The Association of Knowledge Management and Project Management: An Enterprise-wide Approach Based on Stankosky's Four Pillar of Knowledge Management and PMI's Project Management Knowledge Areas

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Dedication

بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

﴿ اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ ﴿١﴾ خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ ﴿٢﴾ اقْرَأْ وَرَبُّكَ الْأَكْرَمُ ﴿٣﴾ الَّذِي عَلَّمَ بِالْقَلَمِ ﴿٤﴾ عَلَّمَ الْإِنسَانَ مَا لَمْ يَعْلَمْ ﴿٥﴾ ﴾ صدق الله العظيم [العلق : 96]

A special feeling of gratitude to my great loving father and mother, Ahmed and Lutfia, without whom none of this could have ever happened or have been possible. I love you.

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Abstract of Dissertation

The Association of Knowledge Management and Project Management: An Enterprise-wide Approach Based on Stankosky's Four Pillar of Knowledge Management and PMI's Project Management Knowledge Areas

There are few studies investigating the association between enterprise-level knowledge management (KM) and project management (PM). Though few, these research studies have demonstrated that the available PM methods and approaches do not adequately include the necessary processes to derive maximum value from project investment (Oun, Blackburn, Olson, & Blessner, 2016). This dissertation offers an important perspective on the potential benefits of considering an enterprise-wide KM approach when management projects. Using a review of literature to collect up-to-date information regarding PM and KM, this dissertation has identified possible research gaps in the use of KM to improve the management of projects. These perceived gaps guided the administration of a survey questionnaire to 128 PM practitioners to obtain KM and PM performance ratings and to investigate the relationship between KM and PM. In this study, Stankosky's Four Enterprise Engineering KM Pillars and the PM Knowledge Areas as acknowledged by the Project Management Institute (PMI) are used to define a conceptual model to map elements of KM and PM performance measurement indicators and to propose quantitative hypotheses. Using Kendall's tau-b correlation coefficient as an appropriate nonparametric measure of association for the survey results, this dissertation reveals significant positive association between the Four Enterprise Engineering KM Pillars and the PM Knowledge Areas. In addition, predictive inference statistics was performed using ordinal logistic regression (OLR) to infer the existence and magnitude of cause–effect relationships. This dissertation also determines which pillars and which elements of the

KM pillars are most predictive of PM success. The significance and the nature of the association and the predictive relationship partially support the dissertation premise that the management of projects improves as KM tools, processes and activities are increasingly used (Oun, Blackburn, Olson, & Blessner, 2016).

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List of Symbols

α	Alpha Level
CI	Confidence Interval
CL	Confidence Level
Ha	Alternative Hypothesis
Ho	Null Hypothesis
Hr	Main research hypothesis is proposed
N	Abbreviation Number and or Sample Size
P	Probability of obtaining a test statistic (p-value)
Pc	p-values for the test of concordance
Ps	p-value for the test of significance
Z	Z score
σ	Standard of Deviation
MOE	Margin of error
τ_b	Kendall's tau-b correlation coefficient statistic

List of Acronyms

APQC	American Productivity and Quality Center
BP	British Petroleum
COP	Community of Practice
CPM	Critical Path Method
DIKW	Data–Information–Knowledge–Wisdom Hierarchy
DOD	Department of Defense
ESA	Ethics, Standards and Accreditation Project
HR	Human Resources
IP	Intellectual Property
IT	Information Technology
KM	Knowledge Management
KM/PM	Knowledge Management/Project Management
KMF	Knowledge Management Framework
NASA	National Aeronautics and Space Administration
OLR	Ordinal Logistic Regression
PERT	Project Evaluation Review Technique
PM	Project Management
PMI	Project Management Institute
PMBOK®	Guide - A Guide to the Project Management Body of Knowledge
SOW	Scope of Work
WBS	Work Breakdown Structure

Chapter 1 - Introduction & Overview

"Knowledge has to be improved, challenged, and increased constantly, or it vanishes."

Peter F. Drucker, The Practice of Management

1.1 Background

Today's available PM methods and approaches do not adequately include the necessary KM tools and processes to derive maximum value from project investment. Even though research work in the field of KM and PM includes studies that focus on the potential benefits of KM on organizations to maintain a competitive advantage, few studies focus on leveraging KM practices, tools, and processes to improve PM (Haddad & Ribie`re, 2007; Lierni & Ribière, 2008). Projects are known by distinct characteristics that include time-limited and complex operations, and problems unpredictability (Whitley, 2006; Oun, Blackburn, Olson, & Blessner, 2016). These characteristics suggest a necessity for improved PM tools and processes that include the management of project knowledge and expertise (Metcalfe & James, 2000). According to Davenport, De Long, & Beers, (1998); Davenport & Prusak, (2000), knowledge management is a challenge for every organization. Specifically, project managers agree on the importance of managing knowledge in the pursuit of project success (Lierni & Ribière, 2008). Researchers have highlighted several methods by which project knowledge can be leveraged to allow workers to make good judgements using accessible information and know-how, (Lierni & Ribière, 2008). The recommended methods and practices include improving the transfer of knowledge across projects using enhanced KM technology and tools (Ajmal, 2009;

Javernick-Will & Levitt, 2009; Oun, Blackburn, Olson, & Blessner, 2016). According to Lierni & Ribière, (2008), the KM technology and tools include asynchronous and synchronous communication, lessons learned, best practices, communities of practice, and repositories of artifacts. Of the recommended KM technology and tools is building a vibrant knowledge sharing culture that is dependent on establishing policies (Ajmal, 2009), project team organizational structures, and establishing well-defined business strategies (Lierni & Ribière, 2008; Newell, 2004; Srikantaiah, Srikantaiah, Koenig, & Al-Hawamdeh, 2010; Sutton, 2010; Turner & Muller, 2005; Waters & Beruvides, 2012). These recommend methods, tools and practices from the literature may help professionals in the field of KM and PM in formalizing the concept of an integrated KM/PM process. However, Dr. Michael Stankosky of the George Washington University recognizes that successful KM programs are inclusive and more complex than organizations anticipate (Oun, Blackburn, Olson, & Blessner, 2016). He supported his enterprise-wide KM conceptual framework on four well-built pillars, namely, organization, leadership, technology and learning (Stankosky, 2005). The four pillars of KM are viewed as elements that are critical for a successful KM system. Failure to detect and manage these elements can result in them becoming major barriers to KM (Bixler, 2002; Calabrese, 2000; Oun, Blackburn, Olson, & Blessner, 2016; Stankosky & Baldanza, 2000).

With regards to PM, the Project Management Institute (PMI) established a guide to define PM processes and to manage individual projects, namely, a Guide to the Project Management Body of Knowledge (PMBOK® Guide). This guide comprises ten project management knowledge areas and includes the processes that need to be completed in order to successfully manage projects. Each of the PM knowledge areas describes the

processes that need to be completed in order to achieve successful PM. In this study, the four pillars of KM and the PM knowledge areas will be used as the theoretical basis and a guide to identify and categorize measures of association to demonstrate the effect of managing project knowledge on PM (PMI, 2013). In this dissertation, Stankosky's four pillars of KM and the ten PMBOK® Guide knowledge areas are used to build a conceptual association model to guide the investigation and the testing of the association between KM and PM (Oun, Blackburn, Olson, & Blessner, 2016).

During the review of literature, it was found that the relationship between KM and PM has not been determined through quantitative research that is based on the four pillars of KM and the ten knowledge areas of PM as will be seen in chapter 2. In this study, the four pillars of KM and the ten PM knowledge areas will be used as the theoretical basis and a guide to define elements related to each of the four KM pillars that are applicable in project environments (Oun, Blackburn, Olson, & Blessner, 2016). Also, the PM knowledge areas as defined in the PMBOK® Guide will be used to identify performance measures that includes attributes by which the processes, inputs, tools and techniques, and outputs related to each PM knowledge areas can be effectively managed (Oun, Blackburn, Olson, & Blessner, 2016).

1.2 Purpose of the Research

This dissertation focuses on highlighting the importance of KM in the project environment, and investigates the possible benefits of leveraging KM tools and processes to improve the outcome of projects. The study identifies, through a review of literature, a list of elements related to each of the four KM pillars and a list of performance measures related to each PM knowledge areas. Perhaps more importantly the study uses the

perceived elements of the four KM pillars and the project management performance measures to develop measurement questions presented in the study's survey in order to quantitatively investigate the relationship between the four KM pillars and the ten PM knowledge areas (Oun, Blackburn, Olson, & Blessner, 2016).

1.3 Research Stakeholders

The study is associated with knowledge management, project management, and performance and efficiency improvements. Hence, the study's stakeholders are in the fields of: engineering management, knowledge management, project management, and systems engineering. The stakeholders' interest will be focused on the integration of knowledge management and project management, and the means by which knowledge management is utilized to improve an organization's project management capabilities.

1.4 Document Organization

The remainder of the research study comprises the following chapters and appendices in which activities are covered and described in details:

1.4.1 Chapter 2 - Literature Review

Chapter 2 sets the stage for the rest of this study by illustrating the findings of the research literature review. In doing so, it offers the background required to better understand KM-related activities and how they apply to project management.

Chapter 2 focuses on projects success and failure, and includes a critical analysis on the role of KM in the context of PM. It illustrates the relationship among different works, and identifies the possible gaps in literature. In relating this research to the KM body of

knowledge, the study identifies a list of elements of KM that are related to the four pillars of KM and are applicable in project environments. The study also identifies a list of PM performance measures using the PM knowledge areas as provided in PMBOK® Guide. These elements of KM and PM performance measures are leveraged in the construction of the survey instrument (described in Chapter 3).

1.4.2 Chapter 3 - Research Design and Methodology

Chapter 3 explains the method used to collect the research's data and explains their appropriateness to the exploration of the research questions outlined at the end of the chapter. It presents details pertaining to the survey questionnaire. Chapter 3 also describes the study's technique for sampling and locating the survey participants. In addition, chapter 3 outlines the procedures for approaching the data, and explains the statistical testing method used to examine and analyze the study's survey data.

1.4.3 Chapter 4 - Results and Data Analysis

The collected data was processed and analyzed in response to the research objectives posed in chapter 1. Chapter 4 describes the results of the data analysis. It documents the findings of the statistical analysis used to measure the degree and the nature of the association and the predictive relationship between elements of the four KM pillars and the PM performance measures (Oun, Blackburn, Olson, & Blessner, 2016).

Findings presented in Chapter 4 outline the foundation for the research's conclusions illustrated in Chapter 5.

1.4.4 Chapter 5 – Conclusions and Discussion

Chapter 5 discusses the conclusions attained from the data results and analysis completed in Chapter 4. It also represents the contribution to the body of knowledge reached as a result of investigating the study's questions or objectives in previous chapters.

1.4.5 Chapter 6 – Limitations and Areas for Future Research

Chapter 6 summarizes the issues and potential limitations affecting this study. Also, Chapter 6 provides recommendations for future research that emerged from this research based on the study's findings and conclusions.

1.4.6 Appendices

1.4.6.1 Appendix A – Survey Instrument

Appendix A presents the study's survey instrument. Details pertaining to the construction, distribution, and processing of the questionnaire can be found in Chapter 3.

1.4.6.2 Appendix B – Minimum Required Sample Size Calculations

Appendix B is an illustration of calculations to determine the number of observations required to include in the dissertation statistical sample that provides sufficient statistical power to derive inferences about PM and KM professional population.

1.4.6.3 Appendix C – Minitab Session Window Output for Cronbach's Alpha Calculations

Appendix C provides result representations of the Cronbach's alpha calculations for

the survey results. Cronbach's alpha is calculated using Minitab 17 for all four KM pillar and for each of the ten PM knowledge areas (Oun, Blackburn, Olson, & Blessner, 2016).

1.4.6.4 Appendix D – Raw Survey Response Data

Appendix D is a spreadsheet representation of raw answer scores for all measurement questions attained as a result of administering the study's survey questionnaire.

Chapter 2 - Literature Review

"There are three principal means of acquiring knowledge available to us: observation of nature, reflection, and experimentation. Observation collects facts; reflection combines them; experimentation verifies the result of that combination."

- Denis Diderot, On the Interpretation of Nature

2.1 Background

Due to increased global competition, and the continued advances in technology and science, knowledge has become one of the most valuable organizational assets (Anantatmula, 2005), and the process to create, store, share, and utilize knowledge is becoming increasingly complicated (Oun, Blackburn, Olson, & Blessner, 2016). However, it may be more complex to create, store, share, and utilize project knowledge given the specificity and uniqueness of the tasks and activities performed in projects that usually differ from one project to another (Polyaninova, 2011). The concept of knowledge management in and for project-based organizations is increasingly vital. Hanisch, Lindner, Mueller, and Wald, (2009) found that there is an urgent need to improve methods of knowledge management in project environments as few organizations implement systematic approaches to manage project knowledge. The body of knowledge is rich with qualitative and quantitative work on the two discrete areas of research, project management and knowledge management. However, little has tried to study the integration of both areas of research (Brooks et al., 2006; Love et al., 2005).

That being said, this research is contributing to the body of knowledge by promoting the concept of integrating KM and PM for the purpose of improving projects outcomes.

Through existing literature, this chapter attempts to investigate the presumption that the management of projects improves as knowledge acquired or created during projects is increasingly managed.

2.1.1 Literature Review Objectives

The literature review for this dissertation is associated with three main objectives. The first objective is to construct a background required to identify, familiarize and examine the reliability of the subject under study. Second objective is to establish relationships between existing literature within the PM and KM fields and this research. Third objective is to build a conceptual model that illustrates the association between the elements of the four pillars of KM (leadership, learning, organization, and technology) and the management of projects. In this study, the management of projects was defined by the management of the ten PM knowledge areas.

2.1.2 Structure of the Literature Review

Although the previous chapter of this dissertation introduced definitions of the basic concepts included in this study, a number of important concepts require further research and discussion to better describe their role in KM and PM. Thus, the literature review for this dissertation includes the following main sections. The first section of this chapter includes a review of definition, background, significant developments, as well as recent activities in knowledge management and project management. The second section includes an analysis of different definitions and measures of evaluation of project and project management success and failure, as well as the means by which project success is measured. The third section comprises of an illustration of knowledge management

literature as it relates to project management and project success. The third section also includes a detailed review of relevant KM/PM literature as it relates to the objectives of this dissertation. The fourth and final section of this chapter explores and highlights gaps in literature concerning the integration of knowledge management and project management.

2.2 Knowledge and Knowledge Management

2.2.1 The concept of knowledge

According to Davenport, Long, and Beers (1998), Knowledge is applicable information. It is a high value form of information combined with context, interpreted data, reflection, and experience. They believe that knowledge and information may be difficult to distinguish. However, both originated from unprocessed data. This hierarchical concept is well noun in literature as the (Knowledge Pyramid) or the data–information–knowledge–wisdom hierarchy (DIKW) (see Figure 2- 1). Many researchers like Rowley (2007); and Frand and Hixon (1999) agree that the first appearance of the hierarchy goes back to 1934 when Thomas Stearns Eliot asked three questions in his poem from the pageant play (The Rock):

"Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?

Where is the information we have lost in data?"

Ackoff (1989); Rowley (2007), whose works are often cited when the DIKW hierarchy is quoted, defined and explained the transformation process between data, information, knowledge, and wisdom.

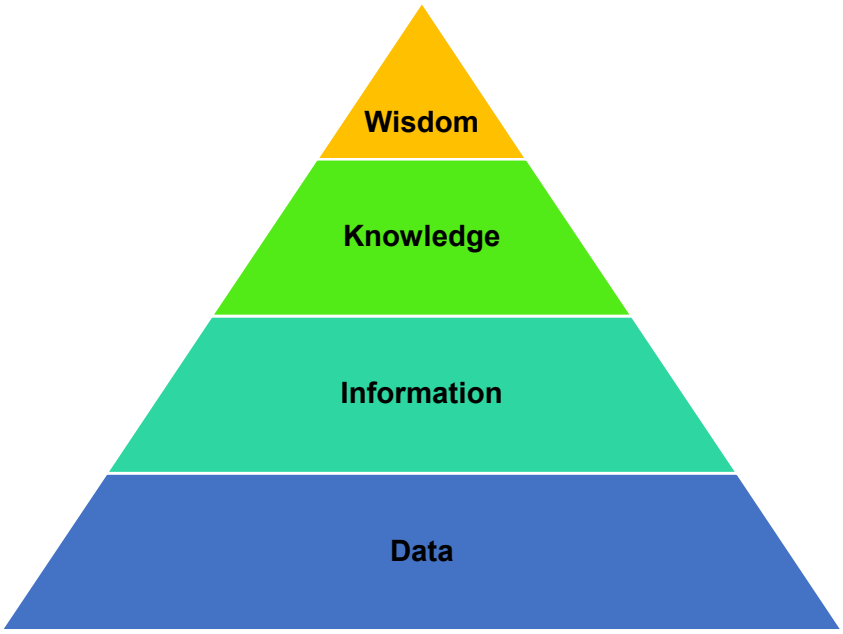

Figure 2-1: The DIKW Hierarchy (Ackoff, 1989; Rowley, 2007)

Ackoff & Rowley put wisdom at the top of the Knowledge Pyramid. Descending from wisdom there are knowledge, information, and finally, at the bottom of the Knowledge Pyramid, data. The outcome was their story of KM: put row data in context to create information, and when the developed information is meaningful we get knowledge. In conformity with Nonaka (1994) that information is essential for the creation and formalization of knowledge, finally, adding judgment (value) to knowledge to create wisdom. Ackoff includes understanding as a fifth level, which is not included typically (Frické, 2009). According to Kemp, Nidiffer, Rose, Small, and Stankosky (2001), the value of knowledge to the Information Age is as significant as the oil was to the Industrial Age. They consider intellectual capital as the main asset and the major driving force of today's markets. Anantatmula (2005) described Knowledge as one of the most valuable organizational assets and that KM is critical to organizations' success.

2.2.2 Knowledge Management

Wenger (2002) and Hall & Sapsed (2005) highlighted the importance of managing and enabling knowledge as it is known to be essential for economical and societal success. Hence, and due to globalization, international competition, and continued technological advances, the focus should go towards maximum utilization of intellectual capabilities and the effective use of knowledge in order to help organizations to achieve a competitive advantage and to support organizations in their pursuit of business success (Hult et al., 2000); (Hall & Sapsed, 2005).

Knowledge Management has been presented in several different ways, of which, Davenport (1994) provided one of the simplest and widely quoted definition:

"Knowledge management is the process of capturing, distributing, and effectively using knowledge."

Later, Gartner Group offered one of the most frequently cited definitions of KM (Duhon, 2004):

"Knowledge management is a discipline that promotes an integrated approach to identifying, capturing, evaluating, retrieving, and sharing all of an enterprise's information assets. These assets may include databases, documents, policies, procedures, and previously un-captured expertise and experience in individual workers."

Despite how old knowledge management is, no universal definition is agreed upon for knowledge management. As such, the following definitions may be cited:

- Knowledge management is the process of acquiring, developing, measuring, distributing, and providing a return on organizational intellectual assets through a set of defined methods, tools, techniques, and values (Van & Riezebos, 2005).
- Knowledge management is the effective use of expertise for competitive

advantage through disciplined approaches (Arkell, 2007).

- Knowledge management is the use of a set of technologies, tools, and processes to optimize knowledge assets (Kamara, Anumba, Carrillo, & Bouchlaghem, 2003).
- Knowledge management is a simplified and improved method, by which knowledge is created, shared, distributed, captured, and understood (Karlsen & Gottschalk, 2004).

The idea of KM is increasingly important in today's fast paced and cost conscious business environment (Rueithe, 2000). According to Jefferson (2006), knowledge management provides organizations with tools and techniques required to manage, organize and utilize the enormous amount of information that organizations need or gain from the work place. The utilization of knowledge in meaningful processes increase productivity and enables more effective decision-making and problem solving capabilities (Jefferson, 2006). The ways and means of organizing valuable information changes along with the quick and rapid changes in the use of technology. These ways and means have changed as there is a need for them to gather their vast amounts of information and items of knowledge from various types of resources (Davenport & Prusak, 2000). In the early days, not many businesses and companies were interested in supporting their workers to enhance their knowledge management capabilities (Sivan, 2001). The objective was focused on how businesses can effectively, identify, exploit, and share knowledge assets by implementing non-sophisticated knowledge management systems (Meihami, B. & Meihami, H. 2014). In the last twenty years, research on knowledge management expanded significantly, during which, expenditure on implementing organizational knowledge management techniques has increased

significantly as well (Sivan, 2001).

2.2.3 Knowledge Assets Categorization and Models Overview

Having recognized the importance of knowledge management, many organizations are therefore working towards long-term prosperity through implementing knowledge management models to effectively utilize employees' knowledge and to use this knowledge as a source for corporate growth and profit (Haslinda & Sarinah, 2009). Many Knowledge Management models, covering a broad range of perspectives, are described in the available literature as effective models. Broadly, the literature recognizes three unique categories of KM models, intellectual capital models, knowledge category models and socially constructed models (Bontis, 2001; Clegg et al., 1996; Haslinda & Sarinah, 2009; McAdam & McCreedy, 1999). Further review of available literature is deemed necessary to determine which categorization method and KM model is appropriate for use in this dissertation in order to investigate the postulated association presented in chapter 3.

2.2.3.1 Intellectual capital models

The intellectual capital models include, as an example, Skandia model of Knowledge Management. This model was created by Leif Edvinsson, the director of Intellectual capital at Skandia. Based on this model, KM is an intellectual capital and can be treated as an asset. As shown in equation 1, Edvinsson considers the value of intellectual capital as a gap between market value and book value. However, Edvinsson considers one form of intellectual property (innovation capital) as part of the organizational capital (Kok, 2007).

Market value = Book value + Intellectual capital ……. (1)

As shown in Figure 2-2, Skandia model assumes that Knowledge is contained in two main categories, namely, human capital (e.g. key personals, experts), and structural capital (e.g. trade marks, databases, IT systems) (Haslinda & Sarinah 2009). Intellectual capital models assume full control on intellectual capital, as is the case for structural capital. Hence, these models disregard the social aspects of knowledge management which can result in having subjective factors treated as objective factors, e.g. reward and recognition (McAdam & McCreedy, 1999).

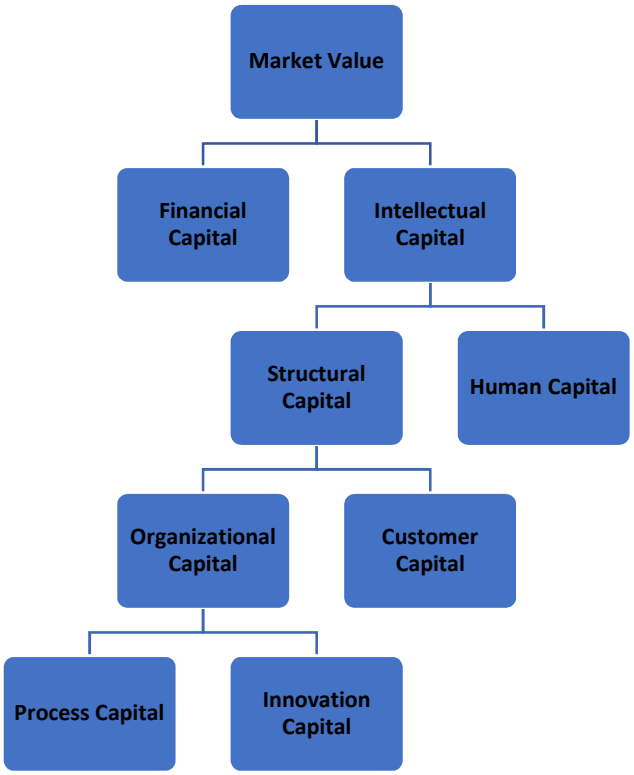

Figure 2-2: Skandia Model of Knowledge Management (Kok, 2007)

2.2.3.2 Knowledge category models

The knowledge category models include but not limited to Boisot's model (Boisot, 1987; Dalkir, 2013) and Nonaka's model (Nonaka & Takeuchi, 1995). The Boisot's model considers knowledge as codified or un-codified knowledge, diffused or undiffused knowledge. Codified knowledge is prepared knowledge and ready for transmission. Un-codified knowledge refers to knowledge not prepared for transmission (e.g. experience). Diffused knowledge is knowledge available and ready for sharing while undiffused Knowledge is not available and not ready for sharing (Boisot, 1987; Dalkir, 2013). In a similar way, Nonaka (1994) depicts organizational knowledge creation as knowledge spiral in which knowledge is classified to tacit and explicit. Tacit knowledge is the unwritten, unspoken, and hidden form of knowledge, while, explicit knowledge is accessible, codified and can be expressed in various communication methods (e.g. writing, drawings, etc.).

Nonaka, Toyama, & Konno (2000) define knowledge assets as resources that are necessary for organizations to create values. As shown in Figure 2-3, Nonaka suggests a categorization for knowledge assets that includes four types, namely, experiential, conceptual, systemic and routine knowledge assets. Experiential knowledge assets comprise of tacit knowledge that is acquired and accumulated in the minds of experienced members of the organization, and then shared amongst other members of the organization, customers, service providers, suppliers and any affiliated organizations. It is due to the tacit nature of experiential knowledge assets that makes this type of knowledge mostly exclusive to the organization. In contrast, conceptual knowledge assets comprise of explicit knowledge that exists in tangible forms stated or perceived by members of the organization, customers, service providers, suppliers or any affiliated organizations.

Examples of conceptual knowledge assets include drawings, pictures, concepts or designs, etc. This type of knowledge assets is considered easy to capture. However, it is challenging to capture and understand how these tangible forms if knowledge was originally perceived (Nonaka, Toyama, & Konno, 2000).

Systemic knowledge assets are considered to be the most visible form of knowledge and comprise of explicit knowledge that is organized and packaged for use, such as manuals, documented, specifications, etc.

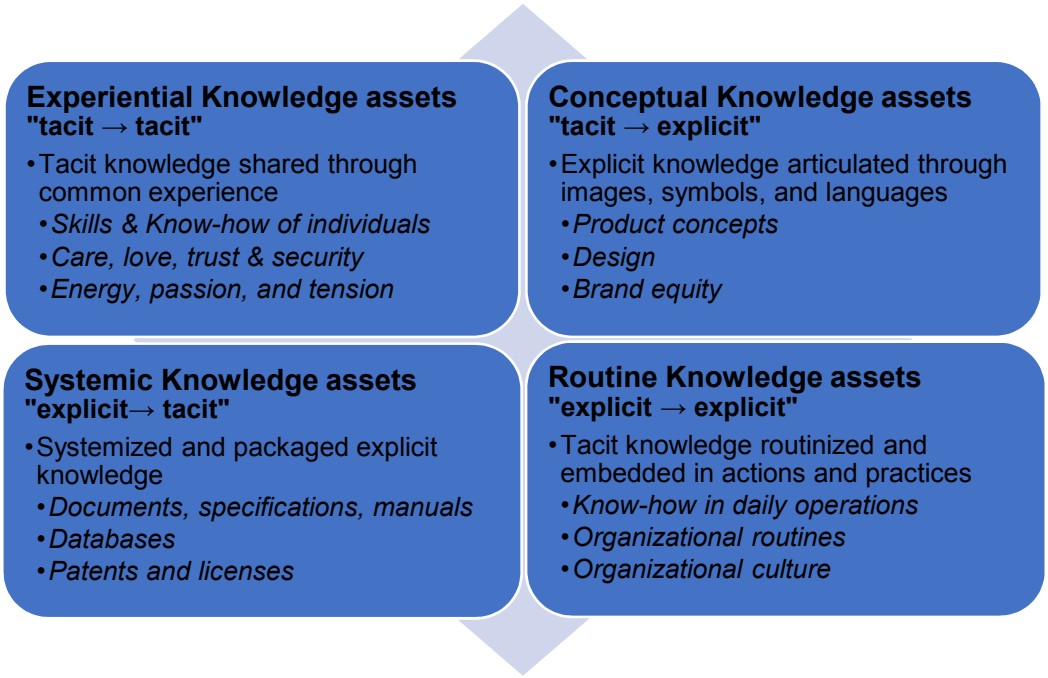

Figure 2-3: The Four Knowledge Assets Categories of Nonaka's KM Model

In contrast, routine knowledge assets consist of tacit knowledge that is embedded in the organization systems and processes. Examples of routine knowledge assets include organizational daily practices and organizational culture (Nonaka, Toyama, & Konno, 2000). Nonaka model is focused on explaining tacit knowledge conversion into explicit

knowledge which is considered ground base for organizational learning and innovation Nonaka (1994). However, from a critical perspective of Haslinda and Sarinah, (2009); McAdam and McCreedy (1999), the transfer of knowledge in organizations is much more complex than Nonaka's and Boisot's simple matrix which requires a pragmatic and systemic approach to manage. Nonaka's and Boisot's knowledge models are argued to be limited or one-dimensional and considered as heavily focused on tacit knowledge (Haslinda & Sarinah, 2009).

2.2.3.3 Socially constructed models

Socially constructed models include models like Demerest's Model (McAdam and McCreedy 1999). The socially constructed models adopt a broader definition of knowledge as being fundamentally associated with organizational learning.

The Demerest's model emphasizes in-house construction of knowledge where knowledge is constructed within the organization through explicit programs as well as through social programs (Begona Lloria, 2008). In his model, Demarest identifies four knowledge categories, namely, imperatives, patterns, rules, and scripts. Imperatives include knowledge derived from organizational objectives, strategies, and operational procedures. Patterns are knowledge resulting from behavioral patterns after a repetition of acts or behaviors. Patterns are predictable and demonstrated in examples like, customer complaints, repeated use of products or services, purchasing behavior, social behavior, etc. Rules are often knowledge based on combined organizational experience or individual experience. Rules include guidelines, procedures, experiments, and manual, etc. scripts, on the other hand, are a form of knowledge that is often known as proven prescriptions for performance. Scripts are knowledge assets that are tested and ready for

reuse, e.g. success stories, training manuals, and case studies, etc. (Demarest, 1997; Kok, 2005).

Stankosky's Four Pillar Knowledge Management Framework Model is also consistent with those considered as socially constructed models yet comprehensive and applicable in a wide range of business domains (Bixler, 2002). Unlike many attempts available in the literature to manage knowledge, Dr. Michael Stankosky of the George Washington University argues that organizations already obtain knowledge assets but lack the know how to communicate and leverage them. Therefore, it was of interest to address the operative work required for the categorization and the management of knowledge assets (Stankosky, 2005). According to Ternes (2012), Stankosky considers knowledge assets as a sequence of repeated inputs, processes, and outputs that take Part in a model that is based on the following architectural keystones:

- Iteration and feedback
- Organizational complexity
- Codification and collaboration
- Legacy considerations, and
- The four KM pillars – Leadership, Organization, Technology, and Learning.

2.3 A Four-Pillar Approach to Knowledge Management

Stankosky (2000, 2005), and Ternes (2011) believe that successful KM programs are typically comprehensive, well planned, and more complex than most organizations expect. Stankosky (2005) investigated the critical elements of KM and found that, regardless of the industry or the business domain, all elements of KM could be grouped under four distinct categories known as Stankosky's Four Pillar of KM, namely,

Leadership, Organization, Technology and Learning (See Figure 2-4). These pillars include components and elements considered important for a successful Knowledge Management framework (KMF) (Stankosky & Baldanza, 2000). According to Bixler (2002), all four pillars must be addressed in order to achieve a basic entry-level KM program (Oun, Blackburn, Olson, & Blessner, 2016).

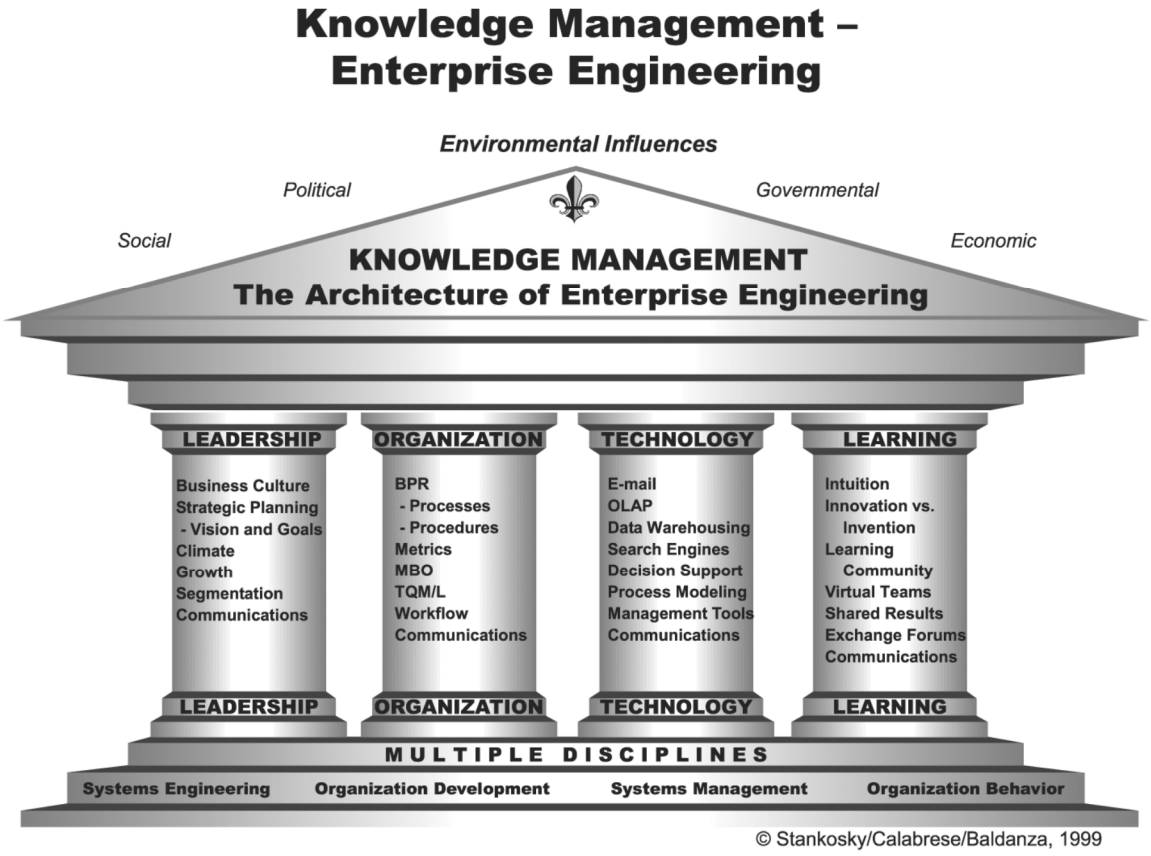

Figure 2-4: The Four Pillars of the Stankosky KM Framework (Stankosky & Baldanza, 2000)

Bixler (2002), Stankosky (2000), Stankosky (2005), Stankosky and Baldanza (2000), and Ternes (2011) define the four KM pillars as follows:

- ***Leadership.*** The KM leadership pillar addresses the goals, strategies, and role of management and leadership with regard to identifying requirements, allocation of funds and resources, and the application of knowledge. This pillar highlights the role of management and leadership in the KM process to achieve organizational goals and objectives. Visionary leaders build business and operational strategies that align KM with business plans to increase the value of KM throughout the organization. Leadership support is required to ensure successful implementation of a knowledge management system (Oun, Blackburn, Olson, & Blessner, 2016).
- ***Organization***. The operational aspect of KM is addressed by the Organization pillar; including progress and performance measurement, organizational strategy, process work-flows, and organizational structures (Oun, Blackburn, Olson, & Blessner, 2016). A KM system should support KM throughout the organization. For KM to be introduced, change must happen at the organizational level. Organizational change requires KM systems to recognize organizational culture and contribute to process improvement.
- ***Technology.*** The technology pillar provides the KM framework with the necessary technology platform and information technology in order to meet the organizational goals and objectives (Oun, Blackburn, Olson, & Blessner, 2016). The Gartner Group described that 10 technology activities and processes are found to be valuable and support the KM system if used collectively. These 10 technology related activities and processes that organizations should consider to construct a KM technology solution include:
  - Synthesis

- Structure and navigation
- Capture and storing
- Searching and retrieval
- Knowledge sharing and collaboration
- Transmitting information
- Integrating with business applications
- Personalization
- Solving and recommending
- Testing and maintenance

The necessary technology platform and information technology consist of tools that support the knowledge sharing and collaboration culture in organizations. Though, Zack (1999) cautions from the over-reliance on technology to implement KM systems and describes it as a great weakness in many organizations. Bixler (2002) argues that long-term success is not a direct result of the positive effect of technology only (Oun, Blackburn, Olson, & Blessner, 2016).

