-1.500	-1.717	-1.164	-1.076	-2.000	-1.232	-1.210	-1.725	-1.280	.901	-.145
Std. Error of Skewness		.285	.287	.289	.285	.285	.285	.285	.289	.287	.287	.289	.287	.285	.285	.285	.285	.287	.287

Exploratory data for experience:

Communalities

	Initial	Extraction
V10	1.000	.752
V11	1.000	.750
V12	1.000	.283
V13	1.000	.428
V14	1.000	.597
V17	1.000	.601
V20	1.000	.721
V23	1.000	.632
V34	1.000	.730

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.060	34.000	34.000	3.060	34.000	34.000
2	2.433	27.029	61.029	2.433	27.029	61.029
3	.921	10.233	71.262			
4	.789	8.769	80.031			
5	.628	6.982	87.013			
6	.508	5.646	92.659			
7	.266	2.952	95.611			
8	.205	2.273	97.884			
9	.190	2.116	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component	
	1	2
V10	.278	.822
V11	.223	.836
V12	.231	.479
V13	.392	.523
V14	.706	-.313
V17	.484	-.606
V20	.822	-.214
V23	.785	.126
V34	.838	-.167

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Confirmatory data for Years of Experience

Communalities

	Initial	Extraction
V10	1.000	.755
V11	1.000	.753
V12	1.000	.290
V13	1.000	.457

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.255	56.386	56.386	2.255	56.386	56.386
2	.852	21.308	77.694			
3	.668	16.699	94.392			
4	.224	5.608	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
V10	.869
V11	.868
V12	.539
V13	.676

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Confirmatory data for Self Assessment Experience

Communalities

	Initial	Extraction
V14	1.000	.595
V17	1.000	.394
V20	1.000	.711
V23	1.000	.535
V34	1.000	.726

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.960	59.203	59.203	2.960	59.203	59.203
2	.937	18.732	77.935			
3	.574	11.478	89.413			
4	.333	6.658	96.071			
5	.196	3.929	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
V14	.771
V17	.627
V20	.843
V23	.731
V34	.852

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Exploratory data for Knowledge Transfer

Communalities

	Initial	Extraction
V3	1.000	.512
V16	1.000	.778
V22	1.000	.838
V25	1.000	.768
V27	1.000	.777
V28	1.000	.774
V32	1.000	.887

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.805	54.361	54.361	3.805	54.361	54.361
2	1.530	21.850	76.211	1.530	21.850	76.211
3	.678	9.684	85.895			
4	.367	5.239	91.134			
5	.326	4.655	95.789			
6	.192	2.744	98.533			
7	.103	1.467	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component	
	1	2
V3	.435	-.568
V16	.880	-.067
V22	.903	-.150
V25	.853	-.199
V27	.543	.694
V28	.345	.810
V32	.941	-.047

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Confirmatory data for Knowledge Transfer

Communalities

	Initial	Extraction
V16	1.000	.788
V22	1.000	.853
V25	1.000	.739
V27	1.000	.278
V32	1.000	.891

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.549	70.972	70.972	3.549	70.972	70.972
2	.791	15.827	86.799			
3	.340	6.803	93.602			
4	.204	4.078	97.679			
5	.116	2.321	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
V16	.888
V22	.924
V25	.859
V27	.527
V32	.944

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Confirmatory data for Identification of Countervailing Risks

Communalities

	Initial	Extraction
V15	1.000	.742
V24	1.000	.735
V29	1.000	.710
V31	1.000	.604
V33	1.000	.786

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.577	71.547	71.547	3.577	71.547	71.547
2	.544	10.874	82.421			
3	.417	8.334	90.755			
4	.278	5.557	96.312			
5	.184	3.688	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
V15	.861
V24	.858
V29	.843
V31	.777
V33	.886

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Confirmatory data for Handling of Countervailing Risks

Communalities

	Initial	Extraction
V18	1.000	.600
V19	1.000	.649
V21	1.000	.243
V26	1.000	.554
V30	1.000	.700

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.746	54.918	54.918	2.746	54.918	54.918
2	.865	17.308	72.225			
3	.687	13.731	85.956			
4	.430	8.603	94.560			
5	.272	5.440	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component
	1
V18	.775
V19	.806
V21	.492
V26	.744
V30	.837

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Reliability data for Years of Experience