- ***Learning.*** The learning pillar addresses the activities and tools involved in the collaboration and sharing of organizational knowledge amongst individuals, groups, and departments, etc. Organizational learning is not just people learning as individuals but also includes learning within groups or teams (Bixler, 2002). Thus, this pillar also addresses practices involved in development of individuals and team skills and capabilities in order to achieve organizational objectives (Oun, Blackburn, Olson, & Blessner, 2016). Organizations will not achieve their KM strategy by using only the best technology or having effective leadership. It is an all-inclusive

approach that involves people who are responsible for using the right tools and performing their duties. In this context, learning is an important part of the overall KM process (Oun, Blackburn, Olson, & Blessner, 2016).

According to Oun, Blackburn, Olson, & Blessner, 2016, in order to validate the existence of the four pillars and their related key elements, and to determine the strength of the four pillars as foundational elements of a KM framework, Calabrese (2000) assessed the beliefs, practices, and preferences associated with each of the four pillars using a survey questionnaire with 240 respondents. The results of this study support the utility of the pillars for use in the assessment and implementation of effective enterprise-wide KM systems. Further, Ternes (2011) tested the strength of the four KM pillars as a foundation for a KM framework. Ternes developed and administered a 45-question survey and concluded that while practices associated with Leadership, Technology, and Learning satisfy current KM needs, improvement in organizational practice is needed related to the Organization pillar. Ternes' recommendations include identifying and recording key processes required for a successful KM system, integrating organizational structure as part of the KM system, and developing plans to manage changes in the KM system (Oun, Blackburn, Olson, & Blessner, 2016).

Based on review of research by Bixler (2002); Calabrese (2000); Stankosky (2000); and Stankosky and Baldanza (2000), the major leadership, organization, technology, learning related KM elements applicable in the project environment are identified as shown in table 2-1.

Table 2-1: Elements of the Four KM Pillars

Leadership	Organization	Technology	Learning
Leadership ‘s endorsement of developing, publishing and sharing its vision, goals and objectives	Process workflows and business processes to rethink (*reengineer*) how to perform projects	Synchronous Communications *(Instant messaging, application and screen sharing, video and audio conferencing, telephone)*	Encouragement of project workers to acquire and share project related knowledge
Executive management’s commitment to KM	Following through organizational strategy	Asynchronous Communications *(Discussion boards, e-mail, message board/broadcasting)*	Trust and collaboration between project team members in an organization to complete their tasks
KM roles capability to promote and implement KM programs and processes	Measuring progress in project activities and project teams’ performance	Collaborative services *(Electronic calendar, task management, survey voting and polling)*	Financial and technological support provided to keep pace with changes and technology advancement
Use of performance metrics to measure progress in activities and teams’ performance	Project teams understanding of organizational strategy	Integrating new technologies with legacy systems to manage new forms of knowledge	Education opportunities and training programs provided in order to build project workers competencies
Following through organizations’ strategic plans	Reward system and performance evaluation criterion	Document control and data management systems	Understanding Tacit & Explicit knowledge language

Table 2 1: Elements of the Four KM Pillars (Cont.)

Leadership	Organization	Technology	Learning
Reward & Recognition system	Managing project records through process work-flows	PM system to schedule, track, and chart the steps in a project as it is being completed	Face-to-face and Internet-based Communities of Practice
–	Organizational structure	Intranet *(e.g. SharePoint, company portal, etc.)*	Learning from the explicit knowledge *(e.g. Manuals, documents, etc.)*
–	–	Communities of practice	Communicating and sharing knowledge among project team members at different project sites *(e.g. Virtual Teams)*
–	–	Expert directories to help identify experts	Learning from fellow co-workers during projects
–	–	Data warehouse system	–

This study does not attempt to determine the applicability or compare between any of the above discussed knowledge management models. Also, it is not in the research scope to identify the strength or weaknesses of any knowledge management model. However, based on the inclusivity of Stankosky's approach to categorizes and communicate the elements of KM, the four pillars of Stankosky's Knowledge Management Framework Model are considered the theoretical basis for the KM/PM association model used in this dissertation. Also, because KM is dependent on the project environment in which it is implemented, there is no general procedure to know the unique contribution of each pillar on project success or on the various dimensions of project management success (Oun, Blackburn, Olson, & Blessner, 2016). However, it is generally accepted that all four KM pillars must be functioning to some degree in order for a KM system to be viewed as successful (Mohamed, Stankosky, & Murray, 2004). According to Stankosky (2005), failure to identify and manage the key elements of the four KM pillars can result in these elements becoming major barriers to successful KM (Oun, Blackburn, Olson, & Blessner, 2016).

2.4 Projects and Project Management

A project is an effort carried out by an individual or a group of people to deliver a product, a result, or to achieve an outcome (Serrat, 2012). Using the simplest language possible, this is how project workers would define projects. Traditionally, however, a project is usually defined as a major effort that is bound by time, cost and quality constraints (Mazzorana-Kremer, Martin, & Wybo, 2015). Literature also provides many more attempts to define projects and Turner (2014) provided one of the most prescriptive definitions:

"A project is an endeavor in which human, financial, and material resources are organized in a novel way to undertake a unique scope of work, of giver specifications, within constrains of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives."

After one of Turner's students objected to the unnecessary details included in the definition, he has chosen to accept a less prescriptive definition, as follows:

"A project is a temporary organization to which resources are assigned to do work to deliver beneficial change."

One of the major professional project management entities in North American, the Project Management Institute (PMI) provided the following definition:

"A project is a temporary endeavor undertaken to create a unique product, service or result. The temporary nature of projects indicates a definite beginning and end. The end is reached when the project's objectives have been achieved or when the project is terminated because its objectives will not or cannot be met, or when the need for the project no longer exists." (PMI, 2013)

Humanity has undertaken projects that go back in history to the construction of the ancient Egyptian pyramids in 2630 BC to the construction of the Great Wall of China during the 7th century BC (Lehner, 1997; Waldron, 1990). At that time, these accomplishments were seen as acts of worship and nation building, and were carried out using the knowledge and experience of priests, engineers, architects, etc. (Weaver, 2007). It was only until the 20th century that organizations started applying systematic approaches to manage the temporary sets of tasks and activities, known as projects, to

create a lasting outcome that is generally a unique product, service, or a result. Managing these sets of tasks and activities by applicable knowledge, skills, tools, and techniques to meet project overall objectives is recognized as Project Management or PM (Kwak, 2005; PMI, 2013).

2.4.1 Inception of Modern Project Management, Prior to 1950's

Many researchers believe that pioneering techniques for modern project management originated in the first 50 years of the 20th century, during which developments in industry, technology, communication, transportation, and management science allowed operational control of project constraints (Kwak, 2005, and Hofstede, 1994). Innovative technologies helped to reduce schedule delays and costs, where, for example, the advancement in the Automobile industry allowed flexible mobility and better resource allocation (Kwak, 2005). Researchers like Kwak (2005) and Hofstede (1994) attribute the conception of modern day project management to Henri Fayol and Frederick Taylor. According to Fayol (1916), managers are bound by a set of functions to carry out any management process, namely, plan, organize, coordinate, control, and direct or command. However, Fayol acknowledges the flexibility of management affairs, where hardly ever do managers apply the same approaches, rules, or principles in identical working conditions. Therefore, the number managerial approaches, rules, and principles are unlimited allowing adaptation to different changing circumstances (Fayol, 1916). Taylor (1911) encourages the development of leaders using a scientific management system that organizes workers for efficient cooperation and teamwork instead of searching for leaders trained by others to decrease inefficiency. Fayol and Taylor claim that the fundamental principles of their approaches are applicable to all kinds of human activities including

project activities (Kwak, 2005; Taylor, 1914). In the 1910's, Henry Gantt introduced the Gantt chart. Gantt chart is a bar chart that illustrates project schedules and summaries key project elements (Weaver, 2007). This period also included the development of Work Breakdown Structure (WBS) as a method of decomposing a project into smaller components for improved control and management (Devi, 2012). WBS and Gantt chart were widely used in projects undertaken during this period. Examples of the major projects during this period include the construction of the Hoover Dam in the 1930's, and the Manhattan Project in the 1940's (Stretton, 2007).

2.4.2 Network Analysis and Planning Techniques, 1950's and 1960's

The beginning of modern day project management can arguably be traced back to the year 1957 when the two major project management movements at their time were developed, namely, Project Evaluation Review Technique (PERT), and Critical Path Method (CPM) (Snyder, 1987; Stretton, 2007; Weaver, 2007). With the idea of developing a scheduling methodology to manage the vast amount of activities performed by hundreds of contractors who worked on the Polaris submarine and missile systems, the US Navy Special Projects Office developed PERT (Hyatt & Weaver, 2006). PERT is a method intended to define main progress points to be used for overall management control of projects. PERT highlights project events and milestones instead of activities (Stretton, 2007). CPM was development by Morgan Walker of DuPont chemical company and James Kelley of Remington Rand Univac while addressing a construction scheduling problem for DuPont (Stretton, 2007). According to Armstrong-Wright (1969), CPM is a network analysis and a project planning technique that determines which project activities are most critical, and calculates the optimal start and finish time for each

project activity so that the project stays within schedule. According to Kwak (2005) and Stretton (2007), the major development in project management in the 1950's was in network analysis and planning techniques, which were primarily concerned with prioritizing and scheduling project activities, known as project time management in modern day project management.

CPM and PERT showed worthiness in application as far as planning and scheduling is concerned. However, PERT had problems with its effectiveness when dealing with different contractors. As such, PERT lacked the capability to integrate the schedules of the many contractors working on the same project. In 1962, the DOD and NASA introduced PERT/COST to the commercial marketplace as an improvement to PERT and CPM in order to handle the cost of project activities (Snyder, 1987). Kelley & Walker (1989) argued that introducing CPM and PERT to the commercial marketplace in addition to their deployment in NASA and DOD projects were the only reasons why CPM and PERT haven't been completely forgotten and abandoned. The progress of project management through the 1960s culminated in the formation of one of the major professional project management entities in North American, the Project Management Institute (PMI) in 1969.

2.4.3 The Guide to the Project Management Body of Knowledge (PMBOK® Guide)

Considering project management as a profession was an issue that had been frequently discussed within PMI in the 1970s. However, it was only until 1983 that PMI presented an early version of its renowned PMBOK® known as the Ethics, Standards and Accreditation project (ESA). The ESA included six project management functions,

namely, managing project cost, time, quality, scope, human resources and communications (Stretton, 2007). Later in 1987, project risk, and procurement management were added. The PMI continued to improve the initial eight PM knowledge areas to the current version of the PMBOK® that includes ten PM knowledge areas, namely, project integration, scope, time, cost, quality, human resource, communication, risk, and procurement management (PMI, 2013).

The PM knowledge areas as provided in a latest Guide to the Project Management Body of Knowledge (PMBOK® Guide) are as follows:

- ***Project Integration Management:*** Includes all processes required to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups.
- ***Project Scope Management:*** Includes all processes required to guarantee inclusion of all the project work required to successfully complete the project.
- ***Project Time Management:*** Includes all processes required to successfully complete the project within the agreed-upon timeframe.
- ***Project Cost Management:*** Includes all processes required to successfully complete the project within the approved budget.
- ***Project Quality Management:*** Includes all processes required to successfully complete the project in a way that satisfies the needs for which it was undertaken.
- ***Project Human Resource Management:*** Includes all processes required to organize, manage, and lead the project team in a way that insures a successful completion of the project.
- ***Project Communications Management:*** Includes all processes required to ensure

timely and appropriate communication of project information in a way that insures a successful completion of the project.

- ***Project Risk Management:*** Includes all processes required to identify, analyze, respond plan, and control risk on a project in a way that insures a successful completion of the project.
- ***Project Procurement Management:*** Addresses all processes required for the procurement of products, services, and material handling to insure a successful project completion.
- ***Project Stakeholders Management:*** Includes all processes necessary to identify and engage all individuals and organizations interested, and/or affected by the project in a way that ensures a successful project completion (Oun, Blackburn, Olson, & Blessner, 2016).

According to PMI (2013), project success is a result of balancing competing project constraints while managing projects. Each constraint represents a PM knowledge area that includes a set of processes, inputs, tools and techniques, and outputs (Belout, 1998; Chua et al., 1999; Hubbard, 1990; Oun, Blackburn, Olson, & Blessner, 2016; Walker & Vines, 2000).

2.5 Understanding Project Success and Failure

Improving project performance and ensuring project success are challenges that project-based organizations face. The risk of project failure is generally due to deficiency in applying the necessary knowledge, skills, tools, and techniques to project activities (Oun, Blackburn, Olson, & Blessner, 2016; PMI, 2013). In 1994, the Standish Group began providing statistics from studying projects around the world. Based on a survey of

executives, they found that only 16% of projects were considered to be successful. The Standish Group divided projects into three distinct categories: Project Success (projects completed on time and budget, with all features and functions as specified), Project Challenged (projects completed, but over cost, over time, and/or lacking all of the features and functions originally specified), and Project Impaired/Failed (projects abandoned or cancelled at some point, thus becoming total losses) (Oun, Blackburn, Olson, & Blessner, 2016). In 2013, the report The CHAOS Manifesto 2013 showed an increase in project success rates, with 39% of all projects being considered as successful, with 18% considered to be failures, and 43% challenged. Despite the noticeable improvement in the project success rate, there is still a significant proportion of unsuccessful projects, highlighting the need to improve project management processes and tools (Oun, Blackburn, Olson, & Blessner, 2016).

Although the project management literature describes project success and failure, the question of how to measure project success has a long history of disputes. There are differences of opinion on what represents project success and the means by which project success is measured (Gemünden, 2015). Hughes, Tippett and Thomas, (2004) and PMI (2013) make a very important distinction between project success measures and project success factors (Oun, Blackburn, Olson, & Blessner, 2016). Project success measures are the criteria by which success or failure is evaluated, whereas project success factors are considered as inputs leading to project success. Traditionally, a successful project is defined as one that delivers the desired results within an agreed-upon timeframe and using the chosen resources (Hughes, Tippett, & Thomas, 2004; Kirsch, 2000; Murphy, Baker, & Fisher, 1974; Oun, Blackburn, Olson, & Blessner, 2016; PMI, 2013). PMI

(2013) describes projects as successful when completed while meeting project objectives, requirements, and stakeholder's expectations. Researchers like Aladwani (2002), Cates and Mollaghasemi (2007), Parsons (2006), and Rosenfeld (2013) describe success or failure of a project in terms of the classical objective outcome measures such as project cost (below, on, or over budget), project duration (early, on time, or late), and outcome quality (with less or better than the required features and functions). According to Langston (2013), the connection between the three main constraints that reinforce successful project delivery was originally defined by Martin Barnes as the iron triangle, time, cost, and output. The three main project constraints continued to be illustrated throughout the literature in different sets of terms - "time, cost, and output (Langston, 2013)," "time, cost, and quality (Ika, 2009)," "budget, schedule, and scope (Agarwal & Rathod, 2006)," and "cheap, fast, and good (Langston, 2013)." However, with the progress in the PM profession, the triangle has increasingly lost favor due to the vast number of project constraints that have emerged in the PM literature (Langston, 2013; Oun, Blackburn, Olson, & Blessner, 2016). Gemünden (2015) criticized the iron triangle for being simplistic, not representative of the key project success measures, and for overlooking the following three major aspects:

- Stakeholder perspectives: Stakeholders value project success by the extent to which their requirements and needs are considered.
- Utilization of project outputs: The value of project outputs comes after project completion and when project outputs are utilized and converting into impactful outcomes.
- Organizational Strategies: Organizations select projects according to the value

contribution of projects to its strategic goals.

Serrador & Turner, (2015) define project success as beyond just satisfying the iron triangle criteria of meeting cost, time, and scope. They consider a project to be successful when meeting all enterprise goals as defined by key stakeholders. Through a survey of 1,386 projects, Serrador & Turner, (2015) found that the fulfillment of the iron triangle has a moderately strong correlation with their definition of project success. The iron triangle is thus neither the only characteristic of project success nor can be ignored.

Early researchers such as Baker, Murphy and Fisher (1974) considered a project to be successful if it satisfied objective as well as subjective factors. According to the American Heritage Dictionary, factors that are objective are those relating to actual events and verifiable data or information as opposed to thoughts, while subjective factors relate to personal feelings, interpretation, perception, attitudes, beliefs, or opinions, instead of reliance on actual events (Oun, Blackburn, Olson, & Blessner, 2016). Baker, Murphy and Fisher (1974) studied 650 projects and determined that subjective factors, characterized by perception, have a significant influence on project success. Hughes, Tippett, and Thomas (2004) studied subjective vs. objective factors in assessing project performance, and while focusing on metrics beyond the traditional objective metrics of cost, time and specifications, they acknowledged the existence of more subjective factors that, while not easy to quantify, can have a significant effect on projects (Oun, Blackburn, Olson, & Blessner, 2016). DeCotiis and Dyer (1979) and Pinto and Slevin (1997) identified three subjective measures of project success: project perceived value, project implementation process, and customer satisfaction with project outcome. Kirsch (2000) also recommended that measurement of project performance to include project team

member satisfaction, as well as costumer's satisfaction (Oun, Blackburn, Olson, & Blessner, 2016).

Hughes, Tippett and Thomas, (2004) and PMI (2013) make a distinction between measuring project management performance and project performance (Oun, Blackburn, Olson, & Blessner, 2016). Project management performance is evaluated against objective factors (cost, time, and quality, etc.), whereas project performance is evaluated against objective as well as subjective factors characterized by perception (customer satisfaction, project team satisfaction, etc.) (Oun, Blackburn, Olson, & Blessner, 2016). It is also often confused between project delivery success and project success. Project management success is affected by factors within the project boundaries and the project team control; whereas project success is affected by elements and factors sometimes beyond the project boundaries and the project team control (Langston, 2013).

In this work, we acknowledge the importance of the PM knowledge areas as defined in the PMBOK® Guide, where all project management processes are described. According to PMI (2013), project success is a result of balancing competing project constraints while managing projects. The competing constraints that are within project boundaries and the project team control include, but are not limited to: scope, schedule, budget, quality, resources, and risk (Oun, Blackburn, Olson, & Blessner, 2016). Each constraint represents a PM knowledge area that includes a set of processes, inputs, tools and techniques, and outputs. These PM tools and techniques include superior capabilities that enable project managers to plan and execute projects with maximum chances of project success (Belout, 1998; Chua et al., 1999; Hubbard, 1990; Oun, Blackburn, Olson, & Blessner, 2016; Walker & Vines, 2000).

PMI (2013) describes the relationship among the competing project constraints as overlapping such that if any one changes, at least one other constraint is likely to be influenced. Based on a field study involving 783 project managers to investigate the impact of the PM knowledge areas on project success, Zwikael (2009) found that the knowledge areas Human Resources, Risk, Scope, and Time have the greatest impact on project success. However, Langston (2013) highlights the importance of all knowledge areas and specifically highlighted the important role of project integration management as it provides an opportunity to unify and optimize all processes, inputs, tools and techniques, and outputs for the other knowledge management areas (Oun, Blackburn, Olson, & Blessner, 2016).

For this work, the definition of project success provided by the PMBOK® Guide is found most inclusive and is deemed appropriate to use for the investigative analysis of the postulated association presented in chapter 3. Accordingly, Table 2-2 presents performance measures classified based on the relevant PM knowledge areas as provided in the PMBOK® Guide. The performance measures encompass attributes by which the processes, inputs, tools and techniques, and outputs related to each PM knowledge areas can be successfully managed (Oun, Blackburn, Olson, & Blessner, 2016).

Table 2-2: PM Knowledge Areas and Related Performance Measures

PM Knowledge Areas (PMI, 2013)	Performance Measures
Project integration management	• Project management planning (Isfahani, 2011) • Scope of work changes (Portny, 2010; PMI, 2013) • Manage and control project work (Isfahani, 2011)
Project scope management	• Project requirements identification (Portny, 2010) • Work breakdown structure (WSB) changes (Portny, 2010; PMI, 2013) • Scope of work changes (Portny, 2010; PMI, 2013)
Project time management	• Work breakdown structure (WSB) changes (Portny, 2010; PMI, 2013) • Identification of project resources & activities requirements (PMI, 2013) • Scheduling & control of project activities (Kerzner, 2013; PMI, 2013; Rosenfeld, 2013)
Project cost management	• Identification of project resources & requirements to perform activities (PMI, 2013) • Budgeting & cost estimation (Kerzner, 2013; PMI, 2013; Rosenfeld, 2013) • Cost control (PMI, 2013)
Project quality management	• Specs identification & quality control (Kerzner, 2013; PMI, 2013) • Project change orders (Kerzner, 2013; PMI, 2013) • Stakeholder satisfaction (Hughes, Tippett, & Thomas, 2004; Kirsch, 2000; PMI, 2013)
Project human resource management	• Experts identification (PMI, 2013; Portny, 2010; Rosenfeld, 2013) • Developing project team (PMI, 2013; Portny, 2010; Rosenfeld, 2013) • Team performance and conflict management (Isfahani, 2011)

Table 2-2: PM Knowledge Areas and Related Performance Measures (Cont.)

PM Knowledge Areas (PMI, 2013)	Performance Measures
Project communication management	• Reporting project performance information (Isfahani, 2011; Rosenfeld, 2013) • Stakeholder identification (Portny, 2010; PMI, 2013) • Knowledge availability to stakeholders (Rosenfeld, 2013)
Project risk management	• Risk response planning (Isfahani, 2011; Hughes, Tippett, & Thomas, 2004; Rosenfeld, 2013) • Risk identification (Isfahani, 2011; Rosenfeld, 2013) • Risk evaluation (Isfahani, 2011; Rosenfeld, 2013)
Project procurement management	• Documentation of purchasing decisions (Isfahani, 2011; Rosenfeld, 2013) • Vendor selection (Rosenfeld, 2013) • Monitoring purchasing contract performance (Isfahani, 2011)
Project stakeholder management	• Stakeholder identification (Portny, 2010) • Knowledge availability to stakeholders (Rosenfeld, 2013) • Stakeholder satisfaction (Hughes, Tippett, & Thomas, 2004; Kirsch, 2000; PMI, 2013)

2.6 KM in the Context of PM

Knowledge management literature as it relates to project management starts in the early 1980's when researchers like Gulliver (1987) shed light on the importance of sharing information amongst projects, sites, departments and workers for post-project appraisals. Boddie (1987), Studied the concept of project postmortem (post-project examination) and the possible benefits of post-project examination on future projects as well as on the organization. Boddie found that most organizations do not conduct post-project examination to collect valuable project knowledge. He listed the possible benefits

from post-project examination as follows:

- Organizational learning where organizations benefit from lessons learned and project team experience, rather than just rely on personal skills and experience.
- Continuous improvements in processes, procedures, and organizational culture.
- Improving scheduling and cost estimation capabilities.
- Enhanced team building and conflict resolution skills.
- Enable timely recognition of accomplishments before proceeding to next project.

In relation to projects, KM is important because some projects depend on the generation of new knowledge that needs to be integrated and included in the organizational practice or otherwise becomes lost or worthless (Oun, Blackburn, Olson, & Blessner, 2016). Other projects depend on sharing and application of knowledge that is acquired and created in previously executed projects (Javernick-Will & Levitt, 2009). KM is also important in relation to projects, because knowledge transfer across projects affects project performance in terms of costs, schedule, and quality (Berteaux & Javernick-Will, 2015; Landaeta, 2008). The transfer and integration of knowledge between projects is very important to avoid repetition of past mistakes at both the project and organizational levels (Javernick-Will & Hartmann, 2011; Oun, Blackburn, Olson, & Blessner, 2016). According to Okhuysen & Eisenhardt (2002), knowledge integration is a systematic process whereby information is shared and combined collectively to create new knowledge.

As a good example of KM in the context of PM. British Petroleum (BP) implements a comprehensive approach to KM that creates a culture for sharing experience, information and knowledge. They focused on embracing a virtual teamwork approach to knowledge

sharing that utilizes expertise from all industries and from all around the world. The virtual teamwork approach helped BP in solving different types of issues associated with project activities, such as equipment testing, plant commissioning, operations, and failure trouble-shooting (Davenport & Prusak, 2000). Nowadays, technology provides a verity of means of communication to share knowledge like stationary and mobile devices with all their capabilities (instant messages, synchronization, multimedia options, etc.) that enable retrieving, modifying and sending documents and information (Jefferson, 2006). It allows the person to decide what type of information to gather, select the method to arrange it, choose where to keep it, and pick who to send or share it with (Jefferson, 2006).

Publications in the Engineering Management body of knowledge that connect to this research interest include the knowledge workers' influence on project team performance at large-size companies (Waters & Beruvides, 2012). Their work showed that project team performance is influenced by project team responsibility as defined by project schedule, cost, and scope. Newell (2004) studied ways to enhance cross-project learning without addressing measures of project success. He found that cross-project learning can be enhanced by capturing successful process and procedures-related lessons and sharing these lessons through social networks. Landaeta (2008) highlighted the positive association between the level of knowledge transfer across projects and project performance in terms of costs, schedule, and quality. Karlsen & Gottschalk (2004), found positive association between the level of knowledge transfer across IT projects and project success, however they considered five project success criteria; project performance (costs, schedule, and quality), project outcome evaluation, system implementation, benefit of client, and benefit of stakeholder.

Haddad and Ribie`re (2007) studied the potential benefits of KM implementation in software acquisition projects. They found that KM is useful for software outsourcing activities, identifying organizational structures. They found that KM is also useful for analyzing costs and risks incurred before, during, and after the contract award. Research by the American Productivity and Quality Center (APQC) found that implementing a KM system that identifies and evaluates the risk of losing knowledge is the best way to preserve knowledge. Their approach was people-centric and based on interviewing experts in the field, carrying out before and after action reviews, and communities of practice, etc.

As codification and personalization are the two known approaches to KM strategies, project managers primarily rely on the codification approach, which is more often focused on the use of technology to manage explicit knowledge (Lierni & Ribière, 2008; Oun, Blackburn, Olson, & Blessner, 2016). However, project and project team performance are influenced by knowledge workers whose main capital is kept in their minds in the form of tacit knowledge (Davenport, 2013; Waters & Beruvides, 2012). Managing skills and tracking who knows what is necessary in order to utilize undocumented tacit knowledge. As such, Rus and Lindvall (2002) identify expert identification and managing expert knowledge as two of the most common problems that KM addresses in projects (Oun, Blackburn, Olson, & Blessner, 2016). It is important to understand that project managers strongly benefit from codification as well as a personalization approach that is more focused on tacit knowledge by connecting people and individual expertise (Lierni & Ribière, 2008). The literature suggests that the balance between people and technology in KM is key for project success (Ho, 2009; Lierni &

Ribière, 2008; Oun, Blackburn, Olson, & Blessner, 2016). Researchers have studied the potential benefits of KM implementation in projects, including investigating people- and technology-related KM tools and processes that may help to carry out successful projects (Hu & He, 2008; Lierni & Ribière, 2008; Waters & Beruvides, 2012). People-centric tools and processes include, but are not limited to, interviewing experts in the field, after-action reviews, communities of practice, mentoring, education opportunities, and training programs (Lierni & Ribière, 2008). Alternatively, researchers such as Hu and He (2008) have adopted a more technology-centric approach when studying the issue of knowledge between projects (Oun, Blackburn, Olson, & Blessner, 2016). They studied the issue of losing project-related knowledge when mismanaged between projects and suggested a web-based project KM system to capture, digitize, validate, share and reuse project knowledge.

This literature review found that research on the integration of KM and PM is lacking in terms of determining the theoretical basis by which the link between KM and PM is established, which is the focus of this dissertation work. In this dissertation, we investigate the presumption that the presence of an enterprise-wide KM system addressing all four KM pillars is significantly associated with PM knowledge areas.

2.7 A Summary of Literature Gaps

The review of literature found no quantitative research that investigates the relationship between the elements of the four KM pillars and the PM knowledge areas. The four pillars of KM and the PM knowledge areas were not used in any previous study as the theoretical basis to investigate the importance of KM in the project environment, or to investigate the possible benefits of leveraging KM tools and processes to improve the

outcome of projects. In some previous studies, survey based research was conducted to investigate the effect of selected KM activities on projects based on researchers' perceived significance of the KM activities. Other studies lacked any form of statistical analysis in support of their findings (Oun, Blackburn, Olson, & Blessner, 2016).

Hence, this dissertation is an attempt to close the gaps in the available literature and contribute to the KM body of knowledge by promoting the concept of integrating KM and PM for the purpose of improving projects outcomes.

Chapter 3 - Research Design and Methodology

"Every day that a better idea goes unused is a lost opportunity. We have to share more, and we have to share faster."

- Ken Derr, Chevron

3.1 Introduction

This chapter explains the methods used in developing the findings of this research. These methods include the technique used to collect research data, procedures for sanitizing the data, and the statistical testing method used to examine and analyze the survey results.

3.1.1 Problem Statement

Improving project performance and project success are challenges that project-based organizations face. Project-based organizations also face risk of project failure that is related to the lack of applying the necessary knowledge, skills, tools, and techniques to project activities (Oun, Blackburn, Olson, & Blessner, 2016; PMI, 2013). In the last twenty years, knowledge has become one of the most valuable organizational assets (Anantatmula, 2005), and researchers have recognized methods to protect and utilize project knowledge. However, today's recognized PM methods do not sufficiently include the required KM processes to derive highest value from project investment (Haddad & Ribie`re, 2007; Lierni & Ribière, 2008; Oun, Blackburn, Olson, & Blessner, 2016).

As an example for project outcome statistics, in their latest report "The CHAOS Manifesto 2013", the Standish Group reported that only 39% of projects the in information systems, information technology, and communications industry were

successful, 43% were considered challenged, and 18% were considered failed. The percentage of challenged and failed projects is significant and requires further research to understand project success and failure in order to improve the tools and processes by which projects are managed.

3.1.2 Research Objective

As expressed in chapter 1, this study focuses on how the four KM pillars (Leadership, Organization, Technology, and Learning) relate to the PM knowledge areas (project integration, scope, time, cost, quality, human resources, communication, risk, procurement, and stakeholder management). Since it has been determined by researchers (i.e.; Bixler, 2002; Stankosky, 2000, 2005; Stankosky & Baldanza, 2000; and Ternes, 2011) that all four KM pillars must be addressed in order to achieve a basic level KM system, and since it has been suggested by PMI (2013) that balancing PM knowledge areas is defining project success, the objective of this work is to determine the existence, degree, and the nature of the relationship between the four KM pillars and the PM knowledge areas (Oun, Blackburn, Olson, & Blessner, 2016).

3.1.3 The Audience

By involving project management practitioners to examine these multiple KM and PM perspectives, using qualitative methods, we can better understand the perspective and beliefs project management practitioners hold about KM use in project environment. With this understanding, researchers can better include variables and develop models about integrating KM in the PM process. Practitioners in the fields of knowledge management, project management, engineering management, systems engineering and

performance and efficiency improvements can plan on the integration of knowledge management and project management, and the means by which KM is utilized to improve a company's project management performance.

3.2 Research Methodology

3.2.1 Type of Research Methods

Initial findings attained during the study's literature review suggested existence of the relationship between KM and PM. However, the study's objectives could not be adequately achieved through a review of literature alone. Therefore, a conceptual association model was proposed and a survey questionnaire was conducted as the non-literature data gathering tool to obtain possible association of KM pillars and PM knowledge areas allowing us to infer causality based on the conceptual association model proposed to guide the research study as described later in this chapter. The survey instrument sought to answer the following main questions: ***(1) To what extent KM is practiced by the participants and implemented in their organizations? (2) To what extent PM was successful within the participant's organization?*** It can be concluded therefore, that the characteristics of the activities performed throughout this study most closely correspond to those of Quantitative methods as defined by Creswell (2013).

3.2.2 Conceptual Association Model

The research conceptual association model proposed herein is based on the itemization of KM and PM conceptual and operational element, reflecting the four KM pillars and PM knowledge areas as its underlying principle. Figure 3-1 shows the conceptual association model for this dissertation. It depicts the association measures

between KM pillars and PM knowledge areas, as suggested by the author to represent a baseline for an enterprise-wide KM approach to PM.

The model illustrates the conceptual definition of the KM pillars by identifying the elements relating to each pillar. The pillars and their corresponding elements are viewed collectively as defining an enterprise-wide KM system (Oun, Blackburn, Olson, & Blessner, 2016). The model also illustrates the conceptual and operational definition of the performance measures used to describe the PM knowledge areas. These PM knowledge areas are viewed collectively as defining project management. Variables are framed this way to indicate the believed direction of causation (i.e., enterprise-wide KM system, or KM pillars, relating to successful project management, or PM knowledge areas) (Oun, Blackburn, Olson, & Blessner, 2016).

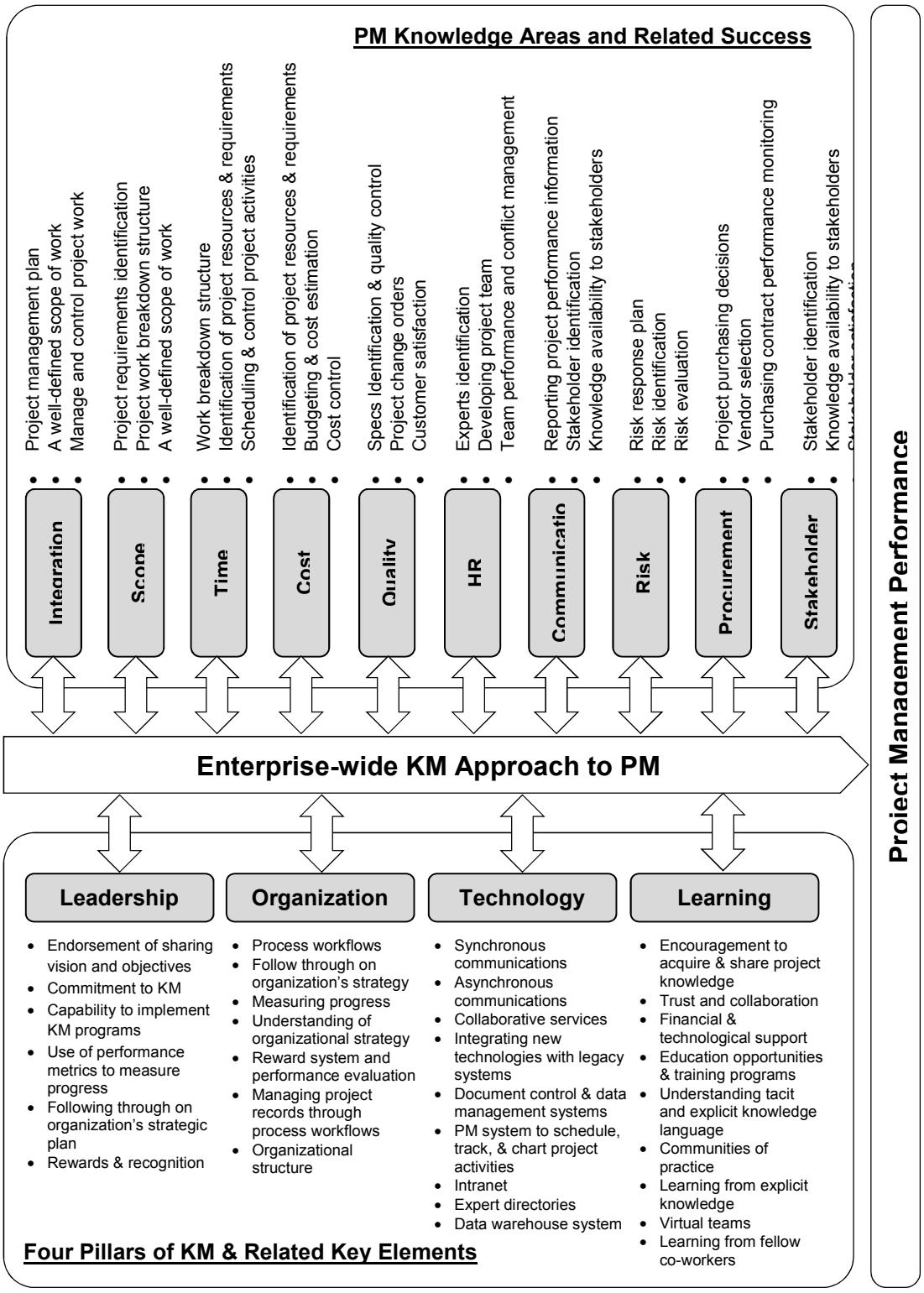

Figure 3-1: Conceptual Model for the Relationship between KM and PM

3.3 Survey Questionnaire

3.3.1 Design of Survey Questionnaire

Using methods suggested by Alreck and Settle (2003) and the work of Oun, Blackburn, Olson, and Blessner, 2016, a set of 51 questions and sub questions was defined in the survey questionnaire, which was comprised of four main parts. Part I included an information sheet about the research study and introduced the researcher and provided participants with the goals, objective, and the procedures of the research study. Part II consists of 4 demographic questions used to assess the nature of the population sample (Alreck & Settle, 2003). Part III, with 29 questions, relates to elements within the four KM pillars that were illustrated in Table 2-2. Questions in this part assess the extent to which KM, as measured by the elements within each pillar, is practiced by the participants and their organizations. Questions were defined relating to each KM pillar, as shown in Figure 3-1, such that each element within a pillar was represented by a single question. For analyses investigating each element, responses for the single question were used, while for analyses investigating each KM pillar, the group of questions representing each pillar was used. In Part IV, 8 main questions and 10 sub-questions were used to assess the extent to which PM is successful within the participants' organizations. Each PM knowledge area is represented by questions corresponding to the knowledge area's measurement factors. As shown in Table 2-1, several of PM measurement factors represent more than one PM knowledge area at the same time. Thus, responses of several sub-questions are used for the analysis of more than one PM knowledge area. For example, a well-defined scope of work is considered to be a performance measure for project integration management as well as for project scope management.

While the focus of the survey questions relating to KM pillars is at the organizational level (since our interest is in enterprise-wide KM systems), the focus of the questions relating to PM knowledge areas is at the project level. Because studying trends over time could not be attained within a single cross-sectional survey, and because respondents likely have served on multiple projects in the past, in completing the survey, respondents were instructed to refer to the most recent project in which they had participated (Oun, Blackburn, Olson, & Blessner, 2016).

Likert-scale responses were used for the questions inquiring about a specific KM or PM measurement factor. All responses were given a numeric value in order to analyze each response. Example: How would you rate your organization in using performance metrics to measure progress in project activities and project teams' performance? Responses were measured in the Likert Scale as the example shown in table 3-1 (Alreck & Settle, 2003).

Table 3-1: Example Responses Used for Survey Questions

Response	Numeric value
To a very little extent	1
To a little extent	2
To some extent	3
To a high extent	4
To a very high extent	5
Don't know / not applicable	6

If respondents selected "Don't know/not applicable" to answer a question, then these

values were eliminated from the data set used for the statistical analysis as it is determined by the author that "Don't know/not applicable" answers hold no value for the study. Raw survey responses for all survey questions can be found in Appendix D.

3.3.2 Content validity

The survey instrument was refined based on expert feedback to assess content validity. All experts included in this process were highly qualified practitioners in the fields of knowledge management and project management. Individual characteristics considered with the selection of all experts are as follows:

- Professional and academic credentials.
- Length and breadth of knowledge and experience in the field of PM and KM.
- Recognition and respect within organization and industry.

Four experts in the field of KM and PM were asked to administer the survey and then code the survey questions for the following set of characteristics (Olson, 2010; Oun, Blackburn, Olson, & Blessner, 2016; Presser et al., 2004):

- **Response Latency:** question is easy to answer and does not require time for an answer to come to mind.
- **Burden:** question does not require heavy cognitive work to answer.
- **Sensitivity:** question does not require revealing sensitive or private information.
- **Inclusivity of PM and KM elements:** element represented by the question merits inclusion as a component of a KM/PM model developed to study the association between KM and PM.

For each question, the experts were asked for a yes or no response to the characteristics questions and to provide comments for improvements.

3.3.3 Internal Consistency

Prior to statistical analysis, the internal consistency across the survey variables attempting to measure the same construct was evaluated by conducting an Item Analysis in Minitab to calculate Cronbach's alpha for the survey results for each of the four KM pillars and for each of the ten PM knowledge areas (Alreck & Settle, 2003; George, 2003; Oun, Blackburn, Olson, & Blessner, 2016). Cronbach's alpha coefficient ranges between 0 and 1 with a higher internal consistency as Cronbach's alpha coefficient is closer to 1. According to George and Mallery (2003), table 3-2 presents the guidelines that explain the level of internal consistency:

Table 3-2: Internal Consistency Guidelines (George & Mallery, 2003)

Cronbach's alpha coefficient (α)	Degree of internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$\alpha < 0.5$	Unacceptable

A Minitab session window output for Cronbach's Alpha calculations for the survey results for each of the four KM pillars and for each of the ten PM knowledge areas can be seen at Appendix C. The measurement scales of the sets of questions representing each of the ten PM knowledge areas exhibited values above the acceptable levels of internal consistency, as determined by Cronbach's alpha values illustrated in Table 3-3.

Table 3-3: Cronbach's Alpha Values for the Survey Results (PM knowledge Areas)

PM Knowledge Area	Cronbach's Alpha
Project Integration Management	0.7759
Project Scope Management	0.7045
Project Quality Management	0.9303
Project HR Management	0.7357
Project Stakeholder Management	0.8092
Project Communication Management	0.7130
Project Procurement Management	0.8213

Looking at the omitted item statistics output in Appendix C, Cronbach's alpha values for project knowledge areas are stable when compared with Cronbach's alpha values after Minitab removes individual questions from the analysis except for project scope and stakeholder management. For project scope management Cronbach's alpha values decreases from 0.7045 to 0.5488 when Minitab removes Question 34.2 from the analysis. Also, Cronbach's alpha decreases from 0.7045 to 0.6095 when Minitab removes Question 34.3 from the analysis. For project stakeholder management Cronbach's alpha values decreases from 0.8092 to 0.6500 when Minitab removes Question 39.2 from the analysis. Also, Cronbach's alpha decreases from 0. 8092 to 0.7188 when Minitab removes Question 39.1 from the analysis. Collectively though, the results suggest that all questions are good indicators of project stakeholder management. Performance measurement for project time, cost, and risk management were evaluated using a single question for each area. Therefore, Cronbach's alpha was not calculated.

For the sets of questions representing each of the four KM pillars, the measurement scales exhibited excellent levels of internal consistency, as determined by Cronbach's alpha values illustrated in Table 3-4.

Table 3-4: Cronbach's Alpha for the Survey Results (Four KM Pillars)

KM Pillar	Cronbach's Alpha
Leadership	0.9347
Organization	0.9590
Technology	0.9603
Learning	0.9636

Looking at the omitted item statistics output in Appendix C, Cronbach's alpha values for all four KM pillars are stable when compared with Cronbach's alpha values after Minitab removes individual questions from the analysis. Therefore, the results suggest that all questions are good indicators of the designated KM pillar.

3.3.4 Minimum Recommended Sample Size

Prior to calculating the recommended sample size, due consideration was given to the following aspects about the target population and the representing sample:

3.3.4.1 Population Size:

The population size for this study would be the total number of worldwide practitioners in the PM and KM domain. It is clearly beyond the study's scope to

determine or approximate the population size, and it is beyond the study's scope to obtain survey responses from the entire population (Creswell, 2013; Siegel & Castellan, 1988).

3.3.4.2 Margin of Error (d):

The Margin of Error (d) defines the likelihood that the results reported by the survey sample are close to the results that could be attained from the entire population. A margin of error of +/- 5% was used during this study (Creswell, 2013; Cochran, 2007; Siegel & Castellan, 1988).

3.3.4.3 Confidence Level (CL)

A confidence level (CL) of 95% was used during this study to correspond to the expected +/- 5% margin of error. The used CL reflects the likelihood that the study's statistical testing results would best represent the entire target population. +/- 5% margin of error corresponds to a Z score of 1.96. The corresponding Z score of 1.96 used during this study was based on the statistical rule (The empirical rule) which considers that for a normal distribution, 95% of all data falls within +/- 1.96 standard deviations of the sample (Alreck & Settle, 2003; Cochran, 2007).

3.3.4.4 Sample Proportion (p)

The sample proportion (p) is the proportion of the study sample sharing a specific perception or judgment towards a survey question. The sample proportion could be determined by using results from pilot surveys, previous survey records, or, if neither are available, a conservative estimation of 50% as the worst case scenario is considered for a binomial test or question (Cochran, 2007; Kotrlik & Higgins, 2001). The study's survey

questions provide the survey participant with six possible valid Likert scale answers to select from. Thus, p = 16.66% is used in estimating the minimum recommended sample size as the proportion (p) of the sample who are selecting one of six Likert scale answers.

3.3.5 Estimating the Minimum Recommended Sample Size

According to Alreck and Settle (2003), Cochran (2007), and Kotrlik and Higgins (2001), there is a minimum sample size, below which the reliability of the resulting data starts declining. Likewise, there is a point of sample size, above which the impact of additional data is insignificant. Cochran (2007) developed a method and formula to estimate the minimum recommended sample size for categorical and ordinal data that represents the entire target populations. Based on sample size determination method for large populations described by Cochran (2007), the formula represented in Equation 3.1 is used to estimate the minimum recommended sample size for this study:

$$n_0 \geq \frac{(Z)^2 * p(1-p)}{(d)^2} \qquad (3.1)$$

(n_0) is the minimum recommended sample size for large populations, (Z) is z score representing the measure of how many standard deviations from the population mean normalized to a standard normal distribution curve, (d) is the acceptable margin of error and recommended precision level, and (p) is the proportion of population who will select one of the six valid Likert scale answers for the survey questions.

Calculations in Equation 3.1 determined that a minimum of 213 valid survey responses are recommended for this study. The calculation used to approximate the

minimum recommended sample size for this study can be found in Appendix B.

3.3.6 Survey Distribution

An invitation to participate in the survey study was sent to 1,118 project management professionals from a wide range of projects and industries around the world. Participants were randomly selected from a list made available by the Project Management Institute (PMI) and were limited to individuals having responsibilities within project-based organizations (Oun, Blackburn, Olson, & Blessner, 2016). Within 6 months of launching the survey, 152 responses were received. Using the responses to demographic questions in Part II of the survey, individuals with the majority of their work activities not within project based organizations were excluded from this study. As such, 128 responses were considered for this study, for an overall response rate of 11.5% of the invited individuals. The response rate of 11.5% corresponds to a 60% of the study's minimum recommended sample size. The 128 valid survey responses fell short of the 213 recommended minimum sample size. However, Minitab power and sample size statistics tool estimated the statistical power for this study at approximately 0.959877 which is higher than the minimum acceptable statistical power rating of 0.8 or higher. A statistical power of 0.8 corresponds to an 80% accuracy of rejecting the null hypothesis when the alternative is true (Reinhart, 2015; Ternes 2011).

The survey was distributed using online software hosted by "Qualtrics: Online Survey Software & Insight Platform" (http://www.qualtrics.com/). The data collection from the finished surveys was performed through Qualtrics survey software. Microsoft Excel 2016 was used for filtering, quality check, and pre-testing, and for the data statistical analysis, Minitab® 17 was used.

3.4 Research Question and Criteria for Data Analysis

The research hypotheses in this dissertation are made as predictions about the potential relationship amongst the variables representing KM and PM. The postulated hypotheses build on the conceptual association model for the relationship between KM and PM shown in Figure 3-1 and the main research question: Is there a significant positive association between the four KM pillars and PM Knowledge areas? Accordingly, the following main research hypothesis is proposed:

Hr: There is a significant positive association between an enterprise-wide KM system and PM.

Several research sub-questions linked to the main research question were developed based on the item hierarchy illustrated in the conceptual association model shown in Figure 3-1. Based on the research sub-questions, the relationship between an enterprise-wide KM system and PM was investigated in detail from four aspects as defined by the following four aggregate levels through which statistical operations were performed.

Level – 1, Each PM knowledge areas vs. overall KM,

Level – 2, each of the four KM pillars vs. overall PM,

Level – 3, elements of the four KM pillars vs. overall PM, and

Level – 4, overall KM pillars vs. overall PM.

3.4.1 Level – 1: The Association between Each PM Knowledge Area and overall KM

This in fact ought to answer the question that if all KM Pillars are available and implemented, then what is the degree and the nature of the association between KM and each PM Knowledge Area? Figure 3-2, as an example, depicts the association between the four KM pillar and project cost management.

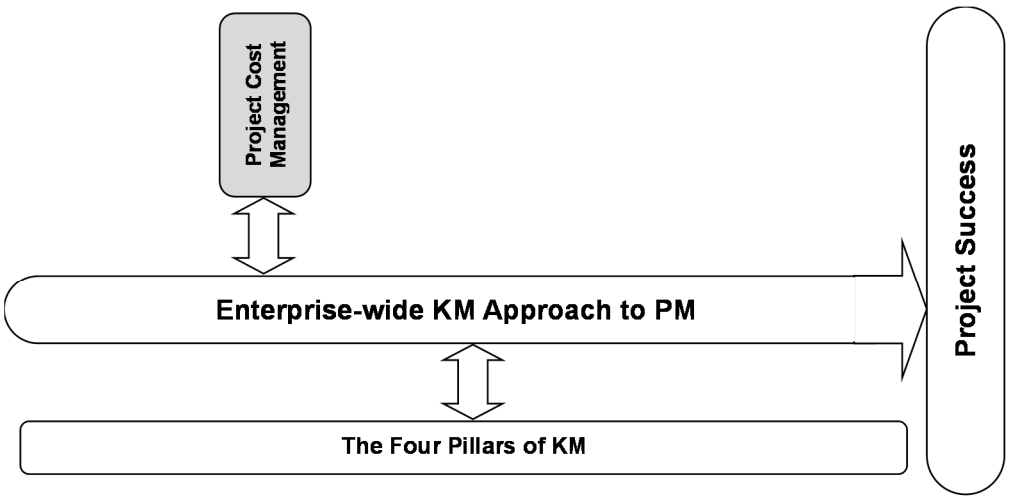

Figure 3-2: The Association between KM and Project Cost Management

In order to shed light on the predicted association between an individual PM knowledge area and the entire enterprise-wide KM system, the corresponding research sub-hypotheses set-1 was developed based on the conceptual association model for the relationship between PM knowledge areas and enterprise-wide KM shown in Figure 3-1, as follows:

H1a: There is a significant positive association between an enterprise-wide KM system and project integration management.

H1b: There is a significant positive association between an enterprise-wide KM system and project scope management.

H1c: There is a significant positive association between an enterprise-wide KM system and project time management.

H1d: There is a significant positive association between an enterprise-wide KM system and project cost management.

H1e: There is a significant positive association between an enterprise-wide KM system and project quality management.

H1f: There is a significant positive association between an enterprise-wide KM system and project human resource management.

H1g: There is a significant positive association between an enterprise-wide KM system and project communication management.

H1h: There is a significant positive association between an enterprise-wide KM system and project risk management.

H1i: There is a significant positive association between an enterprise-wide KM system and project procurement management.

H1j: There is a significant positive association between an enterprise-wide KM system and project stakeholder management.

To investigate the relationship that overall KM has with each PM knowledge area and to test research sub-hypotheses set-1, the median of the participant's responses to all 29

survey questions used in Part II of the survey was determined as an aggregate measure of the presence of the four KM pillars. Then tested against the median of the responses to questions used in Part III of the survey that correspond to each PM knowledge area (Oun, Blackburn, Olson, & Blessner, 2016).

3.4.2 Level – 2: The Association between Each of the Four KM Pillars and Overall PM

This in fact ought to investigate the existence and the nature of the association between each one of the four KM Pillars with overall PM. Figure 3-3, as an example, depicts the association between KM leadership pillar and overall PM.

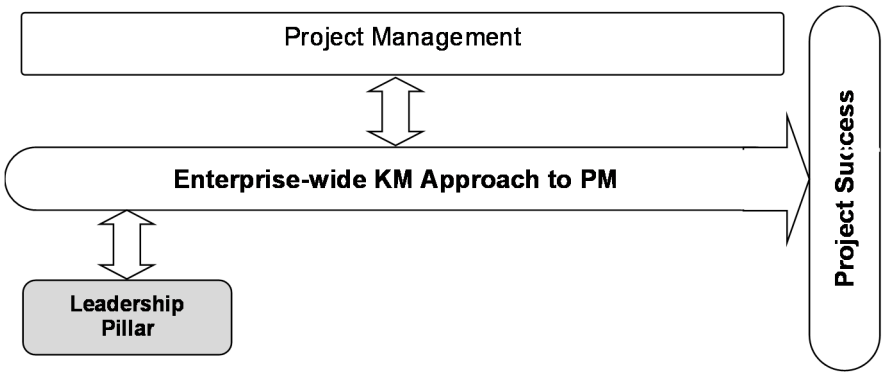

Figure 3-3: The Association between the KM Leadership Pillar and Project Management

In order to shed light on the predicted association that each one of the four KM pillars has with overall PM, the corresponding research sub-hypotheses set-2 was developed based on the conceptual association model for the relationship between PM and enterprise-wide KM shown in Figure 3-1, as follows:

H2a: There is a significant positive association between the KM leadership pillar and project management.

H2b: There is a significant positive association between the KM organization pillar and project management.

H2c: There is a significant positive association between the KM technology pillar and project management.

H2d: There is a significant positive association between the KM learning pillar and project management.

To investigate the relationship that each KM pillar has with overall PM and to test the research sub-hypotheses set-2, the median of the participant's responses for each KM pillar was tested against the median of the participant's responses to all 18 questions and sub-questions used in Part III of the survey as an aggregate measure for overall PM (Oun, Blackburn, Olson, & Blessner, 2016).

3.4.3 Level – 3: The Association between Elements of the Four KM Pillars and Overall PM

This in fact ought to investigate the degree and the nature of the association between each element of the four KM pillars and overall PM? Figure 3-4, as an example, depicts the association between the organizations' commitment to KM, as an element of the leadership KM pillar, and Overall PM.

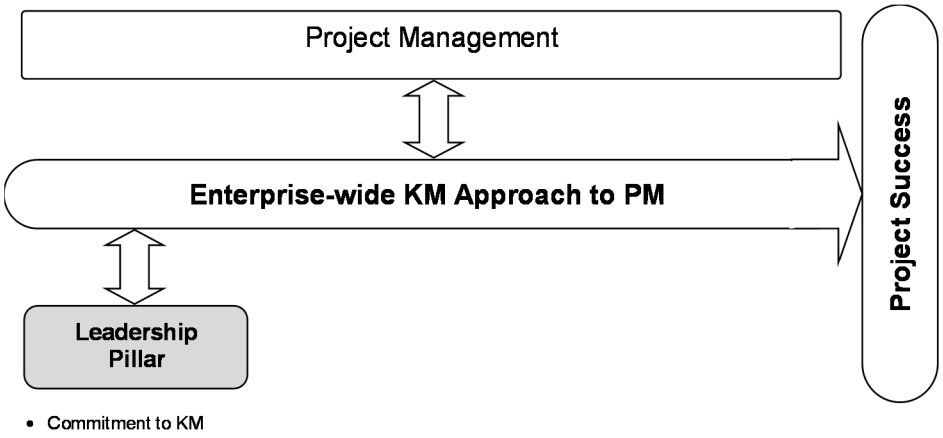

Figure 3-4: The Association between Commitment to KM and Overall PM

In order to shed light on the predicted association that each element of the four KM pillars has with overall PM, sub-hypotheses set 3 was developed to represent all 32 elements of the four KM pillars included in the conceptual association model shown in Figure 3-1. The elements of the four KM pillars could be seen in tables 5-3 through 5-6. The following is the general format that represents all hypotheses included in sub-hypotheses set 3: **There is a significant positive association between an element of a KM pillar and PM.**

To investigate the relationship between elements of the four KM pillars and overall PM, the participant's responses to individual survey questions corresponding to each element of the four KM pillars were tested against the median of the participant's responses to all 18 questions and sub-questions used to measure PM (Oun, Blackburn, Olson, & Blessner, 2016).

3.4.4 Level – 4: The Association between KM and PM

This in fact ought to answer the question that if a four pillar KM system is available and implemented, then what is the degree and the nature of the association between KM and each overall PM? Figure 3-5, as an example, depicts the association between the four pillars of KM and overall PM.

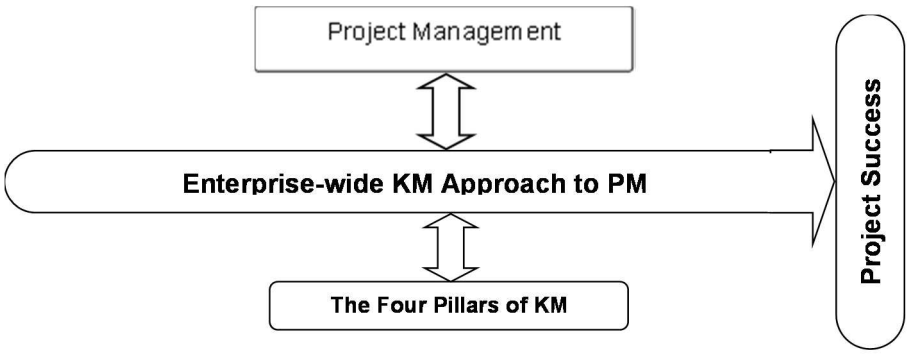

Figure 3-5: The Association between KM and PM

In order to shed light on the predicted association that KM has with overall PM, the corresponding research main hypothesis was developed based on the conceptual association model for the relationship between PM and enterprise-wide KM shown in Figure 3-1, as follows:

Hr: There is a significant positive association between an enterprise-wide KM system and PM.

To investigate the relationship that KM has with PM and to test the main research hypothesis, the median of the participant's responses to all 29 survey questions used in Part II of the survey was determined as an aggregate measure of the presence of the four KM pillars. As an aggregate measure for overall PM, the median of the participant's responses to all 18 questions and sub-questions used in Part III of the survey was determined. These values were then used to investigate the relationship between KM and PM.

3.5 Guidelines and Data Analysis

To investigate the association between responses of the survey measurement questions, the Kendall's tau-b correlation coefficient, τb, was determined to be the appropriate nonparametric measure of association since the data is ordinal. To calculate τb, Cross Tabulation in Minitab was used. On a scale of -1.0 to 1.0, the degree and the nature of the association between variables were determined. A positive τb value suggests that there are more concordant pairs than discordant pairs and demonstrates a positive association between two variables in which the ranking of one variable increases, the ranking of the other one also increases, whereas a negative τb value demonstrates a negative association between two variables in which the ranking of one variable increases as the other decreases, and vice versa (Agresti, 2010; Gibbons, 1985; Oun, Blackburn, Olson, & Blessner, 2016; Siegel & Castellan, 1988). The data analysis in this study was based on determining the statistical significance of the association between any two variables. This was accomplished by calculating and testing p-values for the test of concordance, Pc, and p-values for the test of significance, Ps.

It is important to note that an association does not necessarily imply causation. As

such, testing the association does not prove that effective KM causes successful PM, but the results can be used to justify further investigation into the relationship (Siegel & Castellan, 1988). In order to draw a more predictive conclusion from the data, ordinal logistic regression (OLR) was performed to infer the degree of predictability. OLR was also performed as a predictive analysis to explain the relationship between KM and PM at the aggregate levels explained earlier in this chapter. OLR was carried out using Minitab in order to determine which pillars and which elements of the KM pillars are most predictive of PM success, and to analyze how well PM performance and the performance of the 10 PM knowledge areas are predicted by the management of project knowledge using the tools and processes defined by the elements of the four pillars of KM.

The description of the test of concordance, the test for Kendall's tau-b significance against a critical value, and OLR analysis are as follows:

3.5.1 P-Value for the Test of Concordance, Pc

At a confidence level of 95% corresponding to a significance level (alpha level, α) of 0.05, the p-values for the test of concordance, Pc, were calculated using Cross Tabulation in Minitab to test the concordant and discordant pairs agreement, which measures the association between enterprise-wide KM and PM (Agresti, 2010; Everitt, 2001; Siegel & Castellan, 1988). The hypotheses are as follows:

H_0: The probability of concordance equals the probability of discordance.

H_a: The probability of concordance does not equal the probability of discordance.

A (Pc) level below 0.05 indicates that there is sufficient evidence to conclude that the

probability of concordance is greater than the probability of discordance with variables moving in the same direction (Agresti, 2010).

3.5.2 Test for Kendall's tau-b Significance against a Critical Value

The level of statistical significance of Kendall's tau-b correlation coefficient, τb was tested against a Kendall's tau-b critical value by the left-tailed z-test. The left-tailed z-test was performed at a confidence level of 95% corresponding to an alpha level, α of 0.05 to represent the likelihood of rejecting the null hypothesis when the null hypothesis is true (Agresti, 2010; Everitt, 2001; Siegel & Castellan, 1988).

The guidelines presented in Table 3-5 were used to determine the strength of absolute values of Kendall's tau-b correlation coefficient, τb (Le Roy & Corbett, 2008):

Table 3-5: Guidelines for Kendall's tau-b Correlation Coefficient, τb

Absolute Values τ_b	Degree of Statistical Association
Less than 0.10	very weak
0.10 to 0.19	weak
0.20 to 0.29	moderate
0.30 or above	strong

Hence, for this study, τb-critical = 0.30 is the minimum acceptable value for the correlation coefficient to be considered as statistically significant (Le Roy & Corbett (2008). The general null and alternative hypotheses for τb test of significance against (τb-critical) in this study are as follows:

H_0: $\tau b \geq 0.30$ (The true correlation coefficient is equal to or greater than the minimum acceptable value for the correlation coefficient to be considered as statistically significance).

H_a: $\tau b < 0.30$ (The true correlation coefficient is less than the minimum acceptable value for the correlation coefficient to be considered as statistically significance).

The Z Score is computed by converting τb using Equation 3.2 as follows, where τ is the centered Kendall's tau-b statistic (τb - τb critical), and n is the number of observations (sample size):

$$Z = \frac{3 * \tau * \sqrt{n(n-1)}}{\sqrt{2(2n+5)}} \tag{3.2}$$

To test for statistical significance against (τb critical), the p-value for significance, Ps, is computed using the standard normal distribution function (NORMDIST(Z)) in Microsoft Excel. If (Ps) is less than the pre-selected alpha level of 0.05, then we reject the null hypothesis that (τb) equals (τb-critical) value of 0.3 and accept the alternative that (τb) is less than the (τb critical).

Similarly, if (Ps) is greater than the pre-selected alpha level of 0.05, then we fail to reject the null hypothesis and assume (τb) is equal to or greater than the (τb critical) value of 0.3.

3.5.3 Ordinal Logistic Regression (OLR)

At a confidence level of 95% corresponding to a significance level (alpha level, α) of 0.05, the p-values for the ordinal logistic regression analysis, Pr, were calculated to determine which of the four KM pillars and which elements of KM are most predictive of PM success (i.e. overall PM, and each of the PM knowledge areas) (Siegel & Castellan, 1988).

A (Pr) level below 0.05 indicates that there is sufficient evidence to conclude that a KM element or a KM pillar is statistically significantly predictive of a PM knowledge area or project success (Agresti, 2010). The OLR analysis for each construct was repeated to sequentially exclude insignificant elements/factors. As such, after each iteration, elements/factors with p-values greater than the pre-selected alpha level of 0.05 were excluded one factor at a time until elements and factors with p-values less than the pre-selected alpha level of 0.05 remained.

Chapter 4 - Results and Data Analysis

"Imperfect prediction, despite being imperfect, can be valuable for decision-making purposes."

- Michael Kattan

4.1 Chapter Overview

Chapter 4 describes the results of the data analysis. It documents the findings of the statistical analysis used to measure the degree and the nature of the relationship between KM and PM at several aggregate levels described in chapter 3 and described in details later in this chapter. Findings and information presented in Chapter 4 outline the foundation for the research's conclusions presented in Chapter 5.

4.2 Demographic Observations

The number of survey responses after 6 months of launching the survey was 128 which were 11.5% of the 1118 invited individuals, and represent 60% of the study's recommended sample size.

The demographic summary of the survey showed that the largest number of the survey participants (64, 50%) indicated that they had 5 to 15 years of experience, (35, 27%) indicated that they had more than 25 years of experience, (28, 22%) indicated that they had 16 to 25 years of experience, and (1, < 1%) indicated a less than 5 years of experience (see Table 4-1).

Table 4-1: Respondents Years of Experience

Experience (Years)	# Response	%
< 5 years	1	< 1
5 – 15 years	64	50
16 – 25 years	28	22
> 25 years	35	27

Of those who participated in the research study, (78, 61%) indicated that they were project managers, (22, 17%) indicated that they were project engineers, (19, 15%) indicated that they were department managers, (8, 6%) indicated that they were general managers, and only (1, <1%) indicating a technician level position (see Figure 4-2).

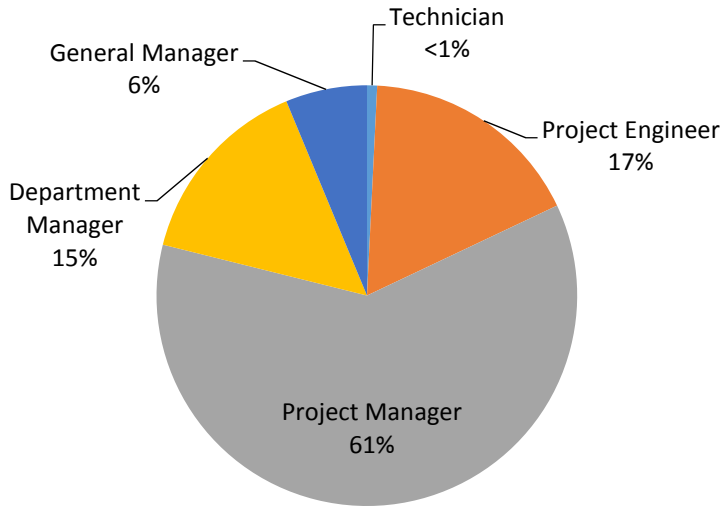

Figure 4-1: Respondent Role

Figure 4-2 shows the respondents' work field: The largest number of respondents (41, 32%) indicated that they are from information technology, (28, 22%) are from the energy industry, (22, 17%) are from construction, (15, 12%) are from telecommunication, (12, 9%) are from manufacturing, and (10, 8%) are from chemical & pharmaceutical.

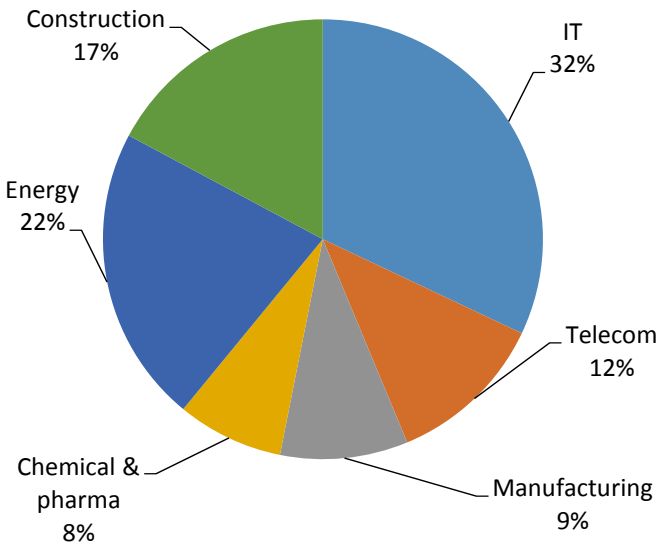

Figure 4-2: Respondent Field of Work

4.3 Survey Question Adjusted Response Rates

As mentioned in chapter 3, if respondents selected "Don't know/not applicable" to answer a question, then these values were eliminated from the data set used for the statistical analysis since "Don't know/not applicable" answers hold no value for the study. Table 4.2 shows the adjusted survey response rate and the percentage of effective responses for each survey question.