Case Processing Summary

		N	%
Cases	Valid	63	87.5
	Excluded[a]	9	12.5
	Total	72	100.0

a. Listwise deletion based on all variables in the procedure.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V10	30.90	343.636	.709	.578
V11	27.90	358.862	.720	.572
V12	38.32	586.446	.362	.772
V13	34.49	490.222	.423	.749

Reliability Statistics

Cronbach's Alpha	N of Items
.746	4

Reliability data for Self Assessment of Experience

Case Processing Summary

		N	%
Cases	Valid	70	97.2
	Excluded[a]	2	2.8
	Total	72	100.0

a. Listwise deletion based on all variables in the procedure.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V14	15.77	9.164	.637	.785
V17	16.21	9.272	.466	.837
V20	15.91	8.253	.722	.757
V23	15.79	9.330	.559	.805
V34	15.69	8.393	.735	.754

Reliability Statistics

Cronbach's Alpha	N of Items
.824	5

Reliability data for Knowledge Transfer

Case Processing Summary

		N	%
Cases	Valid	67	93.1
	Excluded[a]	5	6.9
	Total	72	100.0

a. Listwise deletion based on all variables in the procedure.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V22	15.25	11.101	.859	.852
V16	14.97	11.514	.810	.864
V25	15.22	11.873	.773	.873
V27	14.82	14.907	.421	.937
V32	15.13	10.967	.904	.842

Reliability Statistics

Cronbach's Alpha	N of Items
.900	5

Reliability data for Identification of Countervailing Risks

Case Processing Summary

		N	%
Cases	Valid	68	94.4
	Excluded[a]	4	5.6
	Total	72	100.0

a. Listwise deletion based on all variables in the procedure.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V15	15.31	7.858	.777	.873
V24	15.35	8.769	.773	.876
V29	15.43	7.860	.742	.882
V31	15.32	9.028	.672	.894
V33	15.47	7.984	.817	.863

Reliability Statistics

Cronbach's Alpha	N of Items
.900	5

Reliability data for Handling of Countervailing Risks

Case Processing Summary

		N	%
Cases	Valid	69	95.8
	Excluded[a]	3	4.2
	Total	72	100.0

a. Listwise deletion based on all variables in the procedure.

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
V18	13.91	7.110	.584	.723
V19	14.04	6.719	.637	.703
V21	14.75	7.541	.338	.817
V26	13.97	7.411	.563	.731
V30	13.99	6.867	.686	.691