Table 4-2: Adjusted Survey Response Rate & Percentage of Effective Responses

Question #	Adjusted Response Rate	% Effective Responses
1	128 (of 128)	100.0
2	128 (of 128)	100.0
3	128 (of 128)	100.0
4	128 (of 128)	100.0
5	128 (of 128)	100.0
6	128 (of 128)	100.0
7	128 (of 128)	100.0
8	128 (of 128)	100.0
9	128 (of 128)	100.0
10	127 (of 128)	99.2
11	128 (of 128)	100.0
12	128 (of 128)	100.0
13	128 (of 128)	100.0
14	128 (of 128)	100.0
15	128 (of 128)	100.0
16	128 (of 128)	100.0
17	128 (of 128)	100.0
18	128 (of 128)	100.0
19	128 (of 128)	100.0
20	128 (of 128)	100.0
21	128 (of 128)	100.0
22	128 (of 128)	100.0
23	128 (of 128)	100.0
24	128 (of 128)	100.0
25	128 (of 128)	100.0
26	128 (of 128)	100.0

Table 4-2: Adjusted Survey Response Rate & Percentage of Effective Responses (Cont.)

Question #	Adjusted Response Rate	% Effective Responses
27	128 (of 128)	100.0
28	128 (of 128)	100.0
29	128 (of 128)	100.0
30	128 (of 128)	100.0
31	128 (of 128)	100.0
32	128 (of 128)	100.0
33.1	128 (of 128)	100.0
33.2	128 (of 128)	100.0
33.3	128 (of 128)	100.0
33.4	128 (of 128)	100.0
34.1	127 (of 128)	99.2
34.2	127 (of 128)	99.2
34.3	127 (of 128)	99.2
35	127 (of 128)	99.2
36	125 (of 128)	97.7
37.1	124 (of 128)	96.9
37.2	123 (of 128)	96.1
37.3	123 (of 128)	96.1
37.4	124 (of 128)	96.9
38.1	126 (of 128)	98.4
38.2	125 (of 128)	97.7
39.1	120 (of 128)	93.8
39.2	117 (of 128)	91.4
39.3	123 (of 128)	96.1
40	124 (of 128)	96.9
41.1	110 (of 128)	85.9
41.2	114 (of 128)	89.1
41.3	109 (of 128)	85.2

4.4 Descriptive Statistics for Research Questions

This study sought to investigate the degree and the nature of the association between KM and PM. Resulting data from the research survey questions was entered into Minitab® 17 software and analyzed. The analysis included descriptive statistics of each of the 41 survey questions results as follows:

4.4.1 KM Leadership Pillar

Table 4-3 illustrates the corresponding six questions supporting assessment of the extent to which KM, as measured by the elements within KM leadership pillar, is practiced by the participants and their organizations. Table 4-3 also shows the descriptive statistics for the responses to the six survey questions:

Table 4-3: Leadership Pillar Descriptive Statistics

Variable	Mean	Standard Error Mean	Standard Deviation	Variance	Skewness	Kurtosis
Q5	3.5234	0.0887	1.0037	1.0073	-0.54	0.17
Q6	3.5469	0.0920	1.0413	1.0844	-0.74	0.32
Q7	3.5469	0.0814	0.9210	0.8482	-0.26	-0.21
Q8	3.5703	0.0899	1.0170	1.0344	-0.47	-0.05
Q9	3.5078	0.0973	1.1012	1.2125	-0.58	-0.09
Q14	3.6406	0.0899	1.0174	1.0352	-0.64	0.31

4.4.2 KM Organization Pillar

Table 4-4 illustrates the corresponding seven questions supporting assessment of the extent to which KM, as measured by the elements within KM organization pillar, is practiced by the participants and their organizations. Table 4-4 also shows the descriptive statistics for the responses to the seven survey questions:

Table 4-4: Organization Pillar Descriptive Statistics

Variable	Mean	Standard Error Mean	Standard Deviation	Variance	Skewness	Kurtosis
Q8	3.5703	0.0899	1.0170	1.0344	-0.47	-0.05
Q9	3.5078	0.0973	1.1012	1.2125	-0.58	-0.09
Q10	3.5748	0.0905	1.0198	1.0400	-0.53	-0.04
Q11	3.6094	0.0923	1.0442	1.0903	-0.51	-0.16
Q12	3.5234	0.0921	1.0421	1.0861	-0.55	0.06
Q13	3.5391	0.0914	1.0341	1.0693	-0.63	0.16
Q14	3.6406	0.0899	1.0174	1.0352	-0.64	0.31

4.4.3 KM Technology Pillar

Table 4-5 illustrates the corresponding ten questions supporting assessment of the extent to which KM, as measured by the elements within KM technology pillar, is practiced by the participants and their organizations. Table 4-5 also shows the descriptive statistics for the responses to the ten survey questions:

Table 4-5: Technology Pillar Descriptive Statistics

Variable	Mean	Standard Error Mean	Standard Deviation	Variance	Skewness	Kurtosis
Q15	3.5625	0.0879	0.9941	0.9882	-0.49	-0.10
Q16	3.5859	0.0891	1.0081	1.0162	-0.54	0.06
Q17	3.5781	0.0912	1.0319	1.0647	-0.61	0.08
Q18	3.5625	0.0872	0.9861	0.9724	-0.63	0.19
Q19	3.5469	0.0900	1.0184	1.0372	-0.58	0.29
Q20	4.0080	0.3960	4.4800	20.071	10.44	115.00
Q21	3.6719	0.0860	0.9729	0.9466	-0.55	0.21
Q22	3.6406	0.0892	1.0097	1.0194	-0.58	0.14
Q23	3.5234	0.0934	1.0571	1.1176	-0.53	-0.20
Q24	3.5781	0.0892	1.0087	1.0175	-0.52	0.03

4.4.4 KM Learning Pillar

Table 4-6 illustrates the corresponding twelve questions and sub-questions supporting assessment of the extent to which KM, as measured by the elements within KM learning pillar, is practiced by the participants and their organizations. Table 4-6 also shows the descriptive statistics for the responses to the survey questions

Table 4-6: Learning Pillar Descriptive Statistics

Variable	Mean	Standard Error Mean	Standard Deviation	Variance	Skewness	Kurtosis
Q25	3.5781	0.0878	0.9930	0.9860	-0.49	0.13
Q26	3.6328	0.0783	0.8862	0.7854	-0.17	-0.34
Q27	3.5156	0.0901	1.0194	1.0391	-0.45	-0.16
Q28	3.5313	0.0880	0.9956	0.9911	-0.50	-0.16
Q29	3.6406	0.0892	1.0097	1.0194	-0.53	0.11
Q30	3.5547	0.0858	0.9705	0.9419	-0.37	-0.22
Q31	3.5703	0.0850	0.9613	0.9242	-0.34	-0.15
Q32	3.6641	0.0786	0.8898	0.7918	-0.30	-0.26
Q33.1	3.5469	0.0920	1.0413	1.0844	-0.40	-0.25
Q33.2	3.5547	0.0865	0.9786	0.9576	-0.33	-0.05
Q33.3	3.5781	0.0835	0.9442	0.8915	-0.66	0.57
Q33.4	3.5469	0.0872	0.9870	0.9742	-0.63	0.36

4.4.5 PM Knowledge Areas

Table 4-7 illustrates the corresponding eighteen questions and sub- questions supporting assessment of the extent to which PM is successful within the participants' organizations. Each PM knowledge area is represented by questions corresponding to the knowledge area's performance measurement factors. Table 4-7 also shows the descriptive statistics for the responses to the survey questions:

Table 4-7: PM Knowledge Areas Descriptive Statistics

Variable	Mean	Standard Error Mean	Standard Deviation	Variance	Skewness	Kurtosis
Q34.1	4.1016	0.0585	0.6621	0.4384	-0.61	1.16
Q34.2	3.9453	0.0832	0.9417	0.8867	-1.21	1.71
Q34.3	3.7813	0.0830	0.9386	0.8809	-0.82	0.36
Q35	3.1719	0.0902	1.0203	1.0411	0.14	-0.03
Q36	3.7460	0.0676	0.7583	0.5750	-0.66	0.38
Q37.1	3.8000	0.0672	0.7513	0.5645	-0.58	0.38
Q37.2	3.7903	0.0690	0.7680	0.5898	-0.72	0.50
Q37.3	3.7661	0.0707	0.7872	0.6197	-0.68	0.31
Q37.4	3.8080	0.0608	0.6803	0.4628	-0.68	0.92
Q38.1	3.7891	0.0952	1.0770	1.1599	-1.07	0.81
Q38.2	3.4961	0.0941	1.0607	1.1250	-0.62	-0.27
Q39.1	3.8430	0.0796	0.8757	0.7668	-0.60	-0.16
Q39.2	3.8305	0.0792	0.8604	0.7403	-1.38	1.95
Q39.3	3.7581	0.0754	0.8398	0.7052	-0.69	0.07
Q40	3.7840	0.0784	0.8761	0.7675	-0.73	0.35
Q41.1	3.7658	0.0723	0.7622	0.5810	-1.33	3.43
Q41.2	3.8087	0.0837	0.8973	0.8052	-0.65	0.16
Q41.3	3.7818	0.0746	0.7826	0.6125	-0.65	0.32

4.5 Statistical Analysis and Hypotheses Test Findings

Results from administering the survey measurement questions were transformed to a 1-6 scale and analyzed. For each postulated association, Kendall's tau-b correlation coefficient (τ_b) was computed and p-values for the test of concordance, P_c, as well as the p-values for the test of τ_b significance, P_s were tested. For the test of concordance, a (P_c) level below 0.05 indicates that there is sufficient evidence to conclude that the probability of concordance is greater than the probability of discordance with variables moving in the same direction (Agresti, 2010). For the test of τ_b significance, a one-tailed (left-tail) z-test was used to determine whether the resulting p-value of correlation coefficient significance was greater than or less than the preselected alpha level value of 0.05. A p-value of less than 0.05 suggested that the null hypothesis, H_0, should be rejected accepting that (τ_b) is less than ($\tau_{b\text{-critical}}$) value of 0.3 implying insignificant association. Similarly, a p-value greater than 0.05 suggested that the null hypothesis should not be rejected and assuming that (τ_b) is equal to or greater than ($\tau_{b\text{-critical}}$) value of 0.3 implying a significant association.

For the ordinal logistic regression analysis, p-values, Pr, were calculated using ordinal logistic regression in Minitab to determine which of the four KM pillars and which elements of KM were most predictive of PM success.

4.5.1 Level – 1: Analysis of the Association between Enterprise-wide KM and Each PM Knowledge Area

Analysis of the association between each PM knowledge area and the entire enterprise-wide KM system focused on the statistical testing of ten (10) sub-hypotheses intended to determine the existence and the nature of the postulated association. Table 4.8

provides the results of testing sub-hypotheses set 1. All ten (10) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. However, only seven (7) of the ten (10) hypotheses for the test of (τ_b) significance resulted in failing to reject the null (i.e., hypotheses $H1a_0$, $H1e_0$, $H1f_0$, $H1g_0$, $H1h_0$, $H1i_0$, $H1j_0$).

Table 4-8: Research Sub-Hypotheses set 1 Testing Results

PM Knowledge Area	τ_b	P-Value for test of τ_b significance, Ps	P-Value for test of concordance, Pc
Integration	0.322	0.641	0.000
Scope	0.194	0.038	0.006
Time	0.134	0.003	0.040
Cost	0.195	0.040	0.006
Quality	0.232	0.127	0.001
Human Resource	0.392	0.938	0.000
Communication	0.310	0.569	0.000
Risk	0.216	0.080	0.002
Procurement	0.256	0.233	0.000
Stakeholders	0.337	0.734	0.000

The findings of testing and analyzing each of the ten hypotheses included in research sub-hypotheses set 1 are as follows:

4.5.1.1 Sub-Hypothesis H1a

Testing of sub-hypothesis H1a sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1a:

There is a significant positive association between an enterprise-wide KM system and project integration management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project integration management is successful within the participants' organizations are questions 34.3 and 38.2.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the median values of the participant's responses to questions 34.3 and 38.2.

Key parameters related to testing this association are shown in Table 4-9 and Figure 4-3.

Table 4-9: Sub-Hypothesis H1a Statistical Analysis

N: 128 Z statistic: 0.362	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.322
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.641 Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

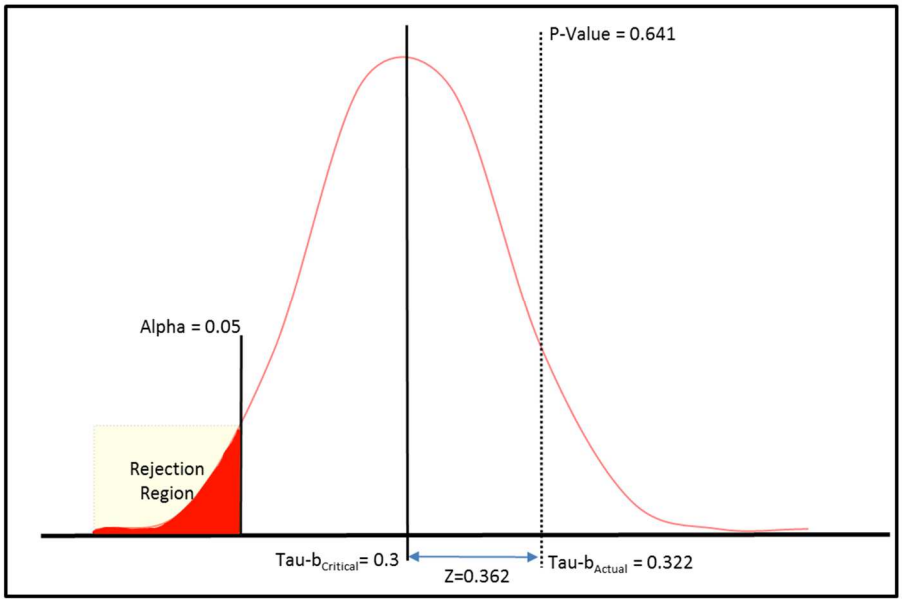

Figure 4-3: Sub-Hypothesis H1a Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.322). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of τ_b significance (P_s) are (0.00) and (0.641) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal

the probability of discordance. P-value for the test of τ_b significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project integration management.

4.5.1.2 Sub-Hypothesis H1b

Testing of sub-hypothesis H1b sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1b:

There is a significant positive association between an enterprise-wide KM system and project scope management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project scope management is successful within the participants' organizations are questions 34.1, 34.2 and 34.3. Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then

statistically tested against the median values of the participant's responses to questions 34.1, 34.2 and 34.3. Key parameters related to testing this association are shown in Table 4-10 and Figure 4-4.

Table 4-10: Sub-Hypothesis H1b Statistical Analysis

N: 128	Alpha Level (α): 0.05
Z statistic: -1.777	Kendall's tau-b (τ_b): 0.194
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.006	p-value (P_s): 0.038
Direction of Association: Positive	Degree of Association: Weak
Result: Reject H_0	**Result: Reject H_0**

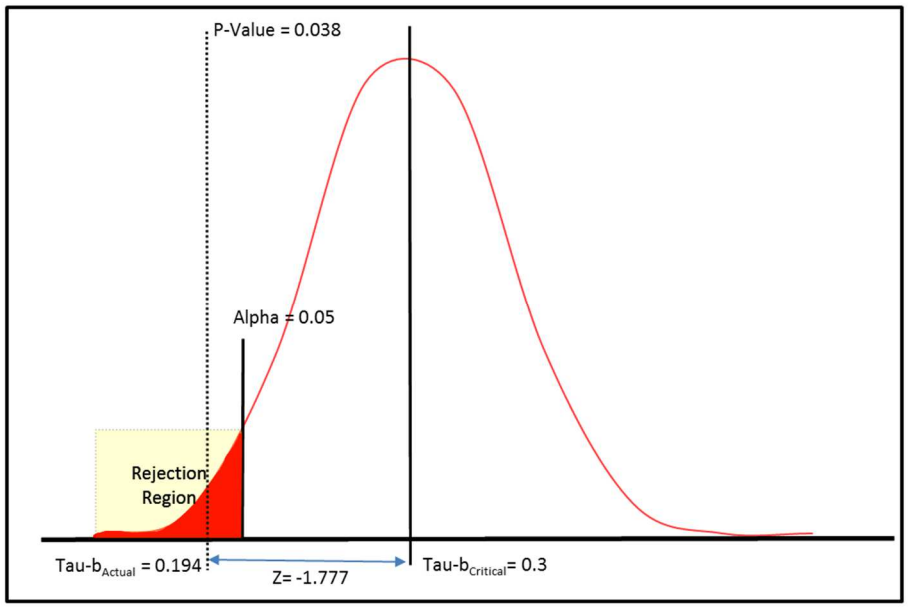

Figure 4-4: Sub-Hypothesis H1b Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.194). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.006) and (0.038) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of τ_b significance (P_s) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 that (τ_b) is less than the minimum acceptable (τ_b) value of 0.30. Therefore, there is insufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project scope management.

4.5.1.3 Sub-Hypothesis H1c

Testing of sub-hypothesis H1c sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1c:

There is a significant positive association between an enterprise-wide KM system and project time management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project scope management is successful within the participants' organizations is questions 35. Using methods described in chapter 3, Cross Tabulation in Minitab was

performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the values of the participant's responses to question 35. Key parameters related to testing this association are shown in Table 4-11 and Figure 4-5.

Table 4-11: Sub-Hypothesis H1c Statistical Analysis

N: 128 Z statistic: -2.783	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.134
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.042 Direction of Association: Positive	p-value (P_s): 0.003 Degree of Association: Weak
Result: Reject H_0	**Result: Reject H_0**

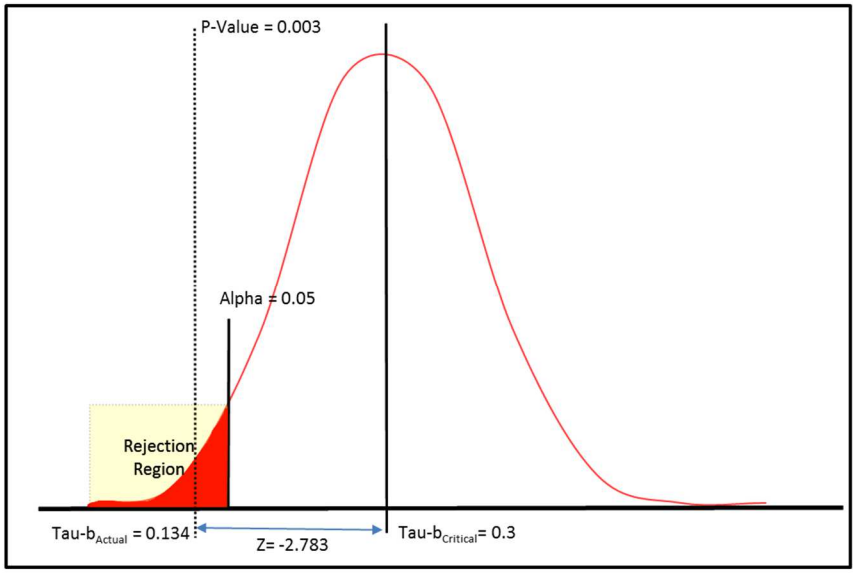

Figure 4-5: Sub-Hypothesis H1c Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.134). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.042) and (0.003) consecutively. As such, the p-value for the test of concordance (P_c) falls slightly below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 that (τ_b) is less than the minimum acceptable (τ_b) value of 0.30. Therefore, there is insufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project time management.

4.5.1.4 Sub-Hypothesis H1d

Testing of hypothesis H1d sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1d:

There is a significant positive association between an enterprise-wide KM system and project cost management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project cost management is successful within the participants' organizations is question 36. Using methods described in chapter 3, Cross Tabulation in Minitab was performed to

calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the values of the participant's responses to question 36. Key parameters related to testing this association are shown in Table 4-12 and Figure 4-6.

Table 4-12: Sub-Hypothesis H1d Statistical Analysis

N: 128 Z statistic: -1.755	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.195
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.006 Direction of Association: Positive	p-value (P_s): 0.040 Degree of Association: Weak
Result: Reject H_0	**Result: Reject H_0**

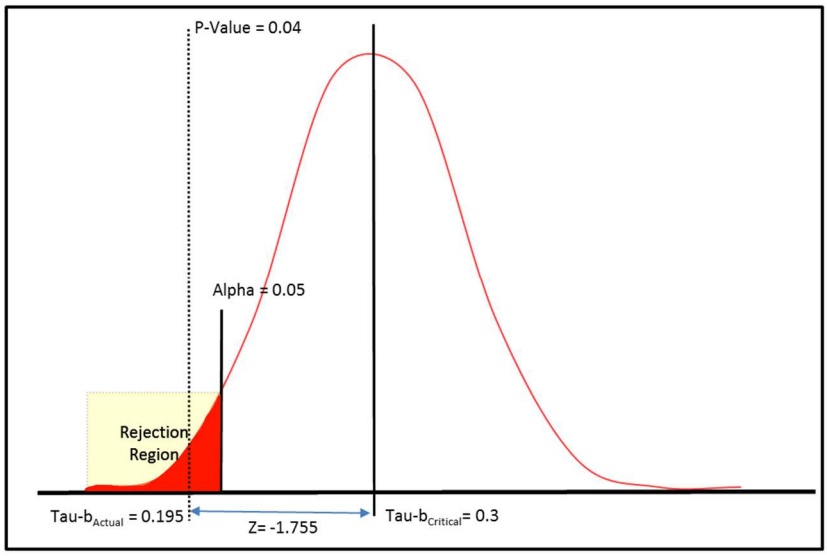

Figure 4-6: Sub-Hypothesis H1d Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.195). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.006) and (0.040) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 that (τ_b) is less than the minimum acceptable (τ_b) value of 0.30. Therefore, there is insufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project cost management.

4.5.1.5 Sub-Hypothesis H1e

Testing of hypothesis H1e sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1e:

There is a significant positive association between an enterprise-wide KM system and project quality management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project quality management is successful within the participants' organizations are questions 37.1 through 37.4. Using methods described in chapter 3, Cross Tabulation in

Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the values of the participant's responses to question 37.1 through 37.4. Key parameters related to testing this association are shown in Table 4-13 and Figure 4-7.

Table 4-13: Sub-Hypothesis H1e Statistical Analysis

N: 128 Z statistic: -1.142	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.232
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.001 Direction of Association: Positive	p-value (P_s): 0.127 Degree of Association: Moderate
Result: Reject H_0	**Result: Fail to Reject H_0**

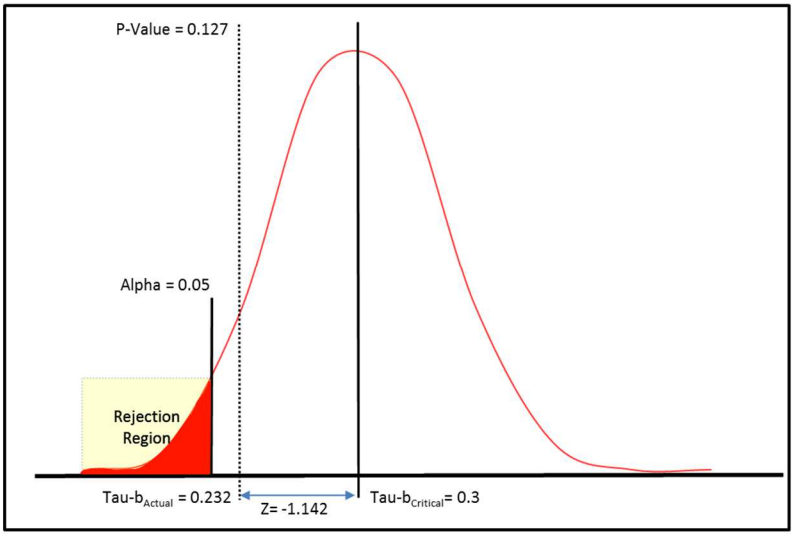

Figure 4-7: Sub-Hypothesis H1e Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.232). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.001) and (0.127) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project quality management.

4.5.1.6 Sub-Hypothesis H1f

Testing of hypothesis H1f sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1f:

There is a significant positive association between an enterprise-wide KM system and project human resource management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which

project human resource management is successful within the participants' organizations are questions 38.1 and 38.2.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the median values of the participant's responses to questions 38.1 and 38.2.

Key parameters related to testing this association are shown in Table 4-14 and Figure 4-8.

Table 4-14: Sub-Hypothesis H1f Statistical Analysis

N: 128 Z statistic: 1.536	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.392
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.938 Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

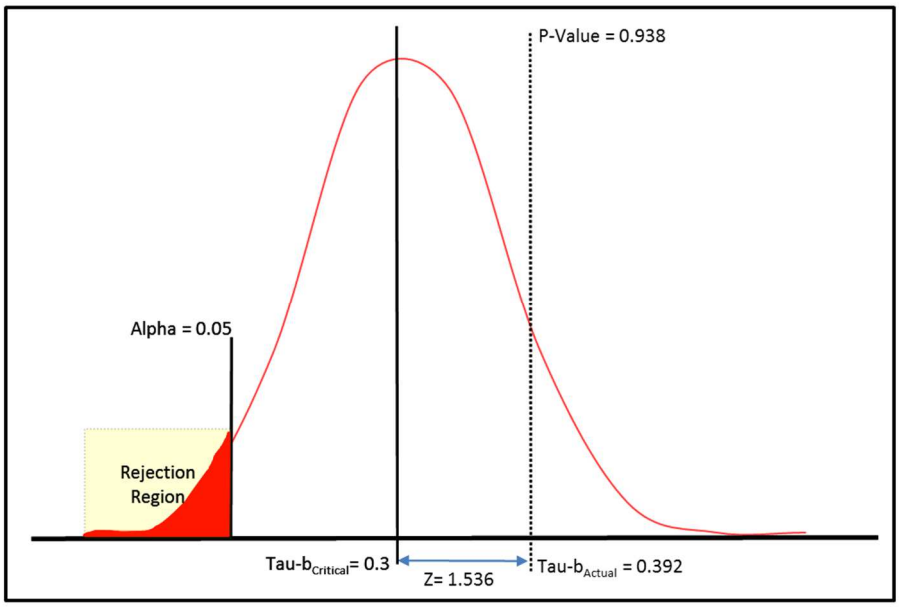

Figure 4-8: Sub-Hypothesis H1f Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.392). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.938) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project human resource management.

4.5.1.7 Sub-Hypothesis H1g

Testing of hypothesis H1g sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1g:

There is a significant positive association between an enterprise-wide KM system and project communication management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project communication management is successful within the participants' organizations are questions 39.2 and 39.3.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the median values of the participant's responses to questions 39.2 and 39.3.

Key parameters related to testing this association are shown in Table 4-15 and Figure 4-9.

Table 4-15: Sub-Hypothesis H1g Statistical Analysis

N: 128	Alpha Level (α): 0.05
Z statistic: 0.175	Kendall's tau-b (τ_b): 0.310
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000	p-value (P_s): 0.569
Direction of Association: Positive	Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

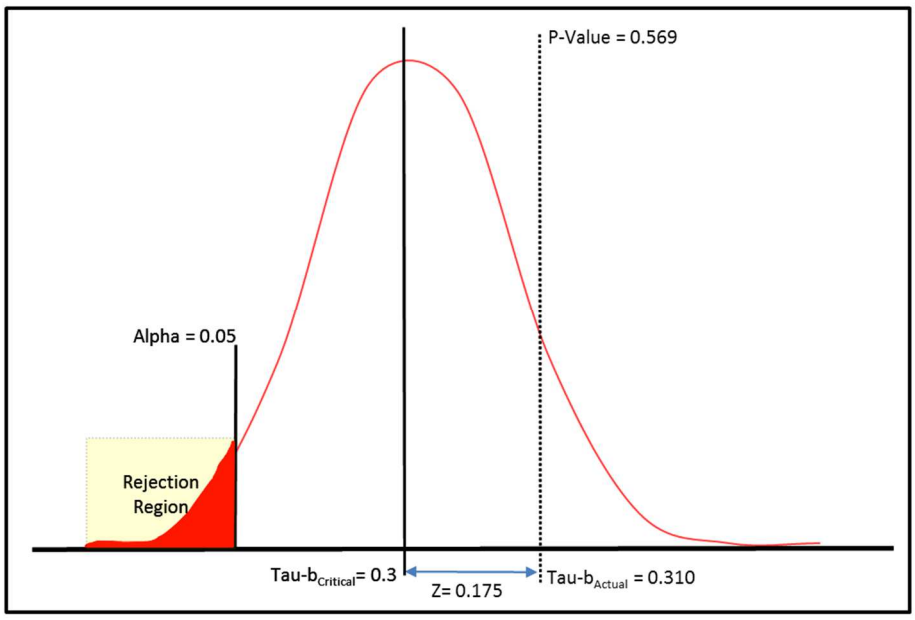

Figure 4-9: Sub-Hypothesis H1g Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.310). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.569) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject

the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project communication management.

4.5.1.8 Sub-Hypothesis H1h

Testing of hypothesis H1h sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1h:

There is a significant positive association between an enterprise-wide KM system and project risk management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project risk management is successful within the participants' organizations is questions 40. Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to

questions 5 through 33 was calculated and then statistically tested against the values of the participant's responses to question 40. Key parameters related to testing this association are shown in Table 4-16 and Figure 4-10.

Table 4-16: Sub-Hypothesis H1h Statistical Analysis

N: 128 Z statistic: -1.402	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.216
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.002 Direction of Association: Positive	p-value (P_s): 0.080 Degree of Association: Moderate
Result: Reject H_0	**Result: Fail to Reject H_0**

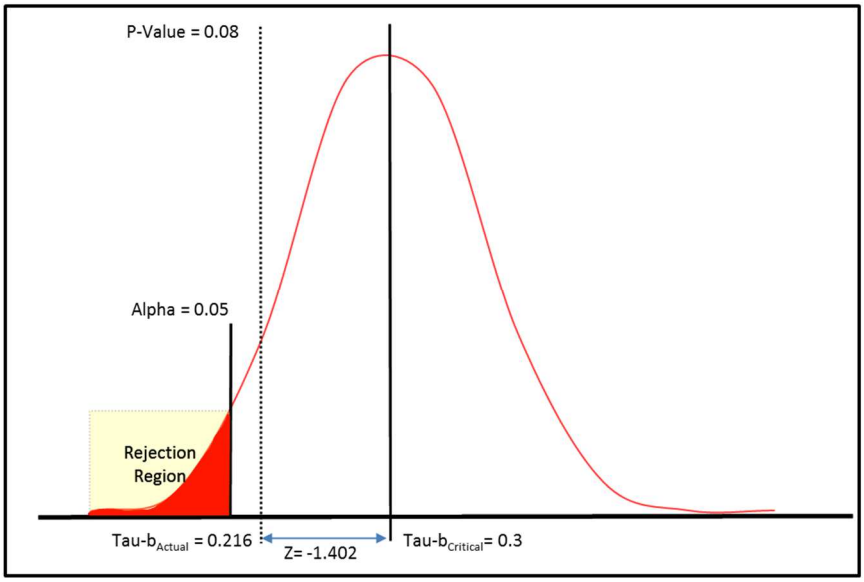

Figure 4-10: Sub-Hypothesis H1h Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.216). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s)

are (0.002) and (0.080) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project risk management.

4.5.1.9 Sub-Hypothesis H1i

Testing of hypothesis H1i sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1i:

There is a significant positive association between an enterprise-wide KM system and project procurement management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project procurement management is successful within the participants' organizations are questions 41.1, 41.2 and 41.3. Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail

approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the median values of the participant's responses to questions 41.1, 41.2 and 41.3. Key parameters related to testing this association are shown in Table 4-17 and Figure 4-11.

Table 4-17: Sub-Hypothesis H1i Statistical Analysis

N: 128 Z statistic: -0.729	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.256
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.233 Degree of Association: Moderate
Result: Reject H_0	**Result: Fail to Reject H_0**

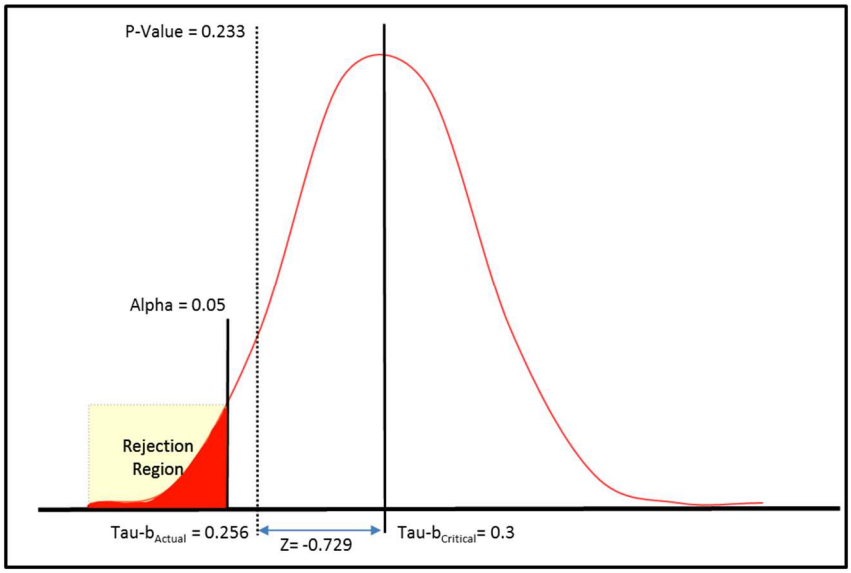

Figure 4-11: Sub-Hypothesis H1i Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.256). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.233) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project procurement management.

4.5.1.10 Sub-Hypothesis H1j

Testing of hypothesis H1j sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H1j:

There is a significant positive association between an enterprise-wide KM system and project stakeholder management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which KM is practiced by the participants and their organizations are: question 5 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which

project stakeholder management is successful within the participants' organizations are questions 39.1, 39.2 and 39.3.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the median values of the participant's responses to questions 39.1, 39.2 and 39.3.

Key parameters related to testing this association are shown in Table 4-18 and Figure 4-12.

Table 4-18: Sub-Hypothesis H1j Statistical Analysis

N: 128 Z statistic: 0.625	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.337
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.734 Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

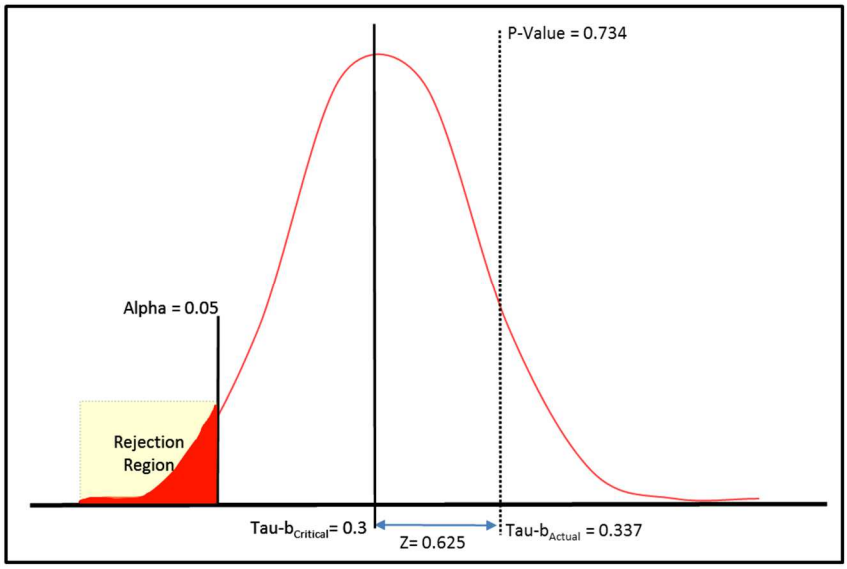

Figure 4-12: Sub-Hypothesis H1j Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.337). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.734) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that there is a significant positive association between an enterprise-wide KM system and project stakeholder management.

4.5.1.11 Ordinal Logistic Regression for Level -1

Ordinal logistic regression in Minitab was used to determine whether a PM knowledge area has a predictive relationship to enterprise-wide KM. To do so, the median value of the participant's responses to questions 5 through 33 was calculated and then statistically tested against the participant's responses to each of the questions 34 through 41 individually. Key parameters related to testing the degree of predictability that each PM knowledge area has on enterprise-wide KM are shown in Table 4-19. Table 4-19 reflects the iteration process of excluded the knowledge area with the highest p-value until only knowledge areas with p-values less than the pre-selected alpha level of 0.05 remained.

Table 4-19: OLR Results for the Effect of PM Knowledge Areas on Enterprise-wide KM

PM Knowledge Area	p-value							
	Run #1	Run #2	Run #3	Run #4	Run #5	Run #6	Run #7	Run #8
Integration	0.528	0.530	0.439	0.479	0.485	0.777	-	-
Scope	0.291	0.262	0.275	0.552	0.542	0.391	0.133	0.117
Time	0.939	-	-	-	-	-	-	-
Cost	0.513	0.474	0.451	0.204	0.131	0.194	0.176	-
Quality	0.824	0.806	-	-	-	-	-	-
Human Resource	0.036	0.036	0.037	0.028	0.024	0.010	0.000	0.000
Stakeholders	0.563	0.565	0.449	0.917	-	-	-	-
Communication	0.277	0.274	0.222	0.060	0.000	0.000	0.000	0.000
Risk	0.476	0.474	0.483	0.613	0.621	-	-	-
Procurement	0.701	0.700	0.687	-	-	-	-	-

The resulting p-values for the ordinal logistic regression analysis, P_r, of project human resource management and project communication management against KM fall below the pre-selected (α) value of 0.05 indicating that both PM knowledge areas are the most predictive PM knowledge areas of KM.

4.5.1.12 Summary of Analysis Results for Level - 1

For level – 1 analysis, testing of hypotheses set 1 sought to determine whether the associations between each PM knowledge area and the entire enterprise-wide KM system are significant. The survey questions used for the 10 hypotheses were structured so that rejecting the null hypotheses for the test of concordance and failing to reject the null hypotheses for the test of (τ_b) significance imply statistically significant positive associations between the PM knowledge areas under study and KM. Rejecting all 10 null hypotheses for the test of concordance and failing to reject all 10 null hypotheses for the test of (τ_b) significance would have suggested in the strongest possible way a significant association between the PM, as explained by PMBOK® GUIDE in its PM knowledge areas, and enterprise-wide KM.

All ten (10) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. However, only seven (7) of the ten (10) hypotheses for the test of (τ_b) significance resulted in failing to reject the null (i.e., hypotheses $H1a_0$, $H1e_0$, $H1f_0$, $H1g_0$, $H1h_0$, $H1i_0$, $H1j_0$). The outcomes of testing the remaining three (3) of the ten (10) hypotheses for the (τ_b) significance resulted in rejecting the null sub-hypotheses $H1b_0$, $H1c_0$ and $H1d_0$.

For the ordinal logistic regression analysis, the analysis was performed to determine

which of the (ten) 10 PM knowledge areas were most predictive of KM. Two (2) of the ten (10) PM knowledge areas resulted in statistically significant results indicating that **project human resource management** and **project communication management** are the most predictive PM knowledge areas of enterprise-wide KM.

4.5.2 Level – 2: Analysis of the Association between the Four KM Pillars and Overall PM

Analysis of the association between each of the four KM pillars and overall project management focused on the statistical testing of four (4) hypotheses intended to determine the existence and the nature of the postulated association. Table 4.20 provides an overview analysis of the testing results of hypotheses set 2. All four (4) hypotheses resulted in rejecting the null hypotheses for the test of concordance and resulted in failing to reject the null hypotheses for the test of (τ_b) significance:

Table 4-20: Research Sub-Hypotheses set 2 Testing Results

KM Pillars	τ_b	P-Value for test of τ_b significance, Ps	P-Value for test of Concordance, Pc
Leadership	0.283	0.389	0.000
Organization	0.314	0.590	0.000
Technology	0.326	0.666	0.000
Learning	0.332	0.705	0.000

The findings of testing and analyzing each of the four hypotheses included in research sub-hypotheses set 2 are as follows:

4.5.2.1 Sub-Hypothesis H2a

Testing of hypothesis H2a sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H2a:

There is a significant positive association between KM leadership pillar and project management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which the tools and processes pertaining to the KM leadership pillar are available and practiced by the participants and their organizations are: questions 5, 6, 7, 8, 9 and 14. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project management is successful within the participants' organizations are questions 34 through 41.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to questions 5, 6, 7, 8, 9 and 14 was calculated and then statistically tested against the median values of the participant's responses to are questions 34 through 41.

Key parameters related to testing this association are shown in Table 4-21 and Figure 4-13.

Table 4-21: Sub-Hypothesis H2a Statistical Analysis

N: 128 Z statistic: -0.283	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.283
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.389 Degree of Association: Moderate
Result: Reject H_0	**Result: Fail to Reject H_0**

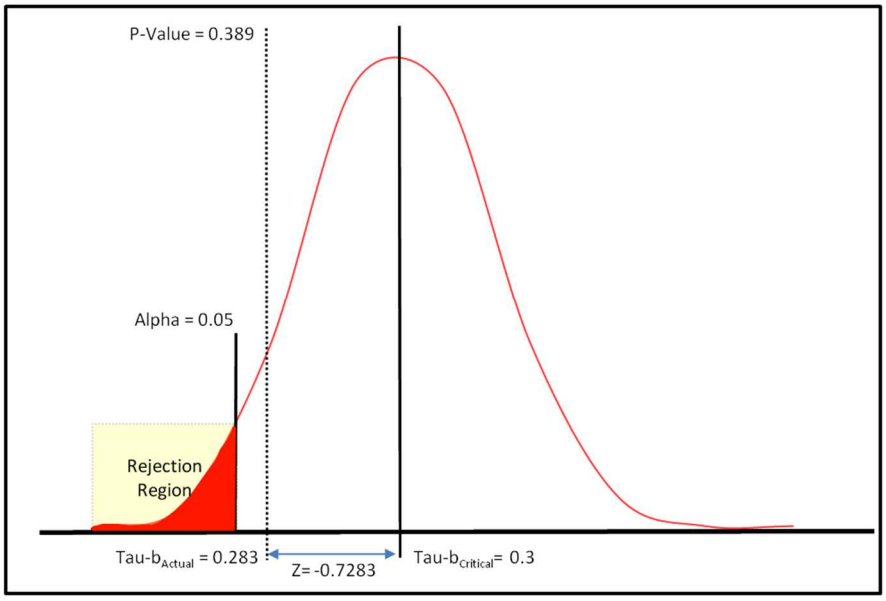

Figure 4-13: Sub-Hypothesis H2a Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.283). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.389) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject

the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that KM leadership pillar has a significant positive association with project management.

4.5.2.2 Sub-Hypothesis H2b

Testing of hypothesis H2b sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H2b:

There is a significant positive association between KM organization pillar and project management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which the tools and processes pertaining to the KM organization pillar are available and practiced by the participants and their organizations are: question 8 through question 14. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project management is successful within the participants' organizations are questions 34 through 41.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to

question 8 through question 14 was calculated and then statistically tested against the median values of the participant's responses to are questions 34 through 41.

Key parameters related to testing this association are shown in Table 4-22 and Figure 4-14.

Table 4-22: Sub-Hypothesis H2b Statistical Analysis

N: 128 Z statistic: 0.228	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.314
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.590 Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

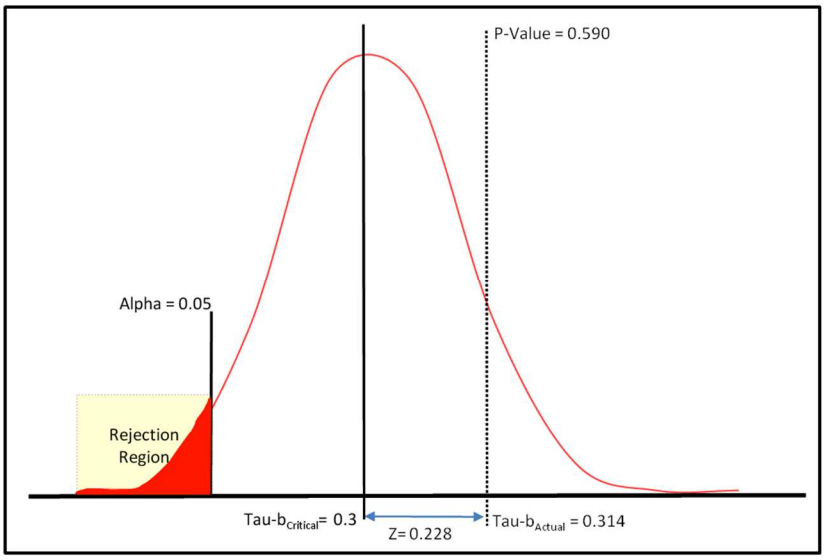

Figure 4-14: Sub-Hypothesis H2b Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.314). Also, the resulting values for

the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.590) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that KM organization pillar has a significant positive association with project management.

4.5.2.3 Sub-Hypothesis H2c

Testing of hypothesis H2c sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H2c:

There is a significant positive association between KM technology pillar and project management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which the tools and processes pertaining to the KM technology pillar are available and practiced by the participants and their organizations are: question 14 through question 25. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project management is successful within the participants' organizations are question 34 through 41.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to

calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to question 15 through question 24 was calculated and then statistically tested against the median values of the participant's responses to are questions 34 through 41. Key parameters related to testing this association are shown in Table 4-23 and Figure 4-15.

Table 4-23: Sub-Hypothesis H2c Statistical Analysis

N: 128 Z statistic: 0.430	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.326
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.666 Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

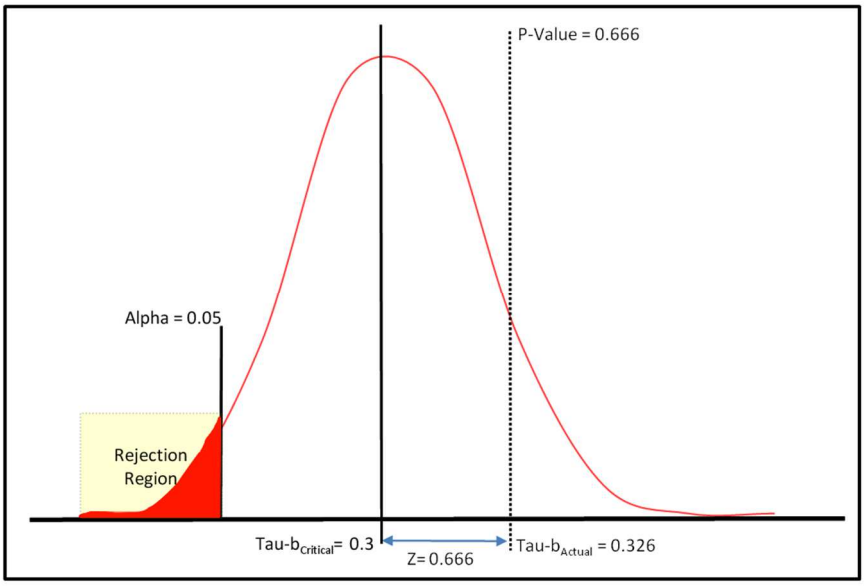

Figure 4-15: Sub-Hypothesis H2c Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.326). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.666) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that KM technology pillar has a significant strong and positive association with project management.

4.5.2.4 Sub-Hypothesis H2d

Testing of hypothesis H2d sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Research Sub-Hypothesis H2d:
There is a significant positive association between KM learning pillar and project management.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which the tools and processes pertaining to the KM learning pillar are practiced by the participants and their organizations are: question 25 through question 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project management is successful within the participants' organizations are question 34 through 41. Using methods

described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to question 25 through question 33 was calculated and then statistically tested against the median values of the participant's responses to are questions 34 through 41. Key parameters related to testing this association are shown in Table 4-24 and Figure 4-16.

Table 4-24: Sub-Hypothesis H2d Statistical Analysis

N: 128 Z statistic: 0.540	Alpha Level (α): 0.05 Kendall's tau-b (τ_b): 0.332
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000 Direction of Association: Positive	p-value (P_s): 0.705 Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

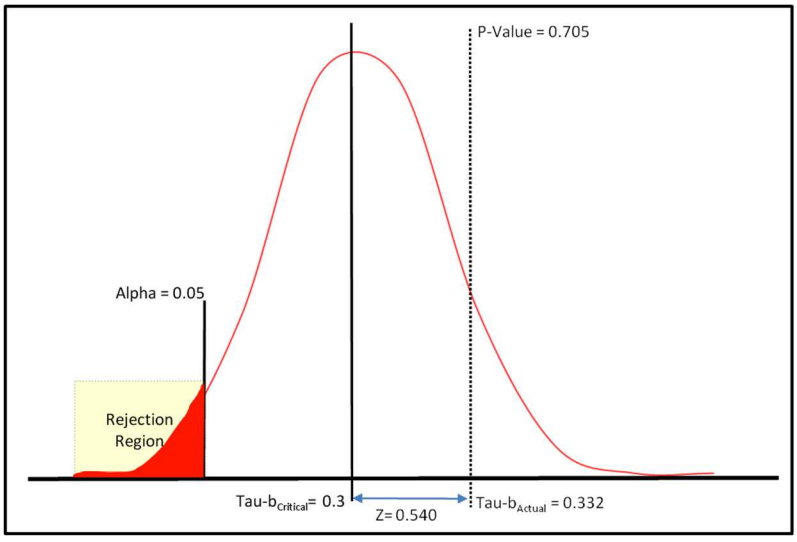

Figure 4-16: Sub-Hypothesis H2d Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.332). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.705) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that KM learning pillar has a significant strong and positive association with project management.

4.5.2.5 Ordinal Logistic Regression for Level -2

The median value of the participant's responses to questions 34 through 41 were calculated and then statistically tested against the median values of the participant's responses to questions representing each KM pillar individually. Key parameters related to testing the effect KM pillars has on PM are shown in Table 4-25.

Table 4-25: OLR Results for the Effect of the Four KM pillars on PM

KM Pillars	p-value	
	Run #1	Run #2
Leadership	0. 110	0. 163
Organization	0. 029	0. 038
Technology	0. 187	0.016
Learning	0. 283	-

Table 4-25 reflects the iteration process of excluded the KM pillar with the highest p-value until only KM pillars with p-values less than the pre-selected alpha level of 0.05 remained. The resulting p-values for the ordinal logistic regression analysis (P_r) of **the organization and technology pillars** against PM fall below the pre-selected (α) value of 0.05 providing sufficient evidence that both the organization and technology pillars are the most predictive KM pillars of PM.

4.5.2.6 Summary of Analysis Results for Level – 2

For level – 2 analyses, testing of sub-hypotheses set 2 sought to determine whether the associations between each of the four KM pillars and overall project management are significant. The survey questions used for the 4 hypotheses were structured so that failing to reject the null hypothesis when testing the significant implies statistically significant associations between each of the four KM pillars and overall project management. Also, rejecting the null hypothesis, while testing the concordance, implies positive associations between each of the four KM pillars and overall project management. All four (4) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. For the test of (τ_b) significance, all four (4) hypotheses resulted in failing to reject the null (i.e., hypotheses $H2a_0$, $H2b_0$, $H2c_0$, $H1d_0$).

For the ordinal logistic regression analysis, analysis sought to determine which of the four (4) KM pillars are most predictive of PM. Two (2) of the four (4) KM pillars resulted in statistically significant results indicating that **the organization and technology pillars** are the most predictive of PM.

4.5.3 Level – 3: Analysis of the Association between Elements of the Four KM Pillars and Overall PM

Analysis of the association between the elements of the Four KM Pillars and PM focused on the statistical testing to determine the existence and the nature of the postulated association. The findings of testing and analyzing each hypothesis included in research sub-hypotheses set 3 sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

General Hypothesis Representing Research Sub-Hypotheses Set 3

There is a significant positive association between an element of a KM Pillar and PM.

4.5.3.1 Leadership – Related KM Elements

Results and survey questions used to assess the extent to which the tools and processes corresponding to leadership–related KM elements are available and practiced by the participants and their organizations are shown in table 4-26.

Table 4-26: Correlations between Leadership–Related KM Elements and PM

Leadership – Related KM Elements	Survey Question	τ_b	P-Value for Test of τ_b significance	P-Value for Test of Concordance
The organization's executive management commitment to managing knowledge that is acquired or created during project periods	Q5	0.382	0.915	0.000

Table 4-26: Correlations between Leadership–Related KM Elements and PM (cont.)

Leadership – Related KM Elements	Survey Question	τ_b	P-Value for Test of τ_b significance	P-Value for Test of Concordance
The organization's leadership endorsement of developing, publishing and sharing its projects vision, goals and objectives	Q6	0.375	0.895	0.000
Knowledge management roles capability to promote and implement knowledge management programs and processes	Q7	0.209	0.063	0.000
Using performance metrics to measure progress in project activities and project teams' performance.	Q8	0.283	0.388	0.0001
Following through organizations' project strategic plans.	Q9	0.347	0.784	0.000
Reward & Recognition system.	Q14	0.361	0.846	0.000

The resulting values for Kendall's tau-b (τ_b) for the correlations between leadership – related KM elements and PM exhibited (0.209) as the lowest value and (0.382) as the highest value. Also, the resulting values for the p-value for the test of concordance (P_c) fall below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-values for the test of τ_b significance (P_s) fall above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30. Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that all leadership –related

KM elements has a significant positive association with PM.

4.5.3.1.1 Ordinal Logistic Regression for Level -3, (KM Leadership Pillar)

The median value of the participant's responses to 34 through 41 were calculated and then statistically tested against the median values of the participant's responses to questions representing each element of the KM leadership pillar.

Key parameters related to testing the predictive relationship the elements of KM leadership pillars have on PM are shown in Table 4-27. Table 4-27 reflects the iteration process of excluded the KM element with the highest p-value until only KM elements with p-values less than the pre-selected alpha level of 0.05 remained.

Table 4-27: OLR Results for the Effect of Elements of KM Leadership Pillar on PM

Leadership – Related KM Elements	Survey Question	p-value				
		Run #1	Run #2	Run #3	Run #4	Run #5
The organization's executive management commitment to managing knowledge that is acquired or created during project periods	Q5	0.042	0. 046	0.019	0.021	0.033
The organization's leadership endorsement of developing, publishing and sharing its projects vision, goals and objectives	Q6	0.251	0. 253	0.192	0.313	0.307

Table 4-27: OLR Results for the Effect of Elements of KM Leadership Pillar on PM (Cont.)

Leadership – Related KM Elements	Survey Question	p-value				
		Run #1	Run #2	Run #3	Run #4	Run #5
Knowledge management roles capability to promote and implement knowledge management programs and processes	Q7	0. 427	0.416	0.374	0.364	-
Using performance metrics to measure progress in project activities and project teams' performance.	Q8	0. 642	-	-	-	-
Following through organizations' project strategic plans.	Q9	0. 354	0. 308	0.382	-	-
Reward & Recognition system.	Q14	0. 447	0. 518	-	-	-

The resulting p-values for the ordinal logistic regression analysis (P_r) of the degree of predictability that organizations management commitment to KM has on PM falls below the pre-selected (α) value of 0.05 indicating that organizations management commitment to KM is the most predictive amongst the tested elements of the KM leadership pillar.

4.5.3.2 Organization– Related KM Elements

Results and survey questions used to assess the extent to which the tools and processes corresponding to organization–related KM elements are practiced by the participants and their organizations are shown in table 4-28.

Table 4-28: Correlations between Organization–Related KM Elements and PM

Organization – Related KM Elements	Survey Question	τ_b	P-Value for Test of τ_b significance	P-Value for Test of Concordance
Measuring progress in project activities and project teams' performance	Q8	0.284	0.394	0.0001
Following through organizational strategy	Q9	0.347	0.784	0.000
Managing project records through process work-flows	Q10	0.378	0.904	0.000
Process workflows and business processes to rethink (reengineer) how to perform projects	Q11	0.386	0.925	0.000
Project teams understanding of what they need to do in order to achieve the project objectives (Understanding organization strategy)	Q12	0.404	0.959	0.000
Organizational structure	Q13	0.354	0.817	0.000
Reward system and performance evaluation criterion	Q14	0.361	0.846	0.000

The resulting values for Kendall's tau-b (τ_b) for the correlations between organization–related KM elements and PM exhibited (0.284) as the lowest value and (0.404) as the highest value. Also, the resulting values for the p-value for the test of concordance (P_c) fall below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-values for the test of τ_b significance (P_s) fall above the pre-selected (α) value of 0.05 providing insufficient

evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30. Therefore, there is sufficient evidence, at α = 0.05, to conclude that all organization –related KM elements has a significant positive association with PM.

4.5.3.2.1 Ordinal Logistic Regression for Level -3, (KM Organization Pillar)

The median value of the participant's responses to 34 through 41 were calculated and then statistically tested against the median values of the participant's responses to questions representing each element of the KM organization pillar. Key parameters related to testing the predictive relationship the elements of KM organization pillar have on PM are shown in Table 4-29. Table 4-29 reflects the iteration process of excluded the KM element with the highest p-value until only KM elements with p-values less than the pre-selected alpha level of 0.05 remained.

Table 4-29: OLR Results for the Effect of Elements of KM Organization Pillar on PM

Organization – Related KM Elements	Survey Question	p-value					
		Run #1	Run #2	Run #3	Run #4	Run #5	Run #6
Measuring progress in project activities and project teams' performance	Q8	0. 389	0. 422	-	-	-	-
Following through organizational strategy	Q9	0. 285	0. 279	0. 224	0.416	-	-
Managing project records through process work-flows	Q10	0. 537	-	-	-	-	-

Table 4-29: OLR Results for the Effect of Elements of KM Organization Pillar on PM (Cont.)

Organization – Related KM Elements	Survey Question	p-value					
		Run #1	Run #2	Run #3	Run #4	Run #5	Run #6
Process workflows and business processes to rethink (reengineer) how to perform projects	Q11	0. 102	0.053	0.055	0.036	0.051	0.111
Project teams understanding of what they need to do in order to achieve the project objectives (Understanding organization strategy)	Q12	0. 011	0. 008	0. 010	0.010	0.013	0.033
Organizational structure	Q13	0. 227	0. 285	0.224	0.334	0.180	-
Reward system and performance evaluation criterion	Q14	0.196	0.162	0.227	-	-	-

The resulting p-values for the ordinal logistic regression analysis (P_r) of the effect that project teams understanding of their organization strategy has on PM falls below the pre-selected (α) value of 0.05 indicating that project teams understanding of their organization strategy is the most predictive amongst the tested elements of the KM organization pillar.

4.5.3.3 Technology– Related KM Elements

Results and survey questions used to assess the extent to which the tools and processes corresponding to technology–related KM elements are practiced by the participants and their organizations are shown in table 4-30.

Table 4-30: Correlations between Technology–Related KM Elements and PM

Technology – Related KM Elements	Survey Question	τ_b	P-Value for Test of τ_b significance	P-Value for Test of Concordance
Synchronous Communications (Discussion boards, instant messaging, application and screen sharing, video and audio conferencing, telephone)	Q15	0.414	0.971	0.000
Asynchronous Communications (e-mail, message broadcasting)	Q16	0.350	0.798	0.000
Collaborative services (Electronic calendar, task management, voting survey and polling)	Q17	0.371	0.882	0.000
Intranet (e.g. SharePoint, company portal, etc.)	Q18	0.379	0.907	0.000
Document control and data management systems	Q19	0.333	0.709	0.000
Project management system to schedule, track, and chart the steps in a project as it is being completed	Q20	0.311	0.573	0.000
Communities of practice	Q21, 33	0.390	0.934	0.000
Data warehouse system	Q22	0.376	0.898	0.000
Integrating new technologies with legacy systems to manage new forms of knowledge that are acquired during project	Q23	0.290	0.433	0.000
Expert directories to help identify experts	Q24	0.358	0.834	0.000

The resulting values for Kendall's tau-b (τ_b) for the correlations between technology – related KM elements and PM exhibited (0.290) as the lowest value and (0.414) as the

highest value. Also, the resulting values for the p-value for the test of concordance (P_c) fall below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-values for the test of τ_b significance (P_s) fall above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that all technology – related KM elements has a significant positive association with PM.

4.5.3.3.1 Ordinal Logistic Regression for Level -3, (KM Technology Pillar)

The median value of the participant's responses to 34 through 41 were calculated and then statistically tested against the median values of the participant's responses to questions representing each element of the KM technology pillar.

Key parameters related to testing the predictive relationship the elements of KM technology pillar have on PM are shown in Table 4-31.

Table 4-31: OLR Results for the Effect of Elements of KM Technology Pillar on PM

Technology – Related KM Elements	Survey Question	p-value							
		Run#1	Run#2	Run#3	Run#4	Run#5	Run#6	Run#7	Run#8
Synchronous Communications (Discussion boards, inst. messaging, screen sharing, video & audio conferencing, telephone)	Q15	0.073	0. 072	0.056	0. 057	0. 045	0. 039	0.059	0.056

Table 4-31: OLR Results for the Effect of Elements of KM Technology Pillar on PM (Cont.)

Technology – Related KM Elements	Survey Question	p-value							
		Run#1	Run#2	Run#3	Run#4	Run#5	Run#6	Run#7	Run#8
Asynchronous Communications (e-mail, message broadcasting)	Q16	0.287	0. 284	0.056	0. 291	0. 341	-	-	-
Collaborative services (Electronic calendar, task management, voting & polling)	Q17	0.833	0. 850	-	-	-	-	-	-
Intranet (e.g. SharePoint, company portal, etc.)	Q18	0.102	0. 098	0.067	0. 040	0. 054	0. 097	0.095	-
Document control & data management syst.	Q19	0.143	0. 146	0. 145	0. 158	0. 202	0. 169	-	-
Project management system to schedule, track, and chart the steps in a project	Q20	0.880	-	-	-	-	-	-	-
Communities of practice	Q21, 33	0.022	0. 022	0. 020	0. 008	0. 004	0. 005	0.013	0.003
Data warehouse system	Q22	0.331	0. 331	0. 319	0. 328	-	-	-	-
Integrating new technologies with legacy systems to manage knowledge	Q23	0.054	0. 052	0. 051	0. 049	0. 068	0. 073	0.043	0.102
Expert directories to help identify experts	Q24	0.782	0. 788	0. 781	-	-	-	-	

Table 4-31 reflects the iteration process of excluded the KM element with the highest p-value until only KM elements with p-values less than the pre-selected alpha level of 0.05 remained.

The resulting p-value for the ordinal logistic regression analysis (P_r) of the degree of predictability that Communities of practice (CoP) have on PM falls below the pre-selected (α) value of 0.05 indicating that Communities of practice (CoP) is the most predictive amongst the tested elements of the KM technology pillar.

4.5.3.4 Learning – Related KM Elements

Results and survey questions used to assess the extent to which the tools and processes corresponding to learning–related KM elements are practiced by the participants and their organizations are shown in table 4-32.

Table 4-32: Correlations between Learning–Related KM Elements and PM

Learning – Related KM Elements	Survey Question	τ_b	P-Value for Test of τ_b significance	P-Value for Test of Concordance
Organization's encouragement of project workers to acquire and share project related knowledge	Q25	0.353	0.812	0.000
Trust and collaboration between project team members in an organization to complete their tasks	Q26	0.274	0.331	0.0002
Financial and technological support provided by an organization for project workers to keep pace with changes and technology advancement in their area of expertise	Q27	0.352	0.808	0.000
Education opportunities and training programs provided by the organization in order to build project workers competencies	Q28	0.426	0.982	0.000

Table 4-32: Correlations between Learning–Related KM Elements and PM (Cont.)

Learning – Related KM Elements	Survey Question	τ_b	P-Value for Test of τ_b significance	P-Value for Test of Concordance
Understanding Tacit & Explicit knowledge language	Q29	0.289	0.426	0.0001
Learning from fellow co-workers during projects	Q30	0.377	0.901	0.000
Learning from the explicit knowledge that is made available by the organization for all workers (e.g. Manuals, documents, etc.)	Q31	0.254	0.220	0.0005
Communicating and sharing knowledge among project team members that are at different project sites (e.g. Virtual Teams)	Q32	0.346	0.779	0.000
Face-to-face and Internet-based Communities of Practice	Q21, 33	0.390	0.934	0.000

The resulting values for Kendall's tau-b (τ_b) for the correlations between learning – related KM elements and PM exhibited 0.254 as the lowest value and 0.426 as the highest value. Also, the resulting values for the p-value for the test of concordance (P_c) fall below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-values for the test of τ_b significance (P_s) fall above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that all learning – related KM elements has a significant positive correlation with PM.

4.5.3.4.1 Ordinal Logistic Regression for Level -3, (KM Learning Pillar)

The median value of the participant's responses to 34 through 41 was calculated and then statistically tested against the median values of the participant's responses to questions representing each element of the KM learning pillar.

Key parameters related to testing the predictive relationship the elements of KM learning pillar have on PM are shown in Table 4-33. Table 4-33 reflects the iteration process of excluded the KM element with the highest p-value until only KM elements with p-values less than the pre-selected alpha level of 0.05 remained.

Table 4-33: OLR Results for the Effect of Elements of KM Learning Pillar on PM

Learning – Related KM Elements	Survey Question	P-value						
		Run#1	Run#2	Run#3	Run#4	Run#5	Run#6	Run#7
Organization's encouragement of project workers to acquire and share project related knowledge	Q25	0. 041	0. 032	0. 029	0. 020	0. 011	0. 018	0. 025
Trust and collaboration between project team members in an organization to complete their tasks	Q26	0. 775	0. 735	-	-	-	-	-
Financial & technological support provided by organizations for workers to keep pace with changes & tech. advancement	Q27	0. 209	0. 194	0. 202	0. 238	0. 281	-	-

Table 4-33: OLR Results for the Effect of Elements of KM Learning Pillar on PM (Cont.)

Learning – Related KM Elements	Survey Question	P-value						
		Run#1	Run#2	Run#3	Run#4	Run#5	Run#6	Run#7
Education opportunities and training prog. provided by the organization to build workers competencies	Q28	0. 370	0. 345	0. 322	0. 315	-	-	-
Understanding Tacit & Explicit knowledge language	Q29	0. 187	0. 191	0. 193	0. 208	0. 256	0. 195	-
Learning from fellow co-workers during projects	Q30	0. 430	0. 454	0. 460	-	-	-	-
Learning from the explicit knowledge that is made available by the organization (e.g. Manuals, documents)	Q31	0. 034	0. 033	0. 032	0. 040	0. 040	0. 028	0. 024
Communicating & sharing knowledge among project team members at different sites (e.g. Virtual Teams)	Q32	0. 803	-	-	-	-	-	-
Face-to-face and Internet-based Communities of Practice	Q21, 33	0. 011	0. 009	0. 007	0. 002	0. 000	0. 000	0. 000

The resulting p-values for the ordinal logistic regression analysis (P_r) of the degree of predictability that three learning-related KM elements have on PM (encouragement of project workers to acquire and share project related knowledge, learning from the explicit knowledge that is made available by the organization, Communities of Practice) fall below the pre-selected (α) value of 0.05 indicating that these elements are the most predictive amongst the tested elements of the KM learning pillars.

4.5.3.5 Summary of Results for Level – 3 Analysis

For level – 3 analysis, testing of the research sub-hypothesis sought to determine the significance and the nature of the association between the elements of the Four KM Pillars and PM. The 32 survey questions used for the research sub-hypothesis set 3 were structured so that rejecting the null hypothesis for the test of concordance, and failing to reject the null hypothesis for the test of τ_b significance imply statistically significant associations between enterprise-wide KM and overall project management.

All thirty-two (32) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. For the test of (τ_b) significance, all thirty-two (32) hypotheses resulted in failing to reject the null.

For the ordinal logistic regression analysis, testing sought to determine which elements of KM are most predictive of PM. The KM elements that are most predictive of PM are as follows:

1- KM Leadership Pillar:
    a. Organizations management commitment to KM.
2- KM Organization Pillar:
    a. Project teams understanding of their organization strategy.
3- KM Technology Pillar:
    a. Communities of Practice.
4- KM Learning Pillar:
    a. Encouragement of project workers to acquire and share project related knowledge,
    b. Learning from the explicit knowledge available by the organization.
    c. Communities of Practice.

4.5.4 Level – 4: Analysis of the Association between KM and PM

Analysis of the association between KM and PM focused on the statistical testing of main research hypothesis intended to determine the existence and the nature of the postulated association. The findings of testing and analyzing the main research hypotheses are as follows:

4.5.4.1 Main Research Hypothesis (Hr)

Testing of hypothesis Hr sought to determine whether the analysis of the data collected for the related survey questions supported a reason for accepting the claim:

Main Research Hypothesis Hr:

There is a significant positive association between an enterprise-wide KM system and PM.

Based on the elements of the Four KM Pillars presented in Table 2-1, the survey questions used to assess the extent to which the tools and processes pertaining to the Four KM Pillars are practiced by the participants and their organizations are questions 5 through 33. Also, based on the performance measures presented in Table 2-2, the survey questions used to assess the extent to which project management is successful within the participants' organizations are questions 34 through 41.