Reliability Statistics

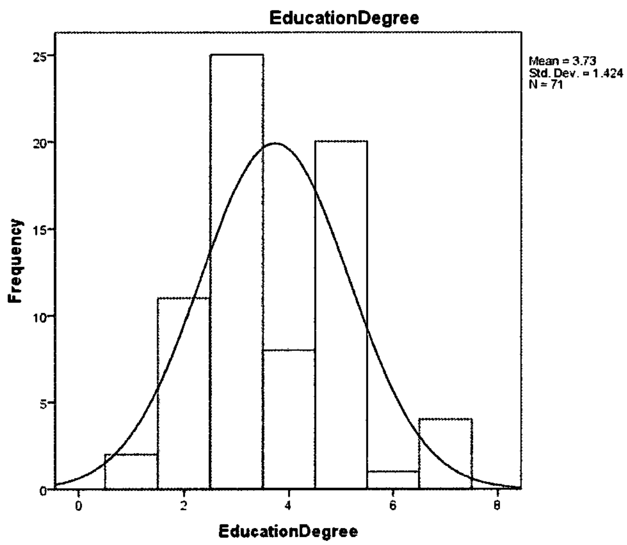
Cronbach's Alpha	N of Items
.776	5

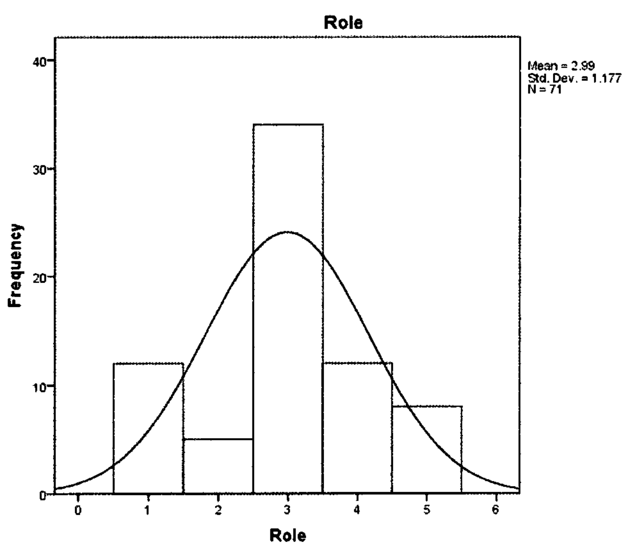
Skewness

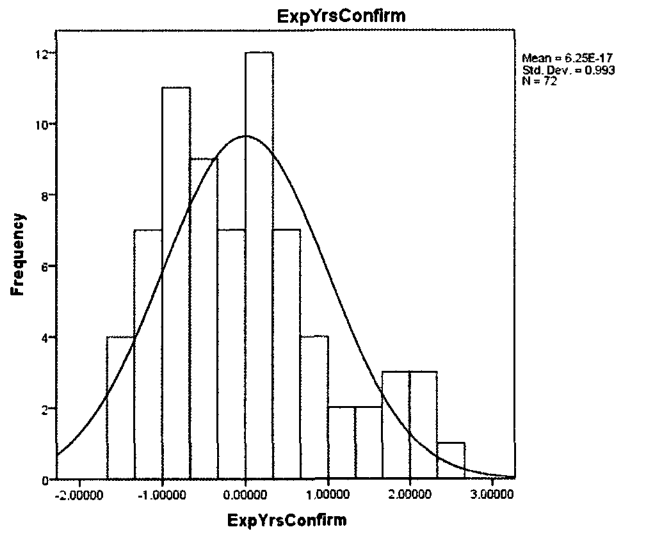
Statistics

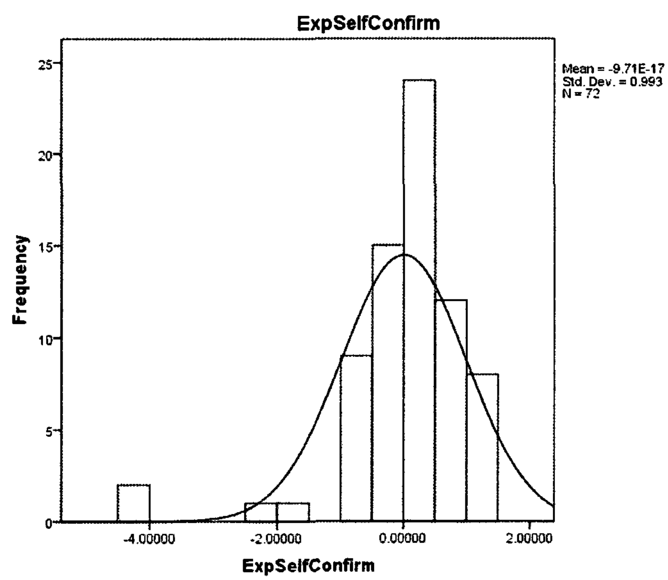
		EducationDegree	Role	ExpYrsConfirm	ExpSelfConfirm	KTConfirm	IDConfirm	HandleConfirm
N	Valid	71	71	72	72	72	72	72
	Missing	1	1	0	0	0	0	0
Skewness		.429	-.188	.702	-2.101	-1.446	-1.787	-1.437
Std. Error of Skewness		.285	.285	.283	.283	.283	.283	.283

Histograms






ExpYrsConfirm
Mean = 6.25E-17
Std. Dev. = 0.993
N = 72
Frequency
0
2
4
6
8
10
12
-2.00000
-1.00000
0.00000
1.00000
2.00000
3.00000
ExpYrsConfirm