Using methods described in chapter 3, Cross Tabulation in Minitab was performed to calculate (τ_b) and (P_c). A normal distribution one-tail approximation was used to test the significance of (τ_b) and to decide whether hypothesis H_0 should or should not be rejected in favor of its alternative H_a. To do so, the median value of the participant's responses to question 5 through question 33 was calculated and then statistically tested against the

median values of the participant's responses to are questions 34 through 41.

Key parameters related to testing this association are shown in Table 4-34 and Figure 4-17.

Table 4-34: Hypothesis Hr Statistical Analysis

N: 128	Alpha Level (α): 0.05
Z statistic: 0.502	Kendall's tau-b (τ_b): 0.330
Test of Concordance	**Test of τ_b Significant**
p-value (P_c): 0.000	p-value (P_s): 0.692
Direction of Association: Positive	Degree of Association: Strong
Result: Reject H_0	**Result: Fail to Reject H_0**

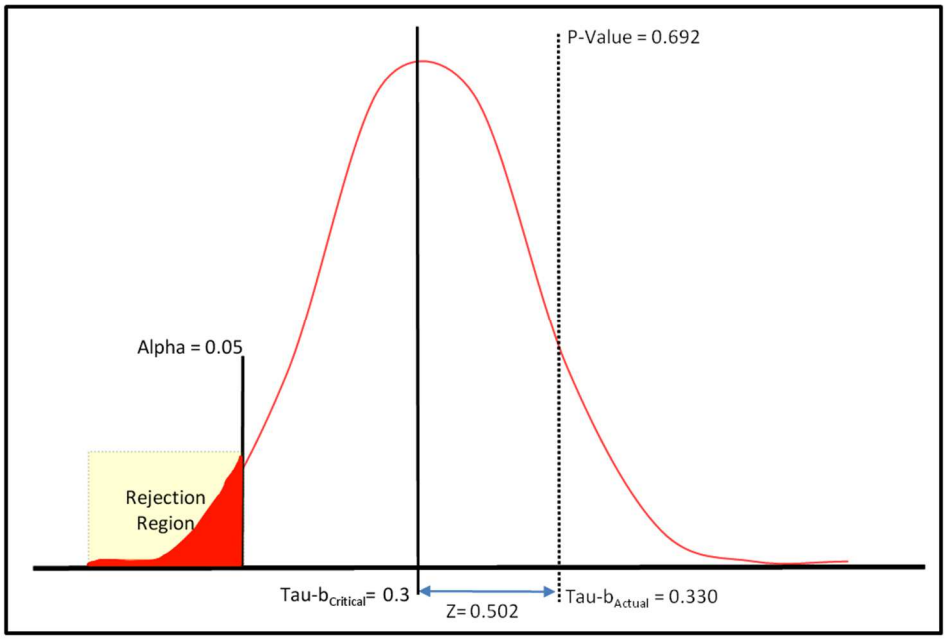

Figure 4-17: Sub-Hypothesis Hr Test of statistical significance

The resulting value for Kendall's tau-b (τ_b) is (0.330). Also, the resulting values for the p-value for the test of concordance (P_c) and the p-value for the test of significance (P_s) are (0.000) and (0.692) consecutively. As such, the p-value for the test of concordance (P_c) falls below the pre-selected (α) value of 0.05 providing sufficient evidence to reject the null H_0 in favor of the alternative that the probability of concordance does not equal the probability of discordance. P-value for the test of significance (P_s) falls above the pre-selected (α) value of 0.05 providing insufficient evidence to reject the null H_0 and assuming that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30.

Therefore, there is sufficient evidence, at $\alpha = 0.05$, to conclude that enterprise-wide KM has a significant positive association with project management.

4.5.4.2 Summary of Results for Level – 4 Analysis

For level – 4 analysis, testing of the main research hypothesis sought to determine whether the association between enterprise-wide KM, represented in the four KM pillars, and overall project management is significant. The survey questions used for the main research hypothesis were structured so that failing to reject the null hypothesis implies statistically significant associations between enterprise-wide KM and overall project management.

The outcomes of testing the main research hypothesis (Hr) strongly suggest a significant positive association between KM (as described with Stankosky's Four Enterprise Engineering KM Pillars) and PM (as acknowledged by the Project Management Institute (PMI).

4.6 A Summary of Chapter Four

The objectives of Chapter 4 were as follows:

1) Examine and analyze results from the administered research survey questions. The analysis included descriptive statistics of survey questions results.
2) Statistically test the research survey results to measure the significance, degree and the nature of the association between KM and PM at several aggregate levels described in chapter 3 in details. The statistical testing included testing of the postulated hypotheses to determine whether they should be rejected or accepted.
3) As stated earlier in chapter 3, association does not necessarily imply causation. As such, testing the association does not prove that effective KM causes successful PM. In order to draw a more reliable predictive conclusion from the data, ordinal logistic regression was used to test the research survey results to determine which pillars and which elements of the KM pillars are most predictive of PM success, and to analyze how well PM performance and the performance of the 10 PM knowledge areas are predicted by the management of project knowledge using the tools and processes defined by the elements of the four pillars of KM, and
4) Layout the findings and report the statistical analysis results.

Section (4.5.1.1 through 4.5.1.10) shows the results for the statistical analysis of hypotheses set 1 and investigating the association between enterprise-wide KM and each one of the ten PM knowledge areas using Kendall's tau-b (τ_b), as well as the p-value for the test of concordance (P_c) and p-value for the test of τ_b significance (P_s). The results suggest significant, strong, and positive associations between enterprise-wide KM and project integration management, human resource management, communication management, and stakeholder management. For project quality, risk, and procurement

management, the results suggest a significant, moderate, and positive correlation with enterprise-wide KM, while results suggest insignificant, weak, yet positive associations between enterprise-wide KM and project scope, time, and cost management. Section (4.5.1.11) also shows the results for the statistical analysis to determine which of the 10 PM knowledge areas are most predictive of KM. Using p-values for the ordinal logistic regression analysis, Pr, results suggest that project human resource management and project communication management are the PM knowledge areas most predictive of enterprise-wide KM.

Section (4.5.2.1 through 4.5.2.4) shows the results for the statistical analysis of hypotheses set 2 and investigating the association between the aggregate measure of overall PM and each of the four KM pillars using Kendall's tau-b (τ_b), as well as the p-value for the test of concordance (P_c) and p-value for the test of τ_b significance (P_s). The results suggest that all four pillars of KM, Leadership, Technology, Organization, and Learning, have significant, strong, and positive correlation with PM. However, results for the statistical analysis to determine which of the four KM pillars are most predictive of PM suggest, using p-values for the ordinal logistic regression analysis, Pr, that KM technology pillar and organization pillar are the most predictive of PM.

From the perspective of considering the elements relating to the four KM pillars as success elements and how PM success improves as KM improves, understanding the association between these elements and PM enables the estimation of how each of these elements associate with project management success and project success. As an example, a negative association between a given element of KM and a PM performance measure indicates that the element may be an obstacle to project success, while a positive

association indicates that it may be a facilitator, or enabler, of PM success.

In order to obtain an insight on the degree and the nature of the association between the elements relating to the four KM pillars and PM, section (4.5.3) shows the results for the statistical analysis of the association between each element of the Four KM Pillars and overall PM. Using Kendall's tau-b (τ_b), as well as the p-value for the test of concordance (P_c) and p-value for the test of τ_b significance (P_s). The results suggest that all 32 elements included in this study as elements of the four pillars of KM, Leadership, Technology, Organization, and Learning, have significant, strong, and positive association with PM. These results do not imply causation. Therefore, ordinal logistic regression was used and the results suggest that the KM elements that are most predictive of PM are; organizations management commitment to KM, project teams understanding of their organization strategy, communities of Practice, encouragement of project workers to acquire and share project related knowledge, and learning from the explicit knowledge that is made available by the organization.

For the analysis of the association between KM and PM described in section (4.5.4), results for the statistical analysis of the main research hypothesis at aggregate level – 4 suggest that KM had a significant, strong, and positive association with PM. It is interesting to note that the correlation between enterprise-wide KM and the overall PM, as shown in Table 4-28, is among the strongest of those that are between overall PM and each of the four enterprise KM pillars individually, as was shown in Table 4-19.

Chapter 5 - Conclusion and Discussion

"Fit no stereotypes. Don't chase the latest management fads. The situation dictates which approach best accomplishes the team's mission. "

- Colin Powell

5.1 Chapter Overview

This chapter recapitulates the study's contributions, conclusions, and suggestions for future research. Initially, chapter 5 summaries the important elements and approaches by which the execution of this research effort was based upon. Further, chapter 5 summarizes the results of the dissertation's statistical testing used to measure the significance, degree and the nature of the association between KM and PM at the aggregate levels described earlier in chapter 3. Moreover, chapter 5 identifies factors and aspects other than the independent variable that may have inclined the results of the dissertation. Finally, chapter 5 links findings of the dissertation literature review with findings made during the dissertation statistical analysis in order to offer suggestions for future research efforts in relation to the association between all KM and PM.

5.2 Research Main Elements and Approaches

Based on accepted research methodology referenced in this dissertation, review of available literature was performed and data collected using a survey questionnaire. The findings from the review of literature in conjunction with the analysis of results from administering the survey questionnaire are leveraged to arrive at the dissertation's conclusions. Reassertion of the dissertation's main elements and approaches as follows:

5.2.1 Summary of Problem Statement

As stated in the study's literature review, the percentage of challenged and failed projects is significant and requires further research to understand project success and failure in order to improve the tools and processes by which projects are managed (Standish Group International, 2013). In the last twenty years, knowledge has become one of the most valuable organizational assets (Anantatmula, 2005), and researchers have recognized methods to protect and utilize project knowledge. However, today's recognized PM methods do not sufficiently include the required KM processes to derive highest value from project investment (Haddad & Ribie`re, 2007; Lierni & Ribière, 2008). Therefore, based on the association analysis of KM and PM conceptual and operational element, reflecting the four KM pillars and PM knowledge areas captured in Figure 3-1, the main problem addressed by this dissertation was the lack of a comprehensive approach to include the necessary KM tools and processes in the management of projects in order to derive highest value from project investment.

5.2.2 Objective of this Research

As illustrated in the previous chapters, the objective of this study was two-fold. Through review of literature, this research first sought to highlight the significance of the inclusion of the different elements of KM in the project environment with the intention of determining potential gaps in the literature carried out in the area of research. It then aimed to focus on how the four KM pillars (Leadership, Organization, Technology, and Learning) are related to PM knowledge areas (project integration, scope, time, cost, quality, human resources, communication, risk, procurement, and stakeholder management) through testing and analysis of data resulted from administering research

survey questions. The statistical analysis sought to measure the significance, degree and the nature of the relationship between all KM and PM at several aggregate levels described in details in chapter 3.

5.3 Research Contribution

The contribution of this research may be looked at from two perspectives; academic and operational. The results and findings of this research contribute to the body of knowledge by promoting the concept of integrating KM and PM for the purpose of improving projects outcomes. Building upon existing literature and based on the information provided by subject matter researchers and experts like Berteaux and Javernick-Will (2015), Davenport (2013), Davenport and Prusak (2000), Haddad and Ribie`re (2007), Ho (2009), Hu and He (2008), Javernick-Will and Levitt (2009), Javernick-Will and Hartmann (2011), Karlsen and Gottschalk (2004), Landaeta (2008), Lierni and Ribière (2008), Newell (2004), Rus and Lindvall (2002), Waters and Beruvides (2012), Waters and Beruvides (2012), and Waters and Beruvides (2012), all of whom support the importance of leveraging KM tools and processes to improve the outcome of projects, this study attempts to investigate the assumption that the management of projects improves as knowledge acquired or created during projects is increasingly managed.

The findings from this study can help practicing engineering managers and project managers to understand the relationship between KM on PM. It also contributes to the body of knowledge and provides practitioners with an overview of how project management success may be associated with effective management of project knowledge (Oun, Blackburn, Olson, & Blessner, 2016). The results of this study imply that effective

use of KM processes and activities are associated with increasing levels of PM success. The study did not find that every KM pillar or element related to the four KM pillars had an equally significant strong association with PM knowledge areas nor did it find that every KM pillar or element related to the four KM pillars had an equally significant predictive relationship with PM and the PM knowledge areas. However, the results highlight the importance of an all-inclusive KM approach to PM that involves people who use the right KM tools and processes and perform project activities under visionary and KM- committed leadership (Oun, Blackburn, Olson, & Blessner, 2016).

Thus, the value of this study to engineering and project managers is that success in managing projects may be influenced by the approach by which project knowledge is managed.

5.4 Conclusion Reached on the Basis of Statistical Analysis

The study's conclusion that was reached on the basis of statistical analysis is twofold:

1) **Conclusion based on the statistical analysis to investigate the association between responses of the survey measurement questions using Kendall's tau-b correlation coefficient, τb, as the appropriate nonparametric measure of association.**

In this section, the research sub-hypothesis receiving "NO" answer when asking the question (Is the Association Significant and Positive?) represents the statistical proof that there is NO significant association between the variables under study. Whereas, the research sub-hypothesis receiving "YES" answer when asking the same question represents the statistical proof that there is a significant association between the variables under study. For the p-value for the test of concordance (P_c), the decision to reject the null hypothesis when testing concordance demonstrated statistically insignificant

evidence suggesting that that the probability of concordance does not equal the probability of discordance. For the p-value for the test of τ_b significance (P_s) the decision not to reject the null hypothesis when testing τ_b significance demonstrated statistically insignificant evidence suggesting that (τ_b) is equal to or greater than the minimum acceptable (τ_b) value of 0.30. Based on the statistical analysis of the survey results, the author anticipated that the association between KM and PM at the aggregate levels 2, 3, and 4, as described in details in Chapter 3, would be found statistically significant between all variable under study. For the statistical analysis at the aggregate level 1, the association between KM and seven (7) out of ten (10) PM knowledge areas, namely, project integration management, quality management, risk management, human resource management, communication management, procurement management, and stakeholder management, would be found statistically significant, while results suggest an insignificant, weak, yet positive association between KM and (3) out of the ten (10) PM knowledge areas, namely, project scope management, time management, and cost management.

2) Conclusion based on the statistical analysis to infer the existence and magnitude of the predictive relationships using ordinal logistic regression (OLR).

For the p-value for the ordinal logistic regression analysis, Pr, p-values less than alpha of 0.05 of each remaining elements and factors and the overall analysis indicate a predictive relationship between the factors and the response variables. Based on the ordinal logistic regression analysis of the survey results, the author found that the predictive relationship with KM at the aggregate level 1 as described in details in Chapter 3, was statistically significant for two (2) of the ten (10) PM knowledge areas. The results

suggest that **project human resource management** and **project communication management** are the PM knowledge areas most predictive of enterprise-wide KM. For the ordinal logistic regression analysis at the aggregate level 2 as described in details in Chapter 3, the author found that the predictive relationship with PM was statistically significant for two (2) of the four (4) KM pillars. The results suggest that **organization and technology pillars** are the KM pillars most predictive of PM. For the ordinal logistic regression analysis at the aggregate level 3 as described in details in Chapter 3, the author found that the predictive relationship with PM was statistically significant for several KM elements. The results suggest that the KM elements most predictive of PM are; **organizations management commitment to KM, project teams understanding of their organization strategy, communities of Practice, encouragement of project workers to acquire and share project related knowledge, and learning from the explicit knowledge that is made available by the organization.**

Conclusion summary of the statistical analysis described in Chapter 4 for all aggregate levels are as follows:

5.4.1 Level – 1: Analysis of the relationship between Enterprise-wide KM and Each PM Knowledge Areas

5.4.1.1 Analysis of the Association between Enterprise-wide KM and Each PM Knowledge Areas

Research sub-hypotheses set 1 focused on determining the association between each PM knowledge area and the entire enterprise-wide KM system through the statistical testing of ten (10) sub-hypotheses as illustrated in Table 5-1. All ten (10) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. However, only

seven (7) of the ten (10) hypotheses for the test of (τ_b) significance resulted in failing to reject the null (i.e., hypotheses $H1a_0$, $H1e_0$, $H1f_0$, $H1g_0$, $H1h_0$, $H1i_0$, $H1j_0$).

Table 5-1: Analysis of Sub-Hypotheses Set 1

Research Sub-Hypotheses		Significant Positive Association?
H1a:	There is a significant positive association between enterprise-wide KM system and project integration management	**YES**
H1b:	There is a significant positive association between enterprise-wide KM system and project scope management	**NO**
H1c:	There is a significant positive association between enterprise-wide KM system and project time management	**NO**
H1d:	There is a significant positive association between enterprise-wide KM system and project cost management	**NO**
H1e:	There is a significant positive association between enterprise-wide KM system and project quality management	**YES**
H1f:	There is a significant positive association between enterprise-wide KM system and project human resource management	**YES**
H1g:	There is a significant positive association between enterprise-wide KM system and project communication management	**YES**
H1h:	There is a significant positive association between enterprise-wide KM system and project risk management	**YES**
H1i:	There is a significant positive association between enterprise-wide KM system and project procurement management	**YES**
H1j:	There is a significant positive association between enterprise-wide KM system and project stakeholder management	**YES**

Therefore, the outcomes of testing sub-hypotheses set 1 strongly suggest significant positive association between enterprise-wide KM and project integration, quality, human

resource, communication, risk, procurement and stakeholder management. The outcomes of testing the remaining three (3) of the ten (10) hypotheses for (τ_b) significance resulted in rejecting the null sub-hypotheses $H1b_0$, $H1c_0$ and $H1d_0$ suggesting No significant association between enterprise-wide KM and project scope, time and cost management.

5.4.1.2 Analysis of the predictive relationship between Enterprise-wide KM and Each PM Knowledge Areas

This section focused on determining the predictive relationship between each PM knowledge area and the entire enterprise-wide KM system through the statistical testing of ten (10) statements as illustrated in Table 5-2.

Table 5-2: Ordinal Logistic Regression Analysis for Level-1

Research Statement	Predictive?
Project integration management has a predictive relationship with enterprise-wide KM system	**NO**
Project scope management has a predictive relationship with enterprise-wide KM system	**NO**
Project time management has a predictive relationship with enterprise-wide KM system	**NO**
Project cost management has a predictive relationship with enterprise-wide KM system	**NO**
Project quality management has a predictive relationship with enterprise-wide KM system	**NO**
Project human resource management has a predictive relationship with enterprise-wide KM system	**YES**
Project communication management has a predictive relationship with enterprise-wide KM system	**YES**

Table 5-2: Ordinal Logistic Regression Analysis for Level-1 (Cont.)

Research Statement	Predictive?
Project risk management has a predictive relationship with enterprise-wide KM system	**NO**
Project procurement management has a predictive relationship with enterprise-wide KM system	**NO**
Project stakeholder management has a predictive relationship with enterprise-wide KM system	**NO**

The outcomes of the ordinal logistic regression analysis for level-1 suggest that two (2) of the ten (10) PM knowledge areas were significant, suggesting that project human resource management and project communication management are the most predictive PM knowledge areas of enterprise-wide KM. However, the remaining seven (7) of the ten (10) statements did not indicate a predictive relationship with the data available.

5.4.2 Level – 2: Analysis of the Relationship between the Four KM Pillars and Overall PM

5.4.2.1 Analysis of the Association between the Four KM Pillars and Overall PM

Research sub-hypotheses set 2 focused on determining the association between the four KM pillars and overall PM through the statistical testing of four (4) sub-hypotheses as illustrated in Table 5-3.

Table 5-3: Analysis of Hypotheses Set 2

Research Sub-Hypotheses		Significant Positive Association?
H2a:	There is a significant positive association between KM leadership pillar and project management	**YES**
H2b:	There is a significant positive association between KM organization pillar and project management	**YES**
H2c:	There is a significant positive association between KM technology pillar and project management	**YES**
H2d:	There is a significant positive association between KM learning pillar and project management	**YES**

All four (4) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. For the test of (τ_b) significance, all four (4) hypotheses resulted in failing to reject the null. Therefore, the outcomes of testing hypotheses set 2 suggest in the strongest possible way a significant positive association between each of Stankosky's Four Enterprise Engineering KM Pillars and the PM (as acknowledged by the PMI).

5.4.2.2 Analysis of the predictive relationship between the Four KM Pillars and Overall PM

This section focused on determining the predictive relationship between the four KM pillars and overall PM through the statistical testing of four (4) statements as illustrated in Table 5-4.

Table 5-4: Ordinal Logistic Regression Analysis for Level-2

Research Statement	Predictive?
KM leadership pillar is predictive of project management	**NO**
KM organization pillar is predictive of project management	**YES**
KM technology pillar is predictive of project management	**YES**
KM learning pillar is predictive of project management	**NO**

The outcomes of the ordinal logistic regression analysis for level-2 suggest that two (2) of the four (4) KM pillar were significant, indicating that **organization and technology pillars** are the most predictive of PM. However, the remaining two (2) of the four (4) statements did not indicate a predictive relationship with the data available.

5.4.3 Level – 3: Analysis of the Relationship between Elements of the Four KM Pillars and Overall PM

5.4.3.1 Analysis of the Association between Elements of the Four KM Pillars and Overall PM

Analysis of the association between the elements of the Four KM Pillars and PM focused on the statistical testing of each element of the four KM pillars against PM to determine the existence and the nature of the postulated association. Tables 5-5 through 5-8 provide results of investigating the significance and the nature of the association.

As shown in Table 5-5, all six (6) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. For the test of (τ_b) significance, all six (6)

hypotheses resulted in failing to reject the null. Therefore, the outcomes of testing leadership–related research sub-hypotheses suggest in the strongest possible way a significant positive association between the leadership–related KM elements of the Four KM Pillars and PM.

Table 5-5: Analysis of Hypotheses Set 3 (Leadership –Related KM Elements)

Survey Question #	Leadership – Related Research Sub-Hypotheses	Significant Positive Association?
Q5	There is a significant positive association between PM and the organization's executive management commitment to managing knowledge that is acquired or created during project periods	**YES**
Q6	There is a significant positive association between PM and the organization's leadership endorsement of developing, publishing and sharing its projects vision, goals and objectives	**YES**
Q7	There is a significant positive association between PM and KM roles capability to promote and implement knowledge management programs and processes	**YES**
Q8	There is a significant positive association between PM and using performance metrics to measure progress in project activities and project teams' performance.	**YES**
Q9	There is a significant positive association between PM and following through organizations' project strategic plans.	**YES**
Q14	There is a significant positive association between PM and Reward & Recognition system.	**YES**

As shown in Table 5-6, all seven (7) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. For the test of (τ_b) significance, all seven (7) hypotheses resulted in failing to reject the null. Therefore, the outcomes of testing

organization–related research sub-hypotheses suggest in the strongest possible way a significant positive association between the organization–related KM elements of the Four KM Pillars and PM.

Table 5-6: Analysis of Hypotheses Set 3 (Organization –Related KM Elements)

Survey Question #	Organization – Related Research Sub-Hypotheses	Significant Positive Association?
Q8	There is a significant positive association between PM and measuring progress in project activities and project teams' performance	**YES**
Q9	There is a significant positive association between PM and following through organizational strategy	**YES**
Q10	There is a significant positive association between PM and managing project records through process work-flows	**YES**
Q11	There is a significant positive association between PM and using process workflows and business processes to rethink (reengineer) how to perform projects	**YES**
Q12	There is a significant positive association between PM and project teams understanding of what they need to do in order to achieve the project objectives (Understanding organization strategy)	**YES**
Q13	There is a significant positive association between PM and organizational structure	**YES**
Q14	There is a significant positive association between PM and reward system and performance evaluation criterion	**YES**

As shown in Table 5-7, all ten (10) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. For the test of (τ_b) significance, all ten (10) hypotheses resulted in failing to reject the null.

Therefore, the outcomes of testing technology–related research sub-hypotheses suggest in the strongest possible way a significant positive association between the technology–related KM elements of the Four KM Pillars and PM.

Table 5-7: Analysis of Hypotheses Set 3 (Technology –Related KM Elements)

Survey Question #	Technology – Related Research Sub-Hypotheses	Significant Positive Association?
Q15	There is a significant positive association between PM and synchronous communications (Discussion boards, instant messaging, application and screen sharing, video and audio conferencing, telephone)	**YES**
Q16	There is a significant positive association between PM and asynchronous communications (e-mail, message broadcasting)	**YES**
Q17	There is a significant positive association between PM and collaborative services (Electronic calendar, task management, voting survey and polling)	**YES**
Q18	There is a significant positive association between PM and Intranet (e.g. SharePoint, company portal, etc.)	**YES**
Q19	There is a significant positive association between PM and document control and data management systems	**YES**
Q20	There is a significant positive association between PM and PM system used to schedule, track, and chart the steps in a project as it is being completed	**YES**
Q21,33	There is a significant positive association between PM and communities of practice	**YES**
Q22	There is a significant positive association between PM and data warehouse system	**YES**
Q23	Integrating new technologies with legacy systems to manage new forms of knowledge that are acquired during project	**YES**
Q24	There is a significant positive association between PM and expert directories used to help identify experts	**YES**

As shown in Table 5-8, all nine (9) hypotheses tested resulted in rejecting the null hypotheses for the test of concordance. For the test of (τb) significance, all nine (9) hypotheses resulted in failing to reject the null. Therefore, the outcomes of testing learning–related research sub-hypotheses suggest in the strongest possible way a significant positive association between the learning–related KM elements of the Four KM Pillars and PM.

Table 5-8: Analysis of Hypotheses Set 3 (Learning –Related KM Elements)

Survey Question #	Learning – Related Research Sub-Hypotheses	Significant Positive Association?
Q25	There is a significant positive association between PM and organization's encouragement of project workers to acquire and share project related knowledge	**YES**
Q26	There is a significant positive association between PM and trust and collaboration between project team members in an organization to complete their tasks	**YES**
Q27	There is a significant positive association between PM and financial and technological support provided by an organization for project workers to keep pace with changes and technology advancement in their area of expertise	**YES**
Q28	There is a significant positive association between PM and education opportunities and training programs provided by the organization in order to build project workers competencies	**YES**
Q29	There is a significant positive association between PM and understanding Tacit & Explicit knowledge language	**YES**
Q30	There is a significant positive association between PM and learning from fellow co-workers during projects	**YES**
Q31	There is a significant positive association between PM and learning from the explicit knowledge that is made available by the organization for all workers (e.g. Manuals, documents, etc.)	**YES**

Table 5-8: Analysis of Hypotheses Set 3 (Learning –Related KM Elements) (Cont.)

Survey Question #	Learning – Related Research Sub-Hypotheses	Significant Positive Association?
Q32	There is a significant positive association between PM and communicating and sharing knowledge among project team members that are at different project sites (e.g. Virtual Teams)	**YES**
Q21,33	There is a significant positive association between PM and face-to-face and Internet-based Communities of Practice	**YES**

5.4.3.2 Analysis of the predictive relationship between Elements of the Four KM Pillars and Overall PM

Analysis of the predictive relationship between the elements of the Four KM Pillars and PM focused on the statistical testing of each element of the four KM pillars against PM to determine which elements of the KM pillars are most predictive of PM success.

The outcomes of testing predictive relationship between the elements of the KM leadership pillar and PM suggest that organizations management commitment to KM is the most predictive amongst the tested elements. The outcomes of testing predictive relationship between the elements of the KM organization pillar and PM suggest that project teams understanding of their organization strategy is the most predictive amongst the tested elements. The outcomes of testing predictive relationship between the elements of the KM technology pillar and PM suggest that Communities of practice (CoP) is the most predictive amongst the tested elements. Finally, the outcomes of testing predictive relationship between the elements of the KM learning pillar and PM suggest that encouragement of project workers to acquire and share project related knowledge, and learning from the explicit knowledge that is made available by the organization are the

most predictive amongst the tested elements.

5.4.4 Level – 4: Analysis of the Association between KM and PM

Analysis of the association between KM and PM focused on the statistical testing of main research hypothesis intended to determine the existence and the nature of the postulated association. Table 5-9 provides a result illustration of testing the main research hypothesis.

Table 5-9: Analysis of Main Research Hypothesis

Main Research Hypotheses		Significant Positive Association?
Hr:	There is a significant positive association between an enterprise-wide KM system and PM knowledge areas.	**YES**

As shown in Table 5-9, the outcomes of testing the main research hypothesis (Hr) strongly suggest a significant positive association between KM (as described with Stankosky's Four Enterprise Engineering KM Pillars) and PM (as acknowledged by the Project Management Institute (PMI).

5.5 Summary of Conclusions

This research study contributes to the body of knowledge by investigating the possible benefits of implementing an enterprise-wide KM approach to PM using quantitative research. In this work, the association between the four pillars of KM (leadership, organization, technology, and learning) and the PM knowledge areas was investigated. Despite potential association arising from the review of literature of this

study and the evidence of statistical association established during the study's analysis of the survey results, it was necessary to highlight that association does not necessarily imply causation. As such, testing the association does not prove that effective KM causes successful PM. Hence, the predictive relationship between the four pillars of KM (leadership, organization, technology, and learning) and the PM knowledge areas was investigated in details at the aggregate levels explained in chapter 3.

Results for the analysis of the association at aggregate level – 1 strongly suggest significant positive association between enterprise-wide KM and project integration, quality, human resource, communication, risk, procurement and stakeholder management. Results from the analysis suggesting No significant association between enterprise-wide KM and project scope, time and cost management. As for the analysis of the predictive relationship at aggregate level – 1, results suggest that project human resource management and project communication management are the PM knowledge areas most predictive of enterprise-wide KM.

Managing skills and tracking who knows what is necessary in order to utilize undocumented "tacit knowledge". The predictive relationship between project human resource management and knowledge management highlights the possible effect of the main areas of project human resource management (expert identification, developing project teams, project team performance, and conflict/problem solving) on knowledge management. As such, it suggests that the role of knowledge management in project human resource management is significant and the focus in project human resource management should be placed on enhancing KM tools and processes that highlight experts' quality, creativity, leadership, and problem-solving skills (Oun, Blackburn,

Olson, & Blessner, 2016; Yahya & Goh, 2002). KM could play a significant role in the processes of identifying experts by using expert directories. Effective project team performance should promote trust and collaboration between project team members, encourage experience and knowledge sharing, and reward employees for high-quality knowledge management practices (Oun, Blackburn, Olson, & Blessner, 2016).

The significant predictive relationship between enterprise-wide KM and project communication management highlight the significant role of KM in all processes required to identify and engage all people or organizations interested in, needed to support, and/or affected by the project in a way that ensures successful completion of the project to their satisfaction. The application of knowledge management to the main three areas of project communication management (reporting project performance information, stakeholder identification, and knowledge availability to stakeholders) could play a constructive role in achieving successful project outcomes (Hughes, Tippett, & Thomas, 2004; Oun, Blackburn, Olson, & Blessner, 2016; PMI, 2013). Project team members are encouraged to acquire and share project knowledge by using enabling tools like communities of practice. It is necessary to provide all stakeholders with access to project knowledge and to keep them informed throughout the project management process by facilitating IT and communication tools and activities (e.g. synchronous and asynchronous communications tools). Management project communication is not just IT. It is also a matter of trust and collaboration between stakeholders directly involved in the project management process. It also includes all processes required to ensure timely and appropriate communication of project Knowledge. Management of project communication could use document control & data management systems to provide

access to knowledge and could use virtual teams and communities of practice to build a sense of trust and collaboration within project teams (Oun, Blackburn, Olson, & Blessner, 2016).

Based on the outcome of the literature review and the survey statistical findings for aggregate level-1, this study suggests that the KM tools and process currently used for the conceptual association model may not be fully in concurrence with the needs of a successful project management; particularly with respect to its Integration, Scope, Time, Cost, Quality, Risk, Procurement, and Stakeholder knowledge areas. As such, detailed studies would be recommended to include KM tools and processes that strongly correlate to successful project management. Including KM tools and processes that are strongly correlated to successful PM would transform the current conceptual association model into something well suited to contribute in vigorous project environments.

With respect to the analysis at the aggregate level -2, the quantitative study supports the research sub-hypothesis set – 2 that there is a significant positive association between each of Stankosky's Four Enterprise Engineering KM Pillars and PM. Results revealed that KM Learning Pillar has the strongest association with PM. Figure 5-1 is an overview of the results presented in Chapter 4 and reveals the degree of statistical association between the four pillar of KM and each PM knowledge area. As such, the four KM pillars tools and processes showed a balanced and a near uniform association across each PM knowledge area independently; however, the application of leadership, organization, technology, and learning related KM tools and processes showed a significantly higher degree of association with project human resource management.

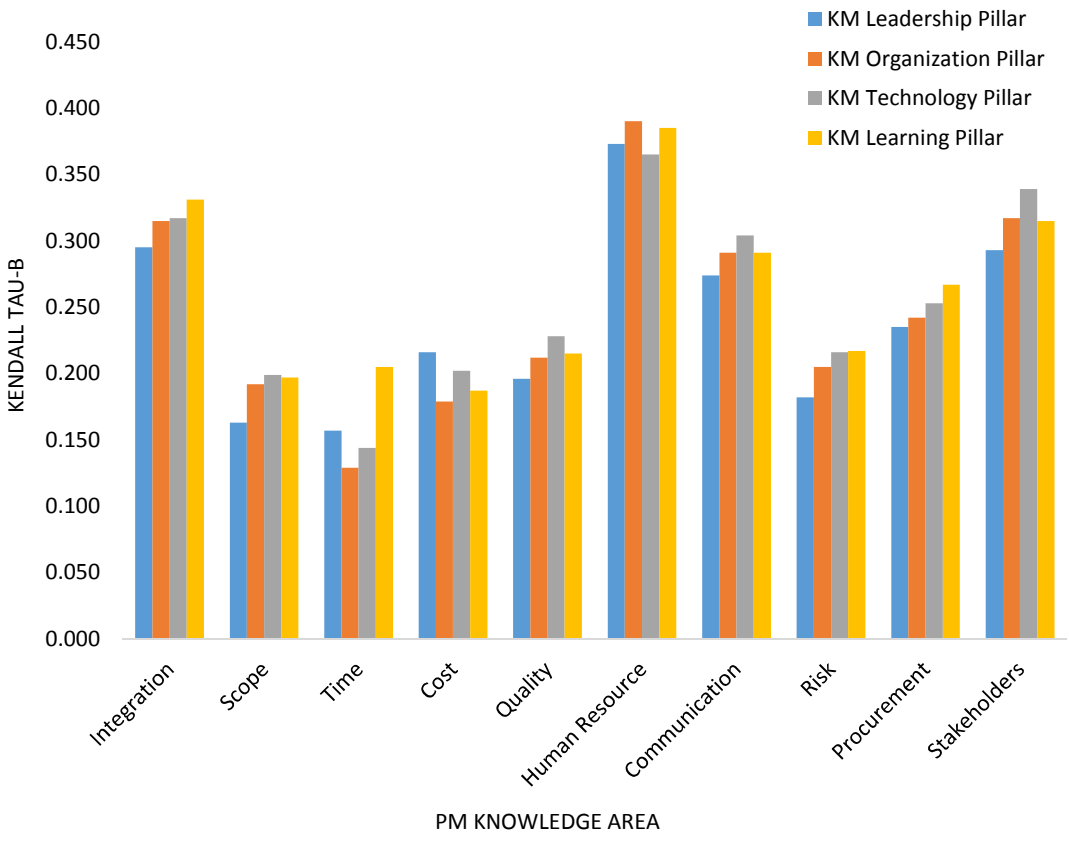

Figure 5-1: Degree of Statistical Association between KM and PM

As for the analysis of the predictive relationship at aggregate level – 2, results suggest that the organization and technology pillars are the most predictive of PM success. The significant predictive relationship between organization and technology pillars and project management highlights the important role of KM in all organizational processes required to identify, define, combine, unify, and coordinate the various project management processes and activities. Project management may well benefit from using PM software, as a KM technology tool, to schedule, manage, and control project information and activities to guarantee compliance with the project management plan and with project scope of work (Oun, Blackburn, Olson, & Blessner, 2016).

Results for the analysis of the association at aggregate level – 3 strongly suggest significant positive association between elements of the four KM pillars and PM. As such, results found that the highest ranked KM element to associate with PM was *education opportunities and training programs provided by the organization in order to build project workers competencies*. The second ranked KM element to associate with PM was *Synchronous Communications (Discussion boards, instant messaging, application and screen sharing, video and audio conferencing, telephone).* The third ranked KM element to associate with PM was *project teams understanding of what they need to do in order to achieve the project objectives*. In general, the degree of the association between all elements of KM and PM were not all strong but they remain significant and they draw attention to the need for an enterprise-wide KM approach to managing projects that recognizes and includes all KM elements related to the four pillars of KM, as well as the PM knowledge areas acknowledged by PMI. This approach is further confirmed through the analysis of the association at aggregate level – 4 which strongly suggest significant positive association between enterprise-wide KM and PM.

However, when level – 3 was tested for the ordinal logistic regression in order to determine the elements of KM that are most predictive of PM, the KM elements that are most predictive of PM are as follows:

1- Organizations management commitment to KM.

2- Project teams understanding of their organization strategy.

3- Communities of Practice.

4- Encouragement of project workers to acquire and share project related knowledge,

5- Learning from the explicit knowledge that is made available by the organization.

Thus, the results partially confirm the major premise of this study that management of projects improvement associates with increased application of enterprise-wide KM processes and activities. In view of the results of the analysis at all 4 aggregate levels, it is important to acknowledge the applicability of the KM tools and processes in the context of the PM knowledge areas as the PMBOK® Guide described project success as a result of balancing the processes and activities within the ten (10) PM knowledge areas while managing projects. However, the management of PM knowledge areas is only possible within project boundaries and within the control limits of project managers and the project organization. As such, project activities and jobs performed by parties other than the project team (e.g. venders, suppliers, subcontractors, etc.) could not be controlled when KM is included in the PM process. For the KM elements that are most predictive of PM in this study, the project manager could not influence the commitment of a vender, a supplier, or a subcontractor to KM. Also, the project manager could not be involved with workers other than his project team or workers within the organization. However, CoP and explicit knowledge that is made available by the organization (e.g. spec. & operating manuals, etc.) are tools and processes that could be shared between the project team and other stakeholders like a vender, a supplier, or a subcontractor. Therefore, further research efforts to include KM element related to all 4 KM pillars in the KM/PM association model to examine potential discrepancies is recommended

Evaluating results of the predictive relationship analysis suggests that in its current form the leadership and learning pillars of the KM/PM association model may not warrant consideration as inclusive elements predicting PM. If true, this dissertation and its findings could have potentially important implications with regard to the structure and

motivation of future revisions of the KM/PM association model. However, evidence in the literature review activity performed during this study equally advocates the merits of addressing all four KM pillars and elements in KM frameworks despite the industry, region, or business domain. Supporting this perceptive is the statistical evidence of the predictive relationship between two (2) of the four (4) KM pillars with PM. Collectively, the most predictive KM pillars and elements of PM lend a reasonable level of credibility to the likelihood that leadership and learning pillars may well be valuable elements for an effective KM/PM association model. Therefore, further research efforts in the area of KM-PM integration to examine potential discrepancies is recommended.

Figure 5-2 reflect the results and findings of this dissertation and shows the conceptual association model highlighting the elements of the KM pillars that are the most predictive of PM. Figure 5-2 also highlights the PM knowledge areas that are most effective.

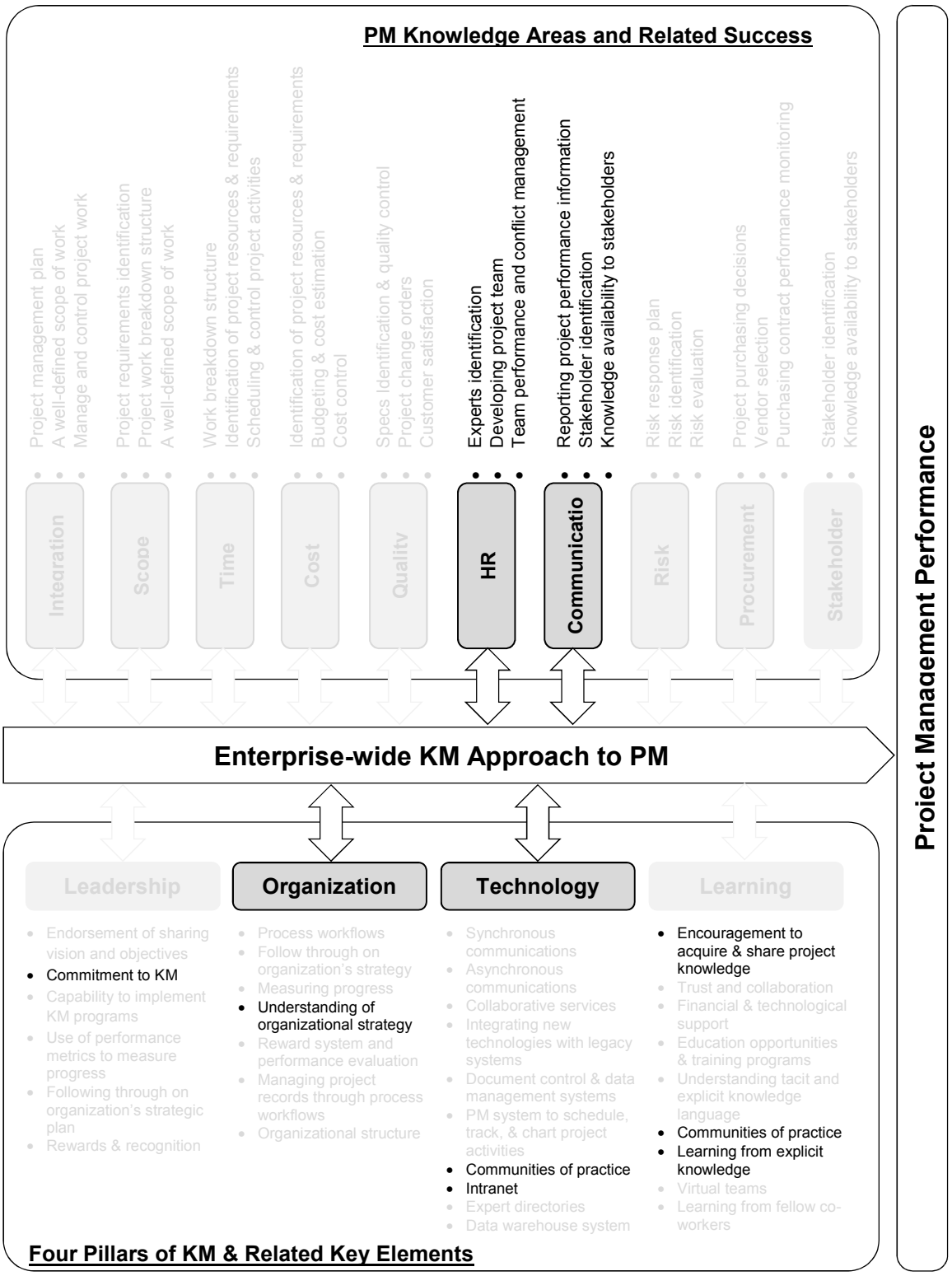

Figure 5-2: Updated Conceptual Model for the Relationship between KM and PM

Chapter 6 - Limitations and Areas for Future Research

"Knowledge of what is does not open the door directly to what should be."

- Albert Einstein

The primary limitation of this work is the scarcity of previous research regarding the association between actionable KM frameworks and PM. Several high-level studies have been conducted to investigate the effect of selected KM activities on projects based on researchers' perceived significance of various KM activities. However, other than limited research institutes and academic activities, a small number of in-depth quantitative studies were found during the literature review. Thus, the apparent lack of in-depth previous research is why we characterize this study as exploratory. Another potential limitation is that the survey respondents were instructed to refer to the most recent project they took Part in when completing the survey, thus, their responses do not reflect a broad range of project experiences participants may have had. Future research should use increased sample size, including the levels of KM implementation in order to identify relevant sub-groups such that the effect of KM on individual project types and industries can be studied (Oun, Blackburn, Olson, & Blessner, 2016).

Additionally, this study collected perceptual measures for both independent and dependent variables from the same survey participants. As such, self-reported data can jeopardize the survey internal consistency if respondents have the tendency to give consistent answers to nonrelated survey questions. This is called (common-method variance, CMV) and in doing so, associations between constructs could either be inflated or deflated (Spector, 2006). However, it is necessary to note that many researchers like

Lindell & Whitney, (2001) and Spector (1987) argue that the issue of CMV should not be exaggerated. Thus, future research could use objective measures of project performance or use different survey participants to collect perceptual measures for independent and dependent variables (Oun, Blackburn, Olson, & Blessner, 2016).

Based on the review of the literature and the findings reported here, suggestions for future research may include exploration related to understanding the dynamics of an integrated KM/PM system and studying the behavior of the integrated systems over time. It is also important to study the effect of implementing different KM systems and models on the management of projects. Another important future research venue would be to study the effect of KM tools and processes on the management of project in specific industries and regions (Oun, Blackburn, Olson, & Blessner, 2016). It is hoped this research continues and pursues the suggested venues in the future in order to potentially find grounds for even better knowledge management approach to project management.

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Appendices

Appendix A - Survey Instrument

Measuring knowledge management application and project performance

Please answer the following questions to the best of your ability:

1) What is your current job position?

[ ] Technician
[ ] Engineer (specify, e.g. Mechanical): …….
[ ] Project Manager
[ ] Department Manager
[ ] General Manager
[ ] Other (specify): ……..

2) How many years of work experience do you have?

[ ] Less than 5 years
[ ] 5 – 15 years
[ ] 16 – 25 years
[ ] More than 25 years

3) What is your field of work?

[ ] Information Technology
[ ] Telecommunications
[ ] Manufacturing
[ ] Chemical "e.g. pharmaceutical"
[ ] Energy "e.g. power, petroleum"
[ ] Construction
[ ] Other (specify): ……

4) What is your highest educational degree earned?

[ ] High school
[ ] Technical diploma
[ ] Associate degree
[ ] Bachelor's degree
[ ] Master's degree
[ ] Doctorate degree
[ ] Other (specify): ……

5) To what extent do you think your organization's executive management is committed to managing knowledge that is acquired or created during project periods?

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

Appendix A - Survey Instrument (Cont.)
Measuring knowledge management application and project performance

6) How would you rate the level of your organization's leadership endorsement of developing, publishing and sharing its projects vision, goals and objectives?

[ ] Very low
[ ] Low
[ ] Moderate
[ ] High
[ ] Very high
[ ] Don't know / not applicable

7) How would you rate the knowledge management roles (core team of people who are actively supporting KM implementation) in your organization with respect to their capability to promote and implement knowledge management programs & processes?

[ ] Very incapable
[ ] Incapable
[ ] Average
[ ] Capable
[ ] Very capable
[ ] Don't know / not applicable

8) How would you rate your organization in using performance metrics to measure progress in project activities and project teams' performance?

[ ] Very unsuccessful
[ ] Unsuccessful
[ ] Average
[ ] Successful
[ ] Very successful
[ ] Don't know / not applicable

9) How would you rate your organization's success in following through its project strategic plans?

[ ] Very unsuccessful
[ ] Unsuccessful
[ ] Average
[ ] Successful
[ ] Very successful
[ ] Don't know / not applicable

10) How would you rate your organization in managing project records through process work-flows?

[ ] Very ineffective
[ ] Ineffective
[ ] Average
[ ] Effective
[ ] Very effective
[ ] Don't know / not applicable

Appendix A - Survey Instrument (Cont.)
Measuring knowledge management application and project performance

11) To what extent does your organization uses process workflows to rethink (reengineer) how it performs projects?

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

12) How would you rate your level of the project team understanding of what they need to do in order to achieve the project objectives?

[ ] Very low
[ ] Low
[ ] Moderate
[ ] High
[ ] Very high
[ ] Don't know / not applicable

13) How would you rate your company's organizational structure with respect to allowing knowledge to be shared and transformed (The interactions between explicit and tacit knowledge) across departments, project teams and locations?

[ ] Very low
[ ] Low
[ ] Moderate
[ ] High
[ ] Very high
[ ] Don't know / not applicable

14) How would you rate the degree to which reward system and performance evaluation criterion are actually deployed in your organization to recognize idea creation and sharing project knowledge?

[ ] To a very little degree
[ ] To a little degree
[ ] To some degree
[ ] To a high degree
[ ] To a very high degree
[ ] Don't know / not applicable

15) Synchronous Communications tools and processes (e.g. Discussion boards, instant messaging, application and screen sharing, video and audio conferencing, telephone) are available in your organization and used by employees to manage project knowledge

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

Appendix A - Survey Instrument (Cont.)
Measuring knowledge management application and project performance

16) Asynchronous Communications tools and processes (e.g. e-mail, message board/broadcasting) are available in your organization and used by employees to manage project knowledge

[ ] To a very little extent [ ] To a high extent
[ ] To a little extent [ ] To a very high extent
[ ] To some extent [ ] Don't know / not applicable

17) Collaborative Services tools and processes (e.g. Electronic calendar, task management, survey voting and polling) are available in your organization and used by employees to manage project knowledge

[ ] To a very little extent [ ] To a high extent
[ ] To a little extent [ ] To a very high extent
[ ] To some extent [ ] Don't know / not applicable

18) Intranet tools and processes (e.g. SharePoint, company portal, etc.) are available in your organization and used by employees to manage project knowledge

[ ] To a very little extent [ ] To a high extent
[ ] To a little extent [ ] To a very high extent
[ ] To some extent [ ] Don't know / not applicable

19) Document control and management systems are available in your organization and used by employees to track and store project related documents

[ ] To a very little extent [ ] To a high extent
[ ] To a little extent [ ] To a very high extent
[ ] To some extent [ ] Don't know / not applicable

20) Project management systems to schedule, track, and chart the steps in a project as it is being completed are available by your organization and used by employees to manage project knowledge

[ ] To a very little extent [ ] To a high extent
[ ] To a little extent [ ] To a very high extent
[ ] To some extent [ ] Don't know / not applicable

Appendix A - Survey Instrument (Cont.)
Measuring knowledge management application and project performance

21) Communities of practice are available in your organization and used by employees to manage project knowledge

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

22) Data warehouse systems where project data can be recalled and analyzed are available in your organization and used by employees

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

23) Your organization integrates new technologies that manage new forms of knowledge acquired or created during project periods with legacy systems

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

24) To what extent do you think expert directories helped your organization to identify and locate experts needed to perform project tasks?

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

25) To what extent do you think your organization encourages project workers to acquire and share project related knowledge?

[ ] Very low
[ ] Low
[ ] Moderate
[ ] High
[ ] Very high
[ ] Don't know / not applicable

Appendix A - Survey Instrument (Cont.)
Measuring knowledge management application and project performance

26) How would you rate the level of trust and collaboration between project team members in your organization to complete their tasks?

[ ] Very low
[ ] Low
[ ] Moderate
[ ] High
[ ] Very high
[ ] Don't know / not applicable

27) How would you rate the level of support provided by your organization for project workers, financially and technologically, to keep pace with changes and technology advancement in their area of expertise?

[ ] Very low
[ ] Low
[ ] Moderate
[ ] High
[ ] Very high
[ ] Don't know / not applicable

28) To what extent does your organization provide its employees and project workers with education opportunities and training programs in order to build their competencies?

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

29) To what extent do you think project workers in your organization understand Tacit & Explicit knowledge language?

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

30) How would you rate the degree to which learning from fellow co-workers is used during projects to build your competency?

[ ] To a very little degree
[ ] To a little degree
[ ] To some degree
[ ] To a high degree
[ ] To a very high degree
[ ] Don't know / not applicable

Appendix A - Survey Instrument (Cont.)
Measuring knowledge management application and project performance

31) How would you rate the extent to which learning from the explicit knowledge that is made available by your organization for all workers (e.g. Manuals, documents, procedures, etc.) is used to build your competency?

[ ] To a very little degree
[ ] To a little degree
[ ] To some degree
[ ] To a high degree
[ ] To a very high degree
[ ] Don't know / not applicable

32) How would you rate the extent to which knowledge is communicated and shared among project team members that are at different project sites (e.g. Virtual Teams)?

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

33) To what extent are face-to-face and/or Internet-based Communities of Practice are used in your organization to:

33.1) capture and store tacit and explicit knowledge during project period

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

33.2) build a knowledge sharing and learning culture

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

33.3) strengthen teamwork across departments, project phases and sites

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

33.4) leverage knowledge management to solve project issues

[ ] To a very little extent
[ ] To a little extent
[ ] To some extent
[ ] To a high extent
[ ] To a very high extent
[ ] Don't know / not applicable

34) In terms of the project scope management,

34.1) my last project's requirements identification met the customer's expectations

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

34.2) my last project was completed according to the work breakdown structure

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

34.3) my last project was completed according to the original scope of work

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

35) In terms of the project time management, my last project was completed

[ ] Very late
[ ] Late
[ ] On time
[ ] Early
[ ] Very early
[ ] Don't know / not applicable

36) In terms of the project cost management, my last project was completed

[ ] Very over budget
[ ] Over budget
[ ] On budget
[ ] Below budget
[ ] Very below budget
[ ] Don't know / not applicable

Appendix A - Survey Instrument (Cont.)
Measuring knowledge management application and project performance

37) In terms of the project quality management,

37.1) my last project was completed with change orders

[ ] Far above expectations
[ ] Slightly above expectations
[ ] Meet expectations
[ ] Slightly below expectations
[ ] Far below expectations
[ ] Don't know / not applicable

37.2) my last project was completed with a punch list of items (a list of tasks or to-do items that must be done at the end of the project).

[ ] Far above expectations
[ ] Slightly above expectations
[ ] Meet expectations
[ ] Slightly below expectations
[ ] Far below expectations
[ ] Don't know / not applicable

37.3) my last project was completed with the customer being

[ ] Very unsatisfied
[ ] Unsatisfied
[ ] Neutral
[ ] Satisfied
[ ] Very satisfied
[ ] Don't know / not applicable

37.4) my last project was completed with myself being

[ ] Very unsatisfied
[ ] Unsatisfied
[ ] Neutral
[ ] Satisfied
[ ] Very satisfied
[ ] Don't know / not applicable

38) In terms of the project human resource management,

38.1) in my last project, my organization successfully identified the experts needed to perform project tasks and developed project team

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

38.2) in my last project, my organization successfully was able to effectively track team member's performance, provided feedback, and resolved conflict issues

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

39) In terms of the project communication and stakeholder management,

39.1) stakeholders (people or organizations impacted by my last project) and the information regarding their interest, involvement, and impact on project success were successfully identified and included as part of a stakeholder management plan

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

39.2) my last project's knowledge was available to stakeholders as planned

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

39.3) my last project's performance information was collected and distributed as planned

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

40) In terms of the project risk management, my last project's risk response plans, tracking identified risks, and evaluating risk processes were effective throughout the project

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

41) In terms of the project procurement management,

41.1) In my last project, documenting purchasing decisions was successful

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

41.2) my last project's vendor selection process was successful throughout the project

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

41.3) In my last project, monitoring purchasing contract performance was successful

[ ] Strongly disagree
[ ] Disagree
[ ] Neither agree nor disagree
[ ] Agree
[ ] Strongly agree
[ ] Don't know / not applicable

End of the survey.
Thank you for taking part of this study.

Appendix B – Minimum Required Sample Size Calculations

$$n_0 \geq \frac{(Z)^2 * p(1-p)}{(e)^2}$$

Where:

p = 1/6 (0.166) where participant may select one of the 6 possible answers.

Z = 1.96 corresponding the desired confidence level of 95%.

e = 0.05 (+/- 5% precision)

$$n_0 \geq \frac{(1.96)^2 * 0.166\ (1 - \ 0.166)}{(0.05)^2}$$

Minimum Required Sample Size (n_0) ≥ 213.4 ≈ 213

Appendix C – Minitab Session Window Output for Cronbach's Alpha Calculations

Item Analysis of (Project Integration Management) Q34.3, Q38.2

* NOTE * 126 cases used, 2 cases contain missing values

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q34.3	126	3.786	0.943
Q38.2	126	3.500	1.064
Total	126	10.929	2.252

Cronbach's Alpha = 0.7759

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q34.3	7.143	1.716	0.4375	1.0000	0.8773
Q38.2	7.429	1.568	0.4850	1.0000	0.8306

Item Analysis of (Project Scope Management) Q34.1, Q34.2, Q34.3

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q34.1	128	4.102	0.662
Q34.2	128	3.945	0.942
Q34.3	128	3.781	0.939
Total	128	11.828	2.032

Cronbach's Alpha = 0.7045

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q34.1	7.727	1.635	0.4695	0.2242	0.6772
Q34.2	7.883	1.338	0.5724	0.3320	0.5488
Q34.3	8.047	1.368	0.5248	0.2914	0.6095

Appendix C – Minitab Session Output for Cronbach's Alpha Calculations (Cont.)

```
Item Analysis of (Project Quality Management) Q37.1, Q37.2, Q37.3, Q37.4

* NOTE * 123 cases used, 5 cases contain missing values

Item and Total Statistics

          Total
Variable  Count    Mean  StDev
Q37.1       123   3.813  0.750
Q37.2       123   3.780  0.763
Q37.3       123   3.772  0.787
Q37.4       123   3.821  0.678
Total       123  15.187  2.711

Cronbach's Alpha = 0.9303



Omitted Item Statistics

                      Adj.               Squared
Omitted   Adj. Total  Total   Item-Adj.  Multiple  Cronbach's
Variable        Mean  StDev  Total Corr      Corr       Alpha
Q37.1         11.374  2.038      0.8587    0.7489      0.9018
Q37.2         11.407  2.040      0.8371    0.7060      0.9090
Q37.3         11.415  2.012      0.8464    0.7250      0.9059
Q37.4         11.366  2.136      0.8040    0.6485      0.9198



Item Analysis of (Project Human Recourse Management) Q38.1, Q38.2

* NOTE * 127 cases used, 1 cases contain missing values
* NOTE * Calculating omitted item statistics requires more than 2 variables.

Item and Total Statistics

          Total
Variable  Count    Mean   StDev
Q38.1       127  3.7953  1.0789
Q38.2       127  3.4961  1.0607
Total       127  7.2913  1.9028

Cronbach's Alpha = 0.7357



Item Analysis of (Project Stakeholder Management) Q39.1, Q39.2, Q39.3

* NOTE * 114 cases used, 14 cases contain missing values

Item and Total Statistics

          Total
Variable  Count    Mean  StDev
Q39.1       114   3.886  0.880
Q39.2       114   3.860  0.819
Q39.3       114   3.798  0.843
Total       114  11.544  2.162
```

Appendix C – Minitab Session Output for Cronbach's Alpha Calculations (Cont.)

```
Cronbach's Alpha = 0.8092


Omitted Item Statistics

           Adj.   Adj.               Squared
Omitted   Total  Total   Item-Adj.  Multiple  Cronbach's
Variable   Mean  StDev  Total Corr      Corr       Alpha
Q39.1     7.658  1.468      0.6769    0.5200      0.7188
Q39.2     7.684  1.483      0.7410    0.5718      0.6500
Q39.3     7.746  1.573      0.5630    0.3280      0.8335


Item Analysis of (Project Communication Management) Q39.2, Q39.3

* NOTE * 116 cases used, 12 cases contain missing values
* NOTE * Calculating omitted item statistics requires more than 2 variables.

Item and Total Statistics

          Total
Variable  Count    Mean   StDev
Q39.2       116  3.8621  0.8225
Q39.3       116  3.8017  0.8363
Total       116  7.6638  1.4622


Cronbach's Alpha = 0.7130



Item Analysis of (Project Procurement Management) Q41.1, Q41.2, Q41.3

* NOTE * 109 cases used, 19 cases contain missing values

Item and Total Statistics

          Total
Variable  Count    Mean  StDev
Q41.1       109   3.752  0.760
Q41.2       109   3.835  0.866
Q41.3       109   3.789  0.783
Total       109  11.376  2.067

Cronbach's Alpha = 0.8213


Omitted Item Statistics

           Adj.   Adj.               Squared
Omitted   Total  Total   Item-Adj.  Multiple  Cronbach's
Variable   Mean  StDev  Total Corr      Corr       Alpha
Q41.1     7.624  1.471      0.6869    0.4718      0.7422
Q41.2     7.541  1.385      0.6699    0.4494      0.7594
Q41.3     7.587  1.461      0.6694    0.4488      0.7599
```

Appendix C – Minitab Session Output for Cronbach's Alpha Calculations (Cont.)

Item Analysis of (Leadership Pillar) Q5, Q6, Q7, Q8, Q9, Q14

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q5	128	3.523	1.004
Q6	128	3.547	1.041
Q7	128	3.547	0.921
Q8	128	3.570	1.017
Q9	128	3.508	1.101
Q14	128	3.641	1.017
Total	128	21.336	5.319

Cronbach's Alpha = 0.9347

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q5	17.813	4.379	0.9213	0.8548	0.9079
Q6	17.789	4.426	0.8237	0.7131	0.9205
Q7	17.789	4.725	0.5878	0.4223	0.9493
Q8	17.766	4.484	0.7820	0.6381	0.9258
Q9	17.828	4.313	0.8905	0.8173	0.9119
Q14	17.695	4.425	0.8480	0.7657	0.9174

Appendix C – Minitab Session Output for Cronbach's Alpha Calculations (Cont.)

Item Analysis of (Organization Pillar) Q8, Q9, Q10, Q11, Q12, Q13, Q14

* NOTE * 127 cases used, 1 cases contain missing values

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q8	127	3.559	1.013
Q9	127	3.496	1.097
Q10	127	3.575	1.020
Q11	127	3.598	1.041
Q12	127	3.512	1.038
Q13	127	3.528	1.030
Q14	127	3.630	1.014
Total	127	24.898	6.500

Cronbach's Alpha = 0.9590

Appendix C – Minitab Session Output for Cronbach's Alpha Calculations (Cont.)

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q8	21.339	5.654	0.8078	0.6636	0.9563
Q9	21.402	5.514	0.8797	0.7888	0.9506
Q10	21.323	5.593	0.8705	0.7710	0.9514
Q11	21.299	5.580	0.8636	0.7674	0.9519
Q12	21.386	5.581	0.8656	0.7619	0.9518
Q13	21.370	5.592	0.8617	0.7512	0.9521
Q14	21.268	5.619	0.8456	0.7387	0.9534

Item Analysis of (Technology Pillar) Q15, Q16, Q17, Q18, Q19, Q20, Q21, Q22, Q23, Q24

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q15	128	3.563	0.994
Q16	128	3.586	1.008
Q17	128	3.578	1.032
Q18	128	3.563	0.986
Q19	128	3.547	1.018
Q20	128	3.617	1.013
Q21	128	3.672	0.973
Q22	128	3.641	1.010
Q23	128	3.523	1.057
Q24	128	3.578	1.009
Total	128	35.867	8.671

Cronbach's Alpha = 0.9603

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q15	32.305	7.855	0.8007	0.6812	0.9569
Q16	32.281	7.789	0.8598	0.7792	0.9546
Q17	32.289	7.775	0.8526	0.7680	0.9549
Q18	32.305	7.892	0.7662	0.7043	0.9583
Q19	32.320	7.819	0.8174	0.6996	0.9563
Q20	32.250	7.819	0.8222	0.7260	0.9561
Q21	32.195	7.840	0.8376	0.7489	0.9555
Q22	32.227	7.850	0.7912	0.6676	0.9573
Q23	32.344	7.754	0.8508	0.7630	0.9549
Q24	32.289	7.819	0.8264	0.7126	0.9559

Appendix C – Minitab Session Output for Cronbach's Alpha Calculations (Cont.)

Item Analysis of (Learning Pillar) Q25, Q26, Q27, Q28, Q29, Q30, Q31, Q32, ...

Item and Total Statistics

Variable	Total Count	Mean	StDev
Q25	128	3.578	0.993
Q26	128	3.633	0.886
Q27	128	3.516	1.019
Q28	128	3.531	0.996
Q29	128	3.641	1.010
Q30	128	3.555	0.970
Q31	128	3.570	0.961
Q32	128	3.664	0.890
Q33.1	128	3.547	1.041
Q33.2	128	3.555	0.979
Q33.3	128	3.578	0.944
Q33.4	128	3.547	0.987
Total	128	42.914	9.878

Cronbach's Alpha = 0.9634

Omitted Item Statistics

Omitted Variable	Adj. Total Mean	Adj. Total StDev	Item-Adj. Total Corr	Squared Multiple Corr	Cronbach's Alpha
Q25	39.336	9.073	0.7933	0.6917	0.9608
Q26	39.281	9.337	0.5797	0.3903	0.9665
Q27	39.398	8.976	0.8720	0.7704	0.9586
Q28	39.383	9.017	0.8504	0.7366	0.9592
Q29	39.273	9.078	0.7702	0.6677	0.9614
Q30	39.359	9.033	0.8574	0.7595	0.9590
Q31	39.344	9.112	0.7775	0.6853	0.9612
Q32	39.250	9.107	0.8541	0.7927	0.9591
Q33.1	39.367	8.982	0.8445	0.7681	0.9594
Q33.2	39.359	9.066	0.8142	0.6998	0.9602
Q33.3	39.336	9.031	0.8865	0.8205	0.9582
Q33.4	39.367	9.020	0.8552	0.7427	0.9591

Appendix D - Raw Survey Data

	Question Number											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Respondent Number	Response Options											
1	5	2	5	4	3	4	3	5	4	4	3	3
2	2	2	1	2	5	5	4	5	5		5	5
3	6	3	5	5	4	2	4	5	4	4	4	4
4	2	2	5	6	4	4	4	4	4	4	4	4
5	5	2	5	4	3	3	3	3	3	3	3	3
6	5	3	2	5	3	3	4	3	3	3	3	3
7	3	3	2	4	4	4	5	4	4	4	4	4
8	3	3	1	5	3	4	3	3	3	3	3	4
9	5	4	3	5	5	5	5	5	5	5	5	4
10	3	4	1	5	5	5	5	5	5	5	5	5
11	3	4	1	4	5	5	3	5	5	5	5	5
12	3	2	3	4	4	4	4	2	4	4	4	4
13	5	2	2	4	3	3	3	3	3	3	5	4
14	2	4	1	5	2	4	2	2	3	2	2	1
15	3	2	2	4	2	1	3	3	2	2	2	2
16	3	3	5	2	3	4	3	3	3	4	3	3
17	3	3	1	4	4	4	5	4	4	4	4	4
18	4	2	4	5	4	4	4	4	4	4	5	3
19	2	1	7	4	4	4	3	4	2	4	4	4
20	3	3	1	5	4	4	4	4	4	4	4	4
21	5	3	5	5	4	4	4	2	4	4	4	4
22	4	3	7	4	3	3	4	3	3	3	3	3
23	2	3	1	4	4	4	4	4	4	3	4	4
24	4	2	4	5	4	3	4	4	4	4	5	4
25	3	3	1	5	4	4	3	4	4	4	4	3
26	4	3	5	4	3	4	5	3	3	5	3	3
27	4	4	3	4	5	4	3	5	5	5	5	5
28	3	2	1	5	1	2	1	2	1	1	2	1
29	3	3	6	4	1	1	2	1	2	3	1	1
30	4	4	1	5	4	4	4	4	4	4	4	3