ExpSelfConfirm
Mean = -9.71E-17
Std. Dev. = 0.993
N = 72
Frequency
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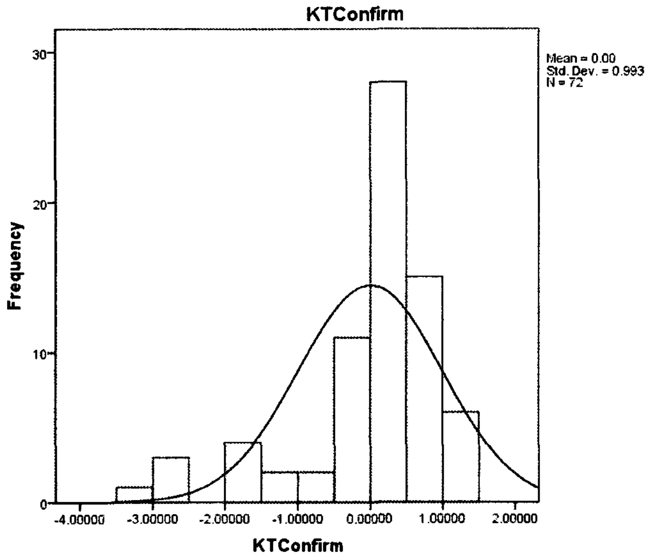
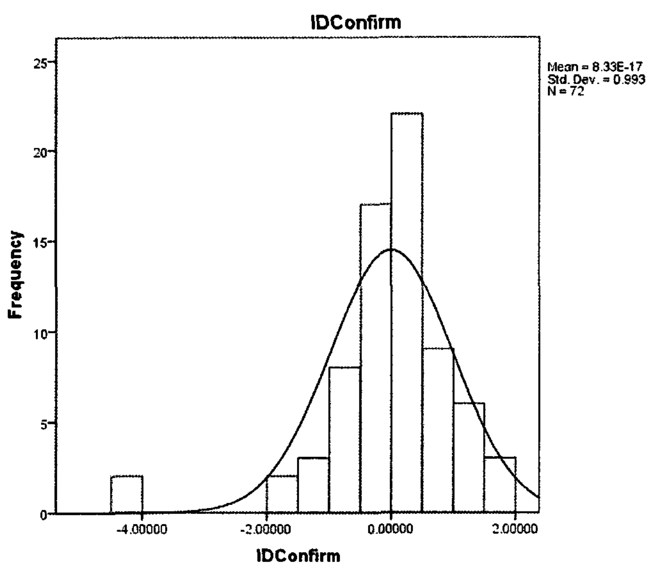
5
10
15
20
25
-4.00000
-2.00000
0.00000
2.00000
ExpSelfConfirm


KTConfirm
Mean = 0.00
Std. Dev. = 0.993
N = 72
Frequency
KTConfirm
-4.00000
-3.00000
-2.00000
-1.00000
0.00000
1.00000
2.00000
0
10
20
30


IDConfirm
Mean = 8.33E-17
Std. Dev. = 0.993
N = 72
Frequency
IDConfirm
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-2.00000
0.00000
2.00000
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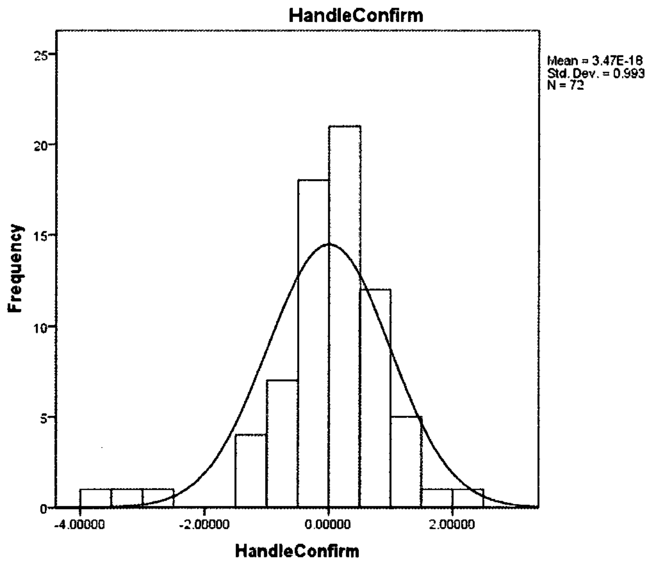
5
10
15
20
25


HandleConfirm
Mean = 3.47E-18
Std. Dev. = 0.993
N = 72
Frequency
25
20
15
10
5
0
-4.00000
-2.00000
0.00000
2.00000
HandleConfirm

Data for Experience Multicollinearity

Correlations

			ExpYrsConfirm	ExpSelfConfirm
Spearman's rho	ExpYrsConfirm	Correlation Coefficient	1.000	.012
		Sig. (2-tailed)	.	.919
		N	72	72
	ExpSelfConfirm	Correlation Coefficient	.012	1.000
		Sig. (2-tailed)	.919	.
		N	72	72