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Respondent Number	Response Options											
31	3	4	1	4	4	5	2	5	5	5	5	5
32	3	2	1	5	4	4	2	4	4	4	4	4
33	3	2	3	4	4	4	4	4	4	4	4	5
34	4	2	6	4	1	1	1	1	1	3	3	2
35	3	3	1	4	3	3	3	3	3	3	3	3
36	6	1	1	5	4	4	4	4	4	4	4	4
37	6	2	1	5	5	5	5	4	5	5	5	5
38	2	2	6	5	3	3	3	3	3	3	5	3
39	4	3	6	5	3	3	4	3	1	3	3	3
40	6	2	7	4	4	4	5	4	4	4	4	5
41	2	3	5	4	5	5	5	5	5	5	5	5
42	2	2	2	5	3	4	4	3	3	3	3	3
43	3	4	1	4	5	4	5	5	5	5	5	5
44	4	3	6	5	3	3	3	4	3	5	3	3
45	3	2	6	5	4	3	4	2	4	4	4	4
46	4	4	1	5	4	4	3	4	4	4	5	4
47	3	3	1	4	4	4	4	4	4	4	4	4
48	3	2	1	5	3	3	4	3	3	3	3	3
49	3	4	1	5	5	5	4	4	5	4	5	5
50	3	3	1	4	3	3	3	3	3	3	3	3
51	5	4	3	2	3	3	3	3	3	2	3	2
52	3	2	1	5	2	2	2	2	1	2	2	2
53	4	3	6	5	3	3	4	3	3	3	5	3
54	3	4	1	4	5	5	5	5	5	5	4	5
55	4	3	4	6	4	4	4	3	4	4	4	4
56	3	4	5	6	4	3	3	4	2	4	4	4
57	3	3	7	1	3	3	4	3	3	3	2	3
58	4	3	7	6	3	4	3	3	3	4	3	3
59	3	4	5	6	4	4	3	4	3	4	3	4
60	5	3	1	4	2	2	3	4	2	2	1	2
61	6	4	7	5	4	4	4	3	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Respondent Number	Response Options											
62	3	4	5	5	4	4	4	4	4	4	4	4
63	5	3	1	4	2	2	2	3	2	2	2	2
64	3	4	5	5	4	4	4	5	5	4	4	4
65	3	3	5	4	3	3	3	3	3	3	3	3
66	6	3	5	4	3	3	3	3	3	3	3	3
67	3	2	1	5	3	3	4	3	3	3	3	2
68	3	4	1	5	1	1	2	1	1	1	1	1
69	6	3	1	4	3	3	3	3	3	3	3	3
70	5	4	3	2	3	3	3	3	3	3	3	3
71	3	2	1	5	2	1	2	2	1	2	2	3
72	3	4	1	4	5	5	5	5	5	5	5	5
73	3	2	1	5	4	4	4	4	4	5	4	4
74	3	2	3	4	4	5	4	4	4	4	4	4
75	4	2	6	4	1	1	3	1	1	1	1	1
76	4	3	4	6	4	4	4	4	4	4	4	4
77	3	4	5	6	4	4	4	4	4	4	4	4
78	3	3	5	5	3	4	3	3	3	3	3	3
79	4	3	4	5	3	3	3	3	3	3	3	3
80	1	3	5	2	3	3	3	3	3	3	3	3
81	3	3	1	4	4	4	4	4	4	4	4	4
82	3	3	1	5	3	4	3	2	3	3	4	3
83	5	4	3	5	5	5	5	5	5	5	5	5
84	3	4	1	5	5	4	5	5	5	5	5	5
85	3	4	1	4	5	5	5	5	5	5	5	5
86	3	2	3	4	4	3	4	4	4	3	4	4
87	4	3	6	4	4	4	3	4	4	4	4	4
88	6	4	7	5	4	5	4	5	4	4	4	4
89	6	2	1	7	3	3	4	3	3	4	3	3
90	4	4	7	5	2	2	3	4	2	2	2	2
91	5	2	7	4	3	3	2	1	3	3	3	3
92	6	2	1	4	4	4	4	4	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Respondent Number	Response Options											
93	3	3	1	5	4	4	4	4	4	3	4	4
94	6	3	7	5	2	2	2	2	2	2	2	2
95	4	3	6	5	3	4	4	3	3	1	2	3
96	3	3	5	4	5	4	3	5	5	5	5	5
97	3	2	2	5	1	3	2	4	3	3	3	1
98	3	4	1	4	5	5	5	5	5	4	5	5
99	4	3	6	5	3	3	3	3	3	2	3	3
100	3	2	6	5	4	4	4	4	4	4	4	4
101	4	4	1	5	4	4	3	5	4	4	4	4
102	3	3	1	4	4	4	3	4	4	4	4	4
103	5	3	3	5	3	3	4	3	3	3	3	4
104	3	4	1	4	4	5	4	5	5	5	5	5
105	4	3	6	5	3	3	3	3	2	3	3	3
106	3	2	7	5	5	3	5	3	5	3	3	4
107	3	3	5	4	5	5	4	5	5	5	5	4
108	3	2	2	5	3	3	5	3	3	1	1	3
109	3	4	1	4	4	5	4	5	5	5	5	5
110	4	3	6	5	3	3	3	3	4	3	4	2
111	3	2	6	5	4	4	4	4	4	4	4	4
112	4	4	1	5	4	4	3	4	4	4	4	4
113	3	3	1	4	4	4	5	4	4	4	4	4
114	4	3	6	5	3	2	3	4	1	4	3	3
115	3	4	1	4	5	5	5	5	5	5	5	5
116	4	3	4	6	5	4	3	4	4	4	4	4
117	3	4	5	6	4	4	4	4	4	5	4	4
118	3	3	5	5	3	3	4	3	3	3	3	3
119	4	3	4	5	3	4	3	3	3	3	3	3
120	3	4	5	5	4	4	4	4	4	4	4	4
121	5	3	1	4	2	2	3	2	2	2	2	1
122	3	4	5	5	4	4	2	4	4	4	4	4
123	3	3	5	4	3	1	3	4	4	4	3	3

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12
Respondent Number	Response Options											
124	3	2	1	5	3	4	4	3	3	3	4	3
125	3	4	1	5	4	5	2	4	5	5	5	5
126	3	3	1	4	3	3	3	3	3	3	3	3
127	5	4	3	2	3	3	3	3	3	3	3	3
128	3	2	1	5	2	1	4	2	1	2	2	3

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24
Respondent Number	Response Options											
1	3	5	3	2	3	2	3	3	3	3	3	3
2	5	5	4	5	5	4	5	5	5	5	5	5
3	4	4	2	4	5	5	4	3	3	4	4	4
4	4	4	4	4	4	2	4	4	4	4	4	4
5	3	3	3	3	3	3	3	3	3	3	3	3
6	3	3	3	3	3	3	3	3	3	3	3	3
7	4	4	4	4	5	4	4	4	4	5	4	4
8	3	3	3	3	3	3	3	3	3	3	3	3
9	5	5	5	5	5	5	5	5	5	5	5	4
10	5	5	5	5	5	5	5	5	5	5	5	5
11	5	5	5	5	5	5	5	5	5	5	5	5
12	4	4	4	4	4	4	4	4	4	4	4	4
13	3	3	3	3	3	2	4	3	3	3	3	3
14	2	4	1	2	2	2	1	2	2	3	2	2
15	2	2	2	2	1	2	2	2	2	2	2	2
16	3	3	3	3	3	2	3	3	3	3	3	3
17	4	5	4	4	4	4	4	4	4	4	4	5
18	4	4	4	4	4	4	4	4	4	4	3	4
19	4	4	4	4	4	4	4	5	4	4	4	4
20	4	4	4	4	4	4	4	4	4	4	4	4
21	3	4	4	4	4	4	4	4	5	4	4	4
22	3	3	4	3	3	3	3	3	5	1	3	3
23	4	4	4	4	4	4	4	4	4	4	4	4
24	4	4	4	4	4	4	4	4	3	4	4	4
25	4	4	5	4	4	4	4	5	4	4	4	3
26	3	3	3	1	3	3	4	3	3	3	3	3
27	5	5	5	5	5	5	5	5	5	5	5	5
28	1	1	2	1	2	1	1	1	2	5	2	1
29	3	1	1	3	1	3	1	2	1	1	1	1
30	4	4	3	4	4	4	4	4	4	4	4	5
31	5	5	5	5	5	5	5	5	5	5	5	5

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24
Respondent Number	Response Options											
32	4	4	4	4	4	4	4	4	4	4	4	4
33	4	4	4	4	4	4	3	4	4	4	4	4
34	1	2	3	2	1	1	2	3	5	5	1	2
35	3	3	3	3	4	3	3	3	3	3	3	3
36	4	4	4	4	5	4	4	4	4	5	4	3
37	5	4	4	5	4	5	5	4	5	5	4	5
38	3	3	3	3	3	4	1	3	4	3	3	3
39	3	3	3	3	2	3	3	3	3	3	3	3
40	4	4	4	4	4	4	3	4	4	4	4	4
41	5	5	5	5	5	5	5	5	5	5	5	5
42	3	3	4	3	3	3	3	3	3	3	3	5
43	4	5	5	5	5	5	5	5	5	5	5	4
44	4	3	3	3	3	3	3	3	3	3	3	3
45	4	4	4	4	4	4	4	4	4	4	4	4
46	4	4	4	4	2	4	4	4	4	4	4	4
47	3	4	4	4	4	3	4	2	4	4	5	4
48	3	3	5	3	3	4	3	4	3	3	4	3
49	5	5	5	5	5	5	5	5	5	5	5	5
50	3	3	3	5	3	3	3	3	3	3	3	3
51	3	3	2	3	4	3	3	3	3	3	3	3
52	2	2	3	2	2	2	3	1	4	1	1	2
53	4	3	3	3	3	5	3	3	3	3	4	4
54	5	5	5	4	5	5	5	5	5	5	5	5
55	4	4	3	4	4	4	4	4	4	4	2	4
56	4	4	4	4	4	4	3	4	4	4	3	4
57	3	3	3	3	3	3	3	3	3	3	3	3
58	3	3	3	3	3	3	3	4	3	3	3	3
59	4	4	4	4	4	4	2	4	4	4	4	4
60	4	2	3	2	1	1	3	2	1	4	2	1
61	3	4	4	4	4	4	4	4	4	4	4	4
62	4	4	4	4	4	4	4	5	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24
Respondent Number	Response Options											
63	2	2	2	2	2	2	4	2	2	2	2	2
64	4	4	4	4	4	4	4	4	4	4	2	4
65	3	3	3	3	3	4	3	3	3	3	4	3
66	3	3	3	3	3	3	3	3	3	3	3	3
67	3	3	3	3	4	3	3	3	3	3	3	3
68	2	1	1	1	2	4	1	1	1	1	2	2
69	3	3	2	3	3	3	3	5	3	3	4	3
70	3	3	3	3	3	3	3	3	3	3	3	3
71	1	1	4	2	3	2	2	2	2	2	2	2
72	5	5	5	5	5	4	5	5	5	5	5	5
73	4	5	4	4	4	4	4	4	4	4	4	5
74	4	4	4	4	4	4	4	4	4	4	4	4
75	1	3	2	5	1	1	4	4	4	4	2	1
76	4	5	4	4	5	4	3	53	4	4	4	4
77	4	5	5	4	4	4	4	4	4	4	4	3
78	4	3	3	3	3	3	3	3	4	3	3	3
79	3	3	3	3	3	3	3	3	3	3	3	3
80	3	3	3	3	3	3	3	3	3	3	3	3
81	4	4	4	4	4	4	4	4	4	4	4	4
82	3	3	3	3	3	3	3	3	3	3	3	3
83	5	4	5	5	5	5	5	5	5	5	5	5
84	5	5	5	5	5	5	5	5	4	5	4	5
85	5	5	5	5	5	5	5	5	5	5	5	5
86	4	4	4	4	4	4	4	4	5	4	4	4
87	3	4	4	4	4	4	4	3	4	4	3	4
88	4	4	4	4	4	4	4	4	4	4	4	4
89	4	4	4	3	3	3	3	3	3	2	3	4
90	2	4	2	2	2	3	2	2	1	2	1	4
91	4	3	3	4	4	4	4	3	4	4	3	3
92	4	4	4	4	4	4	3	4	4	4	4	4
93	4	4	4	3	4	4	4	4	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24
Respondent Number	Response Options											
94	2	2	2	2	2	4	2	2	2	2	2	2
95	1	2	2	3	3	3	3	4	3	3	4	3
96	5	5	4	5	4	5	5	5	5	5	5	5
97	2	3	1	3	1	2	3	3	3	3	1	4
98	5	4	5	5	5	4	5	5	5	5	5	5
99	3	3	3	3	3	3	4	3	3	3	4	2
100	4	4	4	4	4	4	4	4	4	4	4	4
101	4	4	4	4	4	4	4	4	4	4	4	4
102	4	4	4	4	4	4	4	5	4	4	4	4
103	3	1	3	4	4	4	1	3	3	3	2	1
104	5	5	5	5	4	4	5	4	5	5	5	5
105	4	4	4	3	3	3	3	1	3	3	1	3
106	2	5	2	4	4	3	3	4	4	2	2	4
107	5	5	4	5	5	5	5	4	5	5	5	5
108	3	3	3	4	3	3	3	4	4	3	4	4
109	5	5	5	5	5	5	5	5	5	5	5	5
110	3	3	3	3	4	3	3	3	3	4	3	3
111	4	4	4	4	4	4	4	4	4	4	4	4
112	4	4	4	4	4	4	4	4	4	4	4	3
113	4	4	4	4	4	4	4	4	4	4	4	4
114	3	3	3	3	3	4	3	3	3	3	3	3
115	5	5	5	5	5	5	5	5	5	5	5	5
116	4	5	4	4	4	4	4	4	4	4	4	4
117	4	4	4	4	4	4	4	4	4	4	4	4
118	4	3	4	1	3	1	3	4	3	3	3	3
119	1	4	3	3	2	3	3	3	5	4	3	4
120	4	4	4	4	4	4	4	4	4	4	4	4
121	2	3	2	1	2	2	4	1	2	2	2	2
122	4	4	4	4	4	4	4	4	4	4	4	4
123	3	3	2	3	3	3	1	3	3	1	3	3
124	3	3	3	3	3	3	3	5	3	3	5	3

Appendix D - Raw Survey Data (cont.)

	Question Number											
	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24
Respondent Number	Response Options											
125	5	5	5	5	5	4	5	4	5	5	5	4
126	3	3	2	3	3	3	3	5	3	3	4	3
127	3	3	3	3	3	3	3	3	3	3	3	3
128	1	1	4	2	3	2	2	2	2	2	2	2

Appendix D - Raw Survey Data (cont.)

	Question Number										
	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33.1	Q33.2	Q33.3
Respondent Number	Response Options										
1	3	3	3	3	4	3	4	4	3	3	3
2	5	4	5	5	5	5	4	5	5	5	5
3	2	5	3	2	4	4	3	3	2	4	3
4	3	4	4	4	4	4	4	4	4	2	4
5	3	3	3	3	3	3	4	3	3	3	3
6	3	4	3	2	3	3	3	3	3	3	3
7	4	3	4	4	4	4	4	4	4	2	4
8	3	4	3	3	3	4	3	3	3	3	4
9	5	3	5	5	5	5	5	5	5	5	5
10	5	4	5	5	5	5	5	5	5	5	5
11	5	5	4	5	5	5	5	5	5	5	5
12	4	3	4	4	4	4	4	4	2	4	4
13	3	4	3	3	3	3	5	4	4	3	4
14	3	3	4	2	1	2	3	2	2	3	2
15	2	2	2	2	2	3	2	2	3	2	1
16	3	3	3	3	3	3	3	3	3	3	3
17	4	4	4	4	4	4	4	4	3	4	4
18	4	5	4	4	4	4	2	4	4	4	4
19	4	5	4	4	4	4	4	4	4	4	4
20	3	4	4	4	2	3	4	4	4	4	4
21	4	3	2	4	4	4	3	4	4	4	4
22	3	4	3	3	2	3	3	3	3	3	3
23	4	4	4	4	4	4	4	4	2	4	4
24	4	4	4	4	4	2	4	4	4	4	4
25	4	3	4	4	4	4	4	4	4	2	4
26	3	5	2	3	3	3	4	3	3	3	3
27	5	5	5	4	5	5	5	4	5	4	4
28	3	1	1	1	1	3	3	4	1	3	3
29	1	2	3	1	3	1	2	2	3	1	3
30	4	4	4	4	4	4	4	4	4	4	4
31	5	4	5	4	5	5	5	5	5	5	5

Appendix D - Raw Survey Data (cont.)

	Question Number										
	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33.1	Q33.2	Q33.3
Respondent Number	Response Options										
32	4	5	4	4	4	4	4	4	4	4	4
33	2	4	4	4	3	4	2	4	4	4	4
34	1	3	1	3	1	2	1	3	1	4	1
35	3	2	3	3	3	3	3	3	3	3	3
36	4	3	4	4	4	4	4	3	4	4	4
37	5	4	5	5	5	5	5	5	5	5	5
38	5	5	3	3	3	3	3	3	3	5	3
39	3	3	3	4	3	4	3	4	3	3	3
40	2	3	4	4	3	4	2	4	4	4	4
41	5	4	5	5	5	5	5	5	5	5	5
42	3	5	3	5	3	3	3	3	4	3	3
43	5	5	5	5	5	5	5	5	5	5	5
44	3	3	2	3	5	4	3	3	4	3	3
45	4	3	4	4	4	4	4	3	4	4	4
46	4	5	4	4	4	4	4	4	4	3	4
47	3	4	4	4	4	4	4	4	4	4	4
48	3	3	3	3	3	3	5	3	3	3	4
49	4	3	5	5	5	5	4	5	5	5	5
50	4	3	3	2	3	3	3	5	3	3	3
51	3	3	3	3	3	3	4	4	3	3	3
52	1	3	2	2	2	2	2	2	3	2	2
53	4	4	3	4	3	3	3	3	3	3	3
54	5	5	5	4	5	5	5	5	5	5	5
55	4	3	4	4	5	4	4	4	4	3	4
56	4	4	4	4	2	4	4	4	2	4	4
57	3	4	3	3	2	3	3	3	3	3	3
58	3	4	2	3	3	3	3	3	3	3	3
59	4	3	4	4	4	4	4	4	4	4	4
60	2	2	1	2	3	2	4	2	2	1	2
61	4	3	4	4	4	4	4	4	4	3	4
62	3	4	4	4	4	4	4	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number										
	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33.1	Q33.2	Q33.3
Respondent Number	Response Options										
63	2	3	2	2	2	2	3	2	2	2	3
64	4	3	4	4	4	4	3	4	4	4	4
65	3	4	3	3	3	3	3	3	3	3	3
66	3	3	3	2	3	4	3	4	3	3	3
67	3	4	3	3	3	3	3	3	3	3	3
68	3	2	2	1	1	2	3	2	1	2	3
69	4	3	3	3	3	3	3	4	3	3	4
70	3	4	3	3	3	3	3	3	3	3	3
71	4	3	2	2	3	2	2	3	2	3	2
72	5	4	5	5	5	5	5	5	5	5	5
73	4	5	4	4	4	4	4	4	5	4	4
74	4	3	4	4	4	4	4	4	4	4	4
75	1	2	1	3	3	1	1	1	1	1	1
76	4	4	4	4	4	4	3	4	4	4	4
77	4	3	4	5	4	4	4	4	4	4	4
78	3	4	3	4	3	3	4	3	3	3	3
79	3	2	3	3	3	3	3	3	3	3	3
80	3	3	3	3	5	3	3	3	3	3	3
81	4	5	5	4	5	4	4	4	4	4	4
82	2	3	3	2	3	2	2	3	3	3	3
83	5	5	4	5	4	5	5	5	5	5	4
84	5	4	5	4	5	5	5	4	5	5	4
85	5	4	5	5	5	5	5	5	5	5	5
86	5	5	4	4	4	3	4	4	4	3	4
87	4	5	4	4	4	4	4	3	3	4	4
88	4	4	4	4	4	4	4	4	4	4	4
89	3	4	3	3	3	3	2	3	3	3	3
90	4	3	2	2	1	2	2	2	1	2	1
91	4	4	3	4	4	1	3	3	3	3	3
92	4	3	4	4	4	4	4	5	4	4	4
93	4	5	4	4	4	4	4	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number										
	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33.1	Q33.2	Q33.3
Respondent Number	Response Options										
94	2	3	2	2	4	2	2	2	2	2	2
95	3	2	3	3	3	3	4	3	3	4	4
96	5	4	5	5	5	5	5	5	5	5	5
97	3	4	3	3	3	4	3	3	2	3	3
98	5	4	5	5	5	4	5	5	5	5	5
99	3	3	4	3	3	3	3	4	3	3	3
100	4	4	4	4	5	4	4	4	4	4	4
101	4	4	4	4	4	3	4	4	4	3	4
102	4	4	4	4	4	4	4	4	4	4	4
103	3	2	3	2	3	3	3	3	3	2	1
104	5	4	5	5	5	5	5	5	5	5	5
105	3	3	3	1	3	3	3	4	3	3	3
106	3	3	3	3	5	2	3	3	5	4	3
107	5	5	5	5	4	5	5	5	5	5	5
108	1	4	3	3	4	3	3	2	4	4	3
109	5	5	5	5	5	4	5	5	5	5	5
110	4	4	2	3	3	3	4	3	3	3	4
111	4	4	4	4	4	4	4	4	5	4	4
112	4	3	4	4	4	4	3	4	4	4	4
113	4	4	4	4	4	4	4	4	4	4	4
114	3	3	4	3	3	3	3	3	2	3	3
115	5	5	5	5	5	5	5	5	5	5	4
116	4	4	4	4	4	4	4	4	3	4	4
117	4	4	4	4	4	5	4	4	4	4	4
118	3	4	3	4	5	4	3	4	4	3	3
119	3	3	1	3	3	3	3	3	3	3	3
120	3	4	4	4	4	4	4	4	4	4	4
121	2	2	2	2	2	2	3	2	2	1	2
122	4	4	4	4	4	4	3	4	4	4	4
123	3	3	3	3	4	3	1	3	3	3	2
124	3	3	3	3	3	3	3	3	4	5	3

Appendix D - Raw Survey Data (cont.)

	Question Number										
	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33.1	Q33.2	Q33.3
Respondent Number	Response Options										
125	5	5	5	4	5	5	5	5	5	5	5
126	4	3	3	3	3	3	3	4	3	3	4
127	3	3	3	3	3	3	3	3	3	3	3
128	4	3	2	2	3	2	2	3	2	3	2

Appendix D - Raw Survey Data (cont.)

	Question Number									
	Q33.4	Q34.1	Q34.2	Q34.3	Q35	Q36	Q37.1	Q37.2	Q37.3	Q37.4
Respondent Number	Response Options									
1	3	5	4	2	3	3	4	2	3	2
2	4	4	4	4	4	4	3	4	4	4
3	4	4	4	3	3	3	4	4	4	3
4	4	4	3	4	3	4	4	4	3	4
5	3	5	4	5	5	4	4	4	4	4
6	3	4	5	4	5	5	5	4	5	4
7	4	5	4	5	3	4	4	4	4	4
8	3	3	5	3	4	4	4	4	4	4
9	4	4	4	4	3	3	3	3	3	3
10	5	5	5	5	5	4	4	4	4	4
11	5	5	5	4	3	4	5	5	5	5
12	4	5	4	4	3	4	4	4	4	4
13	4	4	3	4	2	2	3	5	2	4
14	1	4	4	4	3	3	3	3	3	3
15	2	5	4	5	3	3	2	2	2	3
16	3	4	2	2	2	2	2	2	5	4
17	4	4	4	4	2	5	5	5	4	5
18	4	5	5	5	3	2	3	3	2	3
19	4	4	4	4	3	5	4	5	5	4
20	4	4	4	4	5	4	4	4	4	4
21	4	4	5	4	3	4	4	4	4	4
22	3	4	1	1	1	4	4	4	4	4
23	4	5	5	5	3	3	3	3	3	3
24	4	5	5	5	3	3	3	3	3	3
25	4	4	4	4	5	4	4	4	4	4
26	3	4	5	5	4	4	4	4	4	4
27	5	3	5	5	2	3	3	3	3	3
28	1	4	4	4	3	3	3	2	3	2
29	2	4	4	2	3					
30	4	4	4	4	2	4	4	4	4	4
31	5	5	5	2	3	4	5	5	5	5

Appendix D - Raw Survey Data (cont.)

	Question Number									
	Q33.4	Q34.1	Q34.2	Q34.3	Q35	Q36	Q37.1	Q37.2	Q37.3	Q37.4
Respondent Number	Response Options									
32	4	5	5	5	2	4	4	4	4	4
33	4	5	4	4	3	4	4	4	4	4
34	3	5	5	5	5	2	2	3	2	2
35	5	3	2	2	2	4	4	4	4	4
36	4									
37	5	4	4	4	3	3	2	2	2	5
38	3	4	4	4	3	4	4	4	4	4
39	3	4	3	4	3	4	4	4	4	4
40	4	5	4	4	3	4	4	4	4	4
41	5	4	4	4	3	4	4	4	4	4
42	3	4	4	3	2					
43	5	4	4	4	3	4	4	4	4	4
44	3	4	4	4	4	4	4	4	4	4
45	4	4	4	4	4	4	4	4	4	4
46	4	4	4	4	5	4	4	4	4	4
47	4	3	4	4	5	4	4	4	4	4
48	4	3	3	3	4	4	4	4	4	4
49	5	4	4	2	4	4	4	4	4	4
50	3	4	4	4	2	3	3	3	3	3
51	3	4	4	4	3	3	3	3	3	3
52	2	5	5	5	5	4	4	4	4	4
53	3	4	3	4	3	4	4	4	4	4
54	5	4	4	4	3	4	4	4	4	4
55	4	4	5	3	3	5	5	5	5	5
56	4	4	4	4	3	2	2	3	3	3
57	3	4	5	5	3	4	4	4	4	4
58	3	4	5	3	3	5	5	4	5	5
59	4	4	4	4	3	3	3	3	3	3
60	2	2	1	2	3	2	4	2	3	4
61	4	5	3	3	1	4	4	5	5	5
62	4	4	4	4	3	3	3	3	3	3

Appendix D - Raw Survey Data (cont.)

	Question Number									
	Q33.4	Q34.1	Q34.2	Q34.3	Q35	Q36	Q37.1	Q37.2	Q37.3	Q37.4
Respondent Number	Response Options									
63	1	2	1	2	1	3	3	2	2	2
64	4	5	3	3	1	5	5	5	4	4
65	3	4	4	4	3	4	4	4	4	4
66	3	4	4	4	3	4	4	4	4	4
67	3	3	3	3	4	4	4	4	4	4
68	1	4	4	2	4	4	4	4	4	4
69	3	4	4	4	2	3	3	3	3	3
70	3	4	4	4	3	3	3	3	2	3
71	2	5	5	5	5	4	4	4	4	4
72	5	5	5	2	3	5	5	5	5	5
73	4	5	5	5	2	4	4	4	4	4
74	4	5	4	4	3	4	4	4	4	4
75	1	5	5	5	5	2	2	3	3	3
76	4	4	5	3	3	5	5	4	5	4
77	4	4	4	4	3	3	3	3	3	3
78	3	4	5	5	3	4	4	4	4	4
79	3	4	5	3	3	4	5	5	5	5
80	3	4	2	2	2	3	2	2	2	2
81	4	4	4	4	2	5	5	5	5	4
82	3	3	5	3	4	4	4	4	4	4
83	5	4	4	4	3	2	3	3	3	3
84	5	5	5	5	5	4	4	4	4	4
85	5	5	5	4	3	5	5	5	4	5
86	4	5	4	4	3	4	4	4	4	4
87	4	5	5	5	5	2	3	2	2	4
88	4	4	2	5	2	4	4	4	4	4
89	3	5	4	5	3	4	5	5	5	5
90	3	4	2	1	2	3	2	3	2	2
91	4	4	4	4	3	4	4	4	4	4
92	4	5	2	5	1	4	4	4	4	4
93	4	5	5	4	1	4	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number									
	Q33.4	Q34.1	Q34.2	Q34.3	Q35	Q36	Q37.1	Q37.2	Q37.3	Q37.4
Respondent Number	Response Options									
94	2	4	2	2	3	4	4	4	4	4
95	3	4	3	4	3	4	4	4	4	4
96	5	4	4	4	3	4	4	4	4	4
97	3	4	4	3	2	3				3
98	5	4	4	4	3	4	4	4	4	4
99	2	4	4	4	4	4	4	4	4	4
100	4	4	4	4	4	4	4	4	4	4
101	4	4	4	4	5	4	4	4	4	4
102	4	3	4	4	5	4	4	4	4	4
103	3	4	3	4	3	4	5	4	4	4
104	4	4	4	4	3	4	4	4	4	4
105	3	3	3	4	3	4	4	4	4	4
106	3	3	3	3	4	5	3	5	3	
107	5	4	4	4	3	4	4	4	4	4
108	4	4	4	3	2	3	3			3
109	4	4	4	4	3	4	4	4	4	4
110	3	4	4	4	4	4	4	4	4	4
111	4	4	4	4	4	4	4	4	4	4
112	4	4	4	4	5	4	4	4	4	4
113	4	3	4	4	5	4	4	4	4	4
114	3	4	3	4	3	4	4	4	4	4
115	5	4	4	4	3	4	4	4	4	4
116	4	4	5	3	3	5	5	5	5	4
117	3	4	4	4	3	3	3	3	3	3
118	1	3	5	5	3	4	4	4	4	4
119	3	4	5	3	3	5	5	5	5	5
120	4	4	4	4	3	3	3	3	3	3
121	2	2	1	2	2	2	3	2	3	3
122	4	5	3	3	1	5	5	4	5	5
123	3	4	4	4	3	4	4	4	4	4
124	3	3	3	3	4	4	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number									
	Q33.4	Q34.1	Q34.2	Q34.3	Q35	Q36	Q37.1	Q37.2	Q37.3	Q37.4
Respondent Number	Response Options									
125	5	4	4	2	4	4	4	4	4	4
126	3	4	4	4	3	3	3	3	3	3
127	3	4	4	4	3	3	3	3	2	3
128	2	5	5	5	5	4	4	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number								
	Q38.1	Q38.2	Q39.1	Q39.2	Q39.3	Q40	Q41.1	Q41.2	Q41.3
Respondent Number	Response Options								
1	5	5			2	2	2	4	2
2	4	4	4	4	4	4	4	4	4
3	4	4	3	4	4	3	4	4	4
4	4	4	4	4	4	4	4	4	4
5	5	5		5	4	5	5	4	4
6	4	2	4	4	5	5	4	4	4
7	5	5	4	4	4	4	3	3	3
8	3	3	4	4	4	4	3	3	3
9	4	3	4	4	3	3	4	4	4
10	1	4	5	4	4	5	4	5	4
11	5	5	5	5	5	5	4	4	4
12	5	4	5	5	4	5	5	5	4
13	4	2	4	4	2	2	4	4	4
14	4	5	4		3	3	4	4	5
15	5	5	4	4	2	4	3	3	3
16	2	2	5	4	2	5		2	
17	4	3	3	4	5	4	4	2	4
18	4	5	4	2	3	5	4	4	4
19	4	4	4	4	5	4	4	4	4
20	4	4	4	4	4	4	4	5	4
21	3	3	3	4	4	5	3	2	3
22	4	4	4	4	4	4	4	4	2
23	5	5	5	5	3	4	5	5	5
24	4	5	4	2	3	5	4	4	4
25	4	4	4	4	4	4	4	5	4
26	4	4	4	4	4	4	4	4	2
27	3	3	3	3	3	4	3	4	3
28	4	2	2	2	2	2			
29	1	1	3	1		1	2	2	4
30	4	4	4	4	4	4	4	4	4
31	5	5	5	5	5	5	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number								
	Q38.1	Q38.2	Q39.1	Q39.2	Q39.3	Q40	Q41.1	Q41.2	Q41.3
Respondent Number	Response Options								
32	5	4	4	5	4	4			
33	5	4	5	5	4	5	5	5	4
34	4	4	3	2	2	4	4	4	4
35	2	2	4	4	4	4	3	3	3
36									
37			2	4	2	3			
38	4	4	2	2	4	5	4	4	4
39	3	3	4	4	4	3	3	3	3
40	5	4	5	5	4	5	5	5	
41	5	3			4				
42	3	4				4	4	3	4
43	5	4	3	4	4	4	4	4	5
44	4	4	4	4	4	4	4	4	4
45	4	5	4	4	4	4	4	4	4
46	4	4	4	4	4	4	4	4	4
47	4	4	4	4	4	4	3	4	3
48	3	3	4	4	4	4	3	3	3
49	4	4	4	4	4	4			
50	2	4	2	2	3	2	4	3	4
51	4	3	3		3	3	3	4	4
52	1	1	5	4	4	5	4	5	4
53	3	3	4	4	4	3	3	3	3
54	5	4	3	4	4	4	4	4	5
55	4	2	5	4	5	4	4	5	5
56	4	4	4	4	3	3	4	4	4
57	4	2	4	4	4	4			
58	4	2	5	4	5	4	4	5	5
59	4	4	4	4	3	3	4	4	4
60	3	2	2	2	2	2	1	2	2
61	5	5	5	5	5	4	5	5	4
62	4	4	4	4	3	3	4	4	4

Appendix D - Raw Survey Data (cont.)

	Question Number								
	Q38.1	Q38.2	Q39.1	Q39.2	Q39.3	Q40	Q41.1	Q41.2	Q41.3
Respondent Number	Response Options								
63	3	2	2	2	2	2	1	2	2
64	5	5	5	5	5	4	5	5	4
65	5	4	4	4	4	4	4	4	4
66	5	4	4	4	4	4	4	4	4
67	3	3	4	4	4	4	3	3	3
68	4	4	4	4	4	4			
69	2	4	2	2	3	2	4	3	4
70	4	3	3		3	3	3	4	4
71	1	1	5	4	4	5	4	5	4
72	5	5	5	5	5	5	4	4	4
73	5	4	4	5	4	4			
74	5	4	5	5	4	5	5	5	4
75	4	4	3	2	2	4	4	4	4
76	4	2	5	4	5	4	4	5	5
77	4	4	4	4	3	3	4	4	4
78	4	2	4	4	4	4			
79	4	2	5	4	5	4	4	5	5
80	2	2	5	4	2	5		2	
81	4	3	3	4	5	4	4	2	4
82	3	3	4	4	4	4	3	3	3
83	4	3	4	4	3	3	4	4	4
84	1	4	5	4	4	5	4	5	4
85	5	5	5	5	5	5	4	4	4
86	5	4	5	5	4	5	5	5	4
87	4	4	3	2	2	4	4	4	4
88	1	1	4	4	4	2	5	5	4
89	2	3	4	4	5	4	4		
90	3	3	2	3	2	4	3	3	2
91	4	4	4	4	4	4			
92	1	1	2	4	4	2	4	1	2
93	5	4	3	4	4	3	4	4	5

Appendix D - Raw Survey Data (cont.)

	Question Number								
	Q38.1	Q38.2	Q39.1	Q39.2	Q39.3	Q40	Q41.1	Q41.2	Q41.3
Respondent Number	Response Options								
94	4	2	2	1	4	2	4	2	2
95	3	3	4	4	4	3	3	3	3
96	5	3			4			3	
97	3	4	3			4	4	3	4
98	5	4	3	4	4	4	4	4	5
99	4	4	4	4	4	4	4	4	4
100	4	5	4	4	4	4	4	4	4
101	4	4	4	4	4	4	4	4	4
102	4	4	4	4	4	4	3	4	3
103	3	3	4	4	4	3	3	3	3
104	5	4	3	4	4	4	4	4	5
105	3	3	4	4	4	3	3	3	3
106	3			3		3		5	3
107	5	3		3	4			3	
108	3	4	3		3	4	4	3	4
109	5	4	3	4	4	4	4	4	5
110	4	4	4	4	4	4	4	4	4
111	4	5	4	4	4	4	4	4	4
112	4	4	4	4	4	4	4	4	4
113	4	4	4	4	4	4	3	4	3
114	3	3	4	4	4	3	3	3	3
115	5	4	3	4	4	4	4	4	5
116	4	2	5	4	5	4	4	5	5
117	4	4	4	4	3	3	4	4	4
118	4	2	4	4	4	4			
119	4	2	5	4	5	4	4	5	5
120	4	4	4	4	3	3	4	4	4
121	3	2	2	2	2	2	1	2	2
122	5	5	5	5	5	4	5	5	4
123	5	4	4	4	4	4	4	4	4
124	3	3	4	4	4	4	3	3	3

Appendix D - Raw Survey Data (cont.)

	Question Number								
	Q38.1	Q38.2	Q39.1	Q39.2	Q39.3	Q40	Q41.1	Q41.2	Q41.3
Respondent Number	Response Options								
125	4	4	4	4	4	4			
126	2	4	2	2	3	2	4	3	4
127	4	3	3		3	3	3	4	4
128	1	1	5	4	4	5	4	5	4