Spearman's 2-tailed Correlation Matrix

Correlations

			Education Degree	Role	ExpYrsConfirm	ExpSelfConfirm	KTConfirm	IDConfirm	HandleConfirm
Spearman's rho	EducationDegree	Correlation Coefficient	1.000	.057	.076	-.168	.035	-.241*	-.151
		Sig. (2-tailed)	.	.642	.527	.161	.770	.043	.208
		N	71	70	71	71	71	71	71
	Role	Correlation Coefficient	.057	1.000	.206	-.295*	-.050	-.301*	-.162
		Sig. (2-tailed)	.642	.	.086	.012	.681	.011	.178
		N	70	71	71	71	71	71	71
	ExpYrsConfirm	Correlation Coefficient	.076	.206	1.000	.012	.098	-.061	-.144
		Sig. (2-tailed)	.527	.086	.	.919	.411	.612	.226
		N	71	71	72	72	72	72	72
	ExpSelfConfirm	Correlation Coefficient	-.168	-.295*	.012	1.000	.468**	.688**	.494**
		Sig. (2-tailed)	.161	.012	.919	.	.000	.000	.000
		N	71	71	72	72	72	72	72
	KTConfirm	Correlation Coefficient	.035	-.050	.098	.468**	1.000	.590**	.430**
		Sig. (2-tailed)	.770	.681	.411	.000	.	.000	.000
		N	71	71	72	72	72	72	72
	IDConfirm	Correlation Coefficient	-.241*	-.301*	-.061	.688**	.590**	1.000	.614**
		Sig. (2-tailed)	.043	.011	.612	.000	.000	.	.000
		N	71	71	72	72	72	72	72
	HandleConfirm	Correlation Coefficient	-.151	-.162	-.144	.494**	.430**	.614**	1.000
		Sig. (2-tailed)	.208	.178	.226	.000	.000	.000	.
		N	71	71	72	72	72	72	72

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Spearman's 1-tailed Correlation Matrix

Correlations

			EducationDegree	IDConfirm	Role	ExpYrsConfirm	ExpSelfConfirm	KTConfirm	HandleConfirm
Spearman's rho	EducationDegree	Correlation Coefficient	1.000	-.241*	.057	.076	-.168	.035	-.151
		Sig. (1-tailed)	.	.021	.321	.264	.080	.385	.104
		N	71	71	70	71	71	71	71
	IDConfirm	Correlation Coefficient	-.241*	1.000	-.301**	-.061	.688**	.590**	.614**
		Sig. (1-tailed)	.021	.	.005	.306	.000	.000	.000
		N	71	72	71	72	72	72	72
	Role	Correlation Coefficient	.057	-.301**	1.000	.206*	-.295**	-.050	-.162
		Sig. (1-tailed)	.321	.005	.	.043	.006	.340	.089
		N	70	71	71	71	71	71	71
	ExpYrsConfirm	Correlation Coefficient	.076	-.061	.206*	1.000	.012	.098	-.144
		Sig. (1-tailed)	.264	.306	.043	.	.459	.206	.113
		N	71	72	71	72	72	72	72
	ExpSelfConfirm	Correlation Coefficient	-.168	.688**	-.295**	.012	1.000	.468**	.494**
		Sig. (1-tailed)	.080	.000	.006	.459	.	.000	.000
		N	71	72	71	72	72	72	72
	KTConfirm	Correlation Coefficient	.035	.590**	-.050	.098	.468**	1.000	.430**
		Sig. (1-tailed)	.385	.000	.340	.206	.000	.	.000
		N	71	72	71	72	72	72	72
	HandleConfirm	Correlation Coefficient	-.151	.614**	-.162	-.144	.494**	.430**	1.000
		Sig. (1-tailed)	.104	.000	.089	.113	.000	.000	.
		N	71	72	71	72	72	72	72

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

Pearson's 1-tailed Correlation Matrix

Correlations

		EducationDegree	IDConfirm	Role	ExpYrsConfirm	ExpSelfConfirm	KTConfirm	HandleConfirm
EducationDegree	Pearson Correlation	1	-.204*	.055	.047	-.182	.016	-.099
	Sig. (1-tailed)		.044	.324	.348	.065	.449	.206
	Sum of Squares and Cross-products	141.915	-20.280	6.429	4.713	-18.105	1.555	-9.838
	Covariance	2.027	-.290	.093	.067	-.259	.022	-.141
	N	71	71	70	71	71	71	71
IDConfirm	Pearson Correlation	-.204*	1	-.246*	-.057	.807**	.607**	.819**
	Sig. (1-tailed)	.044		.019	.318	.000	.000	.000
	Sum of Squares and Cross-products	-20.280	70.000	-20.234	-3.978	56.516	42.486	57.335
	Covariance	-.290	.986	-.289	-.056	.796	.598	.808
	N	71	72	71	72	72	72	72
Role	Pearson Correlation	.055	-.246*	1	.173	-.190	-.053	-.217*
	Sig. (1-tailed)	.324	.019		.075	.056	.330	.034
	Sum of Squares and Cross-products	6.429	-20.234	96.986	14.130	-15.689	-4.362	-17.774
	Covariance	.093	-.289	1.386	.202	-.224	-.062	-.254
	N	70	71	71	71	71	71	71
ExpYrsConfirm	Pearson Correlation	.047	-.057	.173	1	.082	.017	-.133
	Sig. (1-tailed)	.348	.318	.075		.247	.444	.134
	Sum of Squares and Cross-products	4.713	-3.978	14.130	70.000	5.743	1.176	-9.277
	Covariance	.067	-.056	.202	.986	.081	.017	-.131
	N	71	72	71	72	72	72	72
ExpSelfConfirm	Pearson Correlation	-.182	.807**	-.190	.082	1	.483**	.684**
	Sig. (1-tailed)	.065	.000	.056	.247		.000	.000
	Sum of Squares and Cross-products	-18.105	56.516	-15.689	5.743	70.000	33.836	47.898
	Covariance	-.259	.796	-.224	.081	.986	.477	.675
	N	71	72	71	72	72	72	72
KTConfirm	Pearson Correlation	.016	.607**	-.053	.017	.483**	1	.589**
	Sig. (1-tailed)	.449	.000	.330	.444	.000		.000
	Sum of Squares and Cross-products	1.555	42.486	-4.362	1.176	33.836	70.000	41.220
	Covariance	.022	.598	-.062	.017	.477	.986	.581
	N	71	72	71	72	72	72	72
HandleConfirm	Pearson Correlation	-.099	.819**	-.217*	-.133	.684**	.589**	1
	Sig. (1-tailed)	.206	.000	.034	.134	.000	.000	
	Sum of Squares and Cross-products	-9.838	57.335	-17.774	-9.277	47.898	41.220	70.000
	Covariance	-.141	.808	-.254	-.131	.675	.581	.986
	N	71	72	71	72	72	72	72

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

Hypothesis testing data for H1:

Dependent: Identification of Countervailing Risks

Independent: Experience Years & Experience Self Assessment

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	ExpSelf Confirm, ExpYrs Confirm[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: IDConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46.697	2	23.348	69.133	.000[a]
	Residual	23.303	69	.338		
	Total	70.000	71			

a. Predictors: (Constant), ExpSelfConfirm, ExpYrsConfirm

b. Dependent Variable: IDConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	8.799E-17	.068		.000	1.000
	ExpYrsConfirm	-.124	.070	-.124	-1.778	.080
	ExpSelfConfirm	.818	.070	.818	11.730	.000

a. Dependent Variable: IDConfirm

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.817[a]	.667	.657	.58114482

a. Predictors: (Constant), ExpSelfConfirm, ExpYrsConfirm

b. Dependent Variable: IDConfirm

Correlations

		IDConfirm	ExpYrsConfirm	ExpSelfConfirm
Pearson Correlation	IDConfirm	1.000	-.057	.807
	ExpYrsConfirm	-.057	1.000	.082
	ExpSelfConfirm	.807	.082	1.000
Sig. (1-tailed)	IDConfirm	.	.318	.000
	ExpYrsConfirm	.318	.	.247
	ExpSelfConfirm	.000	.247	.
N	IDConfirm	72	72	72
	ExpYrsConfirm	72	72	72
	ExpSelfConfirm	72	72	72

Hypothesis test data for H2:

Dependent: Handling of Countervailing Risks

Independent: Experience Years & Experience Self Assessment

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	ExpSelf Confirm, ExpYrs Confirm[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: HandleConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35.284	2	17.642	35.064	.000[a]
	Residual	34.716	69	.503		
	Total	70.000	71			

a. Predictors: (Constant), ExpSelfConfirm, ExpYrsConfirm

b. Dependent Variable: HandleConfirm

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.710[a]	.504	.490	.70932015

a. Predictors: (Constant), ExpSelfConfirm, ExpYrsConfirm

b. Dependent Variable: HandleConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.185E-17	.084		.000	1.000
	ExpYrsConfirm	-.190	.085	-.190	-2.233	.029
	ExpSelfConfirm	.700	.085	.700	8.227	.000

a. Dependent Variable: HandleConfirm

Correlations

		HandleConfirm	ExpYrsConfirm	ExpSelfConfirm
Pearson Correlation	HandleConfirm	1.000	-.133	.684
	ExpYrsConfirm	-.133	1.000	.082
	ExpSelfConfirm	.684	.082	1.000
Sig. (1-tailed)	HandleConfirm	.	.134	.000
	ExpYrsConfirm	.134	.	.247
	ExpSelfConfirm	.000	.247	.
N	HandleConfirm	72	72	72
	ExpYrsConfirm	72	72	72
	ExpSelfConfirm	72	72	72

Hypothesis test data for H3:

Dependent: Identification of Countervailing Risks

Independent: Knowledge Transfer

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	KTConfirm[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: IDConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	25.786	1	25.786	40.825	.000[a]
	Residual	44.214	70	.632		
	Total	70.000	71			

a. Predictors: (Constant), KTConfirm

b. Dependent Variable: IDConfirm

Correlations

		IDConfirm	KTConfirm
Pearson Correlation	IDConfirm	1.000	.607
	KTConfirm	.607	1.000
Sig. (1-tailed)	IDConfirm	.	.000
	KTConfirm	.000	.
N	IDConfirm	72	72
	KTConfirm	72	72

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.607[a]	.368	.359	.79475026

a. Predictors: (Constant), KTConfirm

b. Dependent Variable: IDConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.190E-16	.094		.000	1.000
	KTConfirm	.607	.095	.607	6.389	.000

a. Dependent Variable: IDConfirm

Hypothesis test data for H4:

Dependent: Handling of Countervailing Risks

Independent: Knowledge Transfer

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	KTConfirm[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: HandleConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	24.272	1	24.272	37.156	.000[a]
	Residual	45.728	70	.653		
	Total	70.000	71			

a. Predictors: (Constant), KTConfirm

b. Dependent Variable: HandleConfirm

Correlations

		HandleConfirm	KTConfirm
Pearson Correlation	HandleConfirm	1.000	.589
	KTConfirm	.589	1.000
Sig. (1-tailed)	HandleConfirm	.	.000
	KTConfirm	.000	.
N	HandleConfirm	72	72
	KTConfirm	72	72

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.589[a]	.347	.337	.80824092

a. Predictors: (Constant), KTConfirm

b. Dependent Variable: HandleConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.750E-17	.095		.000	1.000
	KTConfirm	.589	.097	.589	6.096	.000

a. Dependent Variable: HandleConfirm

Hypothesis test data for H5:

Dependent: Identification of Countervailing Risks

Independent: Role

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Role[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: IDConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.221	1	4.221	4.492	.038[a]
	Residual	65.779	70	.940		
	Total	70.000	71			

a. Predictors: (Constant), Role

b. Dependent Variable: IDConfirm

Correlations

		IDConfirm	Role
Pearson Correlation	IDConfirm	1.000	-.246
	Role	-.246	1.000
Sig. (1-tailed)	IDConfirm	.	.019
	Role	.019	.
N	IDConfirm	72	72
	Role	72	72

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.246[a]	.060	.047	.96937859

a. Predictors: (Constant), Role

b. Dependent Variable: IDConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.623	.315		1.976	.052
	Role	-.209	.098	-.246	-2.119	.038

a. Dependent Variable: IDConfirm

Hypothesis test data for H6:

Dependent: Handling of Countervailing Risks

Independent: Role

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Role[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: HandleConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.257	1	3.257	3.416	.069[a]
	Residual	66.743	70	.953		
	Total	70.000	71			

a. Predictors: (Constant), Role

b. Dependent Variable: HandleConfirm

Correlations

		HandleConfirm	Role
Pearson Correlation	HandleConfirm	1.000	-.216
	Role	-.216	1.000
Sig. (1-tailed)	HandleConfirm	.	.034
	Role	.034	.
N	HandleConfirm	72	72
	Role	72	72

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.216[a]	.047	.033	.97645500

a. Predictors: (Constant), Role

b. Dependent Variable: HandleConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.547	.318		1.723	.089
	Role	-.183	.099	-.216	-1.848	.069

a. Dependent Variable: HandleConfirm

Hypothesis test data for H7:

Dependent: Identification of Countervailing Risks

Independent: Education - Degree

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Education Degree[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: IDConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.898	1	2.898	3.023	.086[a]
	Residual	67.102	70	.959		
	Total	70.000	71			

a. Predictors: (Constant), EducationDegree

b. Dependent Variable: IDConfirm

Correlations

		IDConfirm	Education Degree
Pearson Correlation	IDConfirm	1.000	-.203
	EducationDegree	-.203	1.000
Sig. (1-tailed)	IDConfirm	.	.043
	EducationDegree	.043	.
N	IDConfirm	72	72
	EducationDegree	72	72

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.203[a]	.041	.028	.97908121

a. Predictors: (Constant), EducationDegree

b. Dependent Variable: IDConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.533	.328		1.627	.108
	EducationDegree	-.143	.082	-.203	-1.739	.086

a. Dependent Variable: IDConfirm

Hypothesis test data for H8:

Dependent: Handling of Countervailing Risks

Independent: Education - Degree

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Education Degree[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: HandleConfirm

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.682	1	.682	.689	.409[a]
	Residual	69.318	70	.990		
	Total	70.000	71			

a. Predictors: (Constant), EducationDegree

b. Dependent Variable: HandleConfirm

Correlations

		HandleConfirm	EducationDegree
Pearson Correlation	HandleConfirm	1.000	-.099
	EducationDegree	-.099	1.000
Sig. (1-tailed)	HandleConfirm	.	.205
	EducationDegree	.205	.
N	HandleConfirm	72	72
	EducationDegree	72	72

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.099[a]	.010	-.004	.99511620

a. Predictors: (Constant), EducationDegree

b. Dependent Variable: HandleConfirm

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.259	.333		.777	.440
	EducationDegree	-.069	.084	-.099	-.830	.409

a. Dependent Variable: HandleConfirm

VITA

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EDUCATION
- M.S., Engineering Management, Old Dominion University, 2001, Norfolk, VA
- B.S., Physics, Virginia Military Institute, 1987, Lexington, VA

EXPERIENCE
Naval Surface Warfare Center, Dahlgren, VA 7/2003 – present
Deputy Program Manager. Maritime Weapons and Control Systems. Undersea Warfare Systems Advanced Development Technical Projects Manager. Manage complex technical projects including strategic and mission planning, budgeting, task tracking, risk management and resource management.

EG&G, Dahlgren, VA 2/1995 – 7/2003
Undersea Warfare Contract Manager. Provide technical support and managed the planning, control and direction of resources to achieve programmatic objectives.

Tracor Applied Sciences, Crystal City, VA 8/1991 – 2/1995
Systems Engineer, Undersea Warfare Advanced Development Systems. Defined system requirements and analyzed operational , system and functional requirements.

United States Naval Reserves, White Oak, MD 5/1991 – 5/1993
Surface Warfare Officer. Public Affairs Officer, Assistant Test and Evaluation Officer and Assistant Training Officer. Evaluated and presented technical projects.

United States Navy 5/1987 – 5/1991
Surface Warfare Officer. Anti-Submarine Warfare Officer, Ship's Weapons Coordinator, Command Duty Officer. Trained and managed personnel in Combat Systems and Operations to employ sensors and fire control systems for tactical use.

MEMBERSHIPS, BOARDS AND PUBLICATIONS
- Member of the Acquisition Professional Community
- Systems Planning, Research, Development and Engineering Level III Certified
- Member, Program Executive Office for Undersea Warfare Risk Management Board
- Thesis: Determination of the Impact of a Human Capital Decision Cost Model on the Economic Performance Measures of a Technical Services Company. 2001.