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Old Dominion University

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SHARED LEADERSHIP IN SIX SIGMA TEAMS FROM THE NORTH SHORE-LIJ HEALTH SYSTEM

by

Brian J. Galli
B.S. May 2007, Binghamton University
M.S. July 2009, Missouri University of Science & Technology

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Old Dominion University in Partial Fulfillment of the
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Approved by:

Dr. Holly Handley (Director)

Dr. Pilar Pazos (Member)

Dr. Rafael Landaeta (Member)

Dr. Ray Luechtefeld (Member)

ABSTRACT

SHARED LEADERSHIP IN SIX SIGMA TEAMS FROM THE NORTH SHORE-LONG ISLAND JEWISH HEALTH SYSTEM

Brian J. Galli
Old Dominion University, 2013
Director: Dr. Holly Handley

The main goal of the research was to identify the relationships that the internal research team environment and external coaching variables had with the degree of shared leadership in the context of Six Sigma teams from the North Shore LIJ Health System. Furthermore, the research ascertained the relationships that these variables had with two performance metrics: a team's ability to complete project deliverables and satisfy customer's requirements. This research also sought to understand additional factors that affected the five variables.

The research found that while shared leadership did not positively change as a team progressed through the phases of the DMAIC (define, measure, analyze, improve, and control) process, shared leadership had unique relationships with the four variables. The study identified that all of these relationships are impacted by several factors in the team environment. A team's degree of shared leadership and the development of these relationships were most influenced by the complexity of the deliverables and change management that were associated with the phases. A direct relationship was also found between shared leadership and decision-making. This relationship was found to impact shared leadership and the relationships that shared leadership had with the four variables. The presence of the three dimensions of the internal team environment condition was also instrumental to the development of these relationships. The research also concluded that the degree and style of external coaching had a critical role in the development of these relationships. The study also identified general organizational issues that affected both the development of the five variables and the Six Sigma model.

The results of this research have contributed to building the body of knowledge in several areas, including leadership development, team dynamics, the Six Sigma and improvement science methodologies, and social network theory. This study also builds

practical knowledge by outlining implications to factors such as change management and leadership development. The research builds knowledge by proposing a model that outlines a continuum for how shared decisions can be made in a team. The research also outlines a series of improvement strategies that future teams and coaches can improve the effectiveness of Six Sigma teams.

This dissertation is dedicated to my loving wife, Catherine, who has provided continuous love and support to me throughout this entire journey. Her guidance and love have helped me overcome many obstacles and she has been a beacon of support for me.

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NOMENCLATURE

SNA	Social Network Analysis (also known as Social Network Theory)
NSLIJ	North Shore LIJ Health System (NSLIJ Health System)
CLI & DIS	Center for Learning and Innovation & Division of Improvement Sciences
DOE	Design of Experiments
DIS	Division of Improvement Sciences
DMAIC	Define, Measure, Analyze, Improve, and Control (Six Sigma Procedure)
FMEA	Failure Modes and Effects Analysis
CTQ	Critical To Quality Tree
$(S_C)^2$	Variance of centrality (centralization) in social network analysis
$C_D(n_i)$	The in-degree centrality of individual I
$C_D(n^*)$	The maximum observed value and g is the number of team members
α	Statistical alpha value (also known as Type I error in statistics)
β	Statistical beta value (also known as Type II error in statistics)
N	Population Size (i.e. population available for sampling)
ANOVA	Analysis of Variance
Xbar	Mean (average) of a sample
σ^2	Variance of a sample
σ	Standard deviation of a sample
H_0	Null Hypothesis
H_1	Alternative Hypothesis
δ	Power Level
SOW	Statement of Work
SIPOC	Supplier, Input, Process, Output, and Customer Diagram
MSA	Measurement Systems Analysis
WWW	What, Who, When action plan (Six Sigma Term)

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CHAPTER 1

INTRODUCTION

1.1 Research Topic Background

Shared leadership has received a lot of attention in the past few years, mainly due to the fact that the traditional "top-down" approach to leadership is not as effective in today's society as it has been in the past. In today's business and engineering environments, organizations are striving for maximum efficacy and efficiency in order to remain competitive and to outperform rivals. More organizations have employees complete projects in a team format, since it enables the organization to quickly adjust to the various requirements and demands of its industry. But, in order to work effectively in team formats, the proper leadership model must be selected to enable the team to make rational, timely, and effective team-decisions.

In the past 20 years, the "shared leadership" leadership model has begun to be researched in both academic and industrial circles. This model has been shown to provide team members and organizations with many benefits, including the ability to complete projects on time and make decisions that were not only effective, but also logical (Carson, Marrone, & Tesluk, 2007, p. 1217). Simultaneously, many organizations have turned towards Six Sigma methodologies as a way to develop both innovative solutions and the skills of today's knowledge workers and project managers. Today's problems and projects are more complex and uncertain than ever. Traditional project management techniques are proving more and more inadequate and organizations are leaning towards Six Sigma methodologies that enable them to be more adaptive to change and allow greater flexibility when coping with dynamic project requirements. They provide organizations with the ability to distribute responsibility to project teams, which helps those teams proactively respond to the changing demands of their projects.

A review of the research performed by Carson et al. (2007) has shown that very little research has addressed the topic of the shift to internally distributed forms of shared leadership. Some research has shown that scholars have encouraged the use of leadership being shared by team members. For example, Gibbs (1954) was the first to argue that "leadership is probably best conceived as a group quality, as a set of functions which

must be carried out by the group" (Carson et al., 2007, p. 1217). This type of concept was known as "distributed leadership." Research has also shown that "when team members voluntarily and spontaneously offer their influence to others in support of shared goals, shared leadership can provide organizations with competitive advantage through increases in commitment, in the personal and organizational resources brought to bear on complex tasks, in openness to reciprocal influence from others, and in the sharing of information" (Carson et al., 2007, p. 1218). Koschzeck's (2009) research finds that organizations that utilized shared influential acts perform much better than those that rely on a single individual for shared leadership. One can conclude that organizations perform much more efficiently when they utilize a shared leadership team format as opposed to the single-individual form of leadership. These opinions and ideas challenged the conventional thought on leadership, but review of the research shows that there is not much empirical work on shared formats of leadership, such as the concept of shared leadership.

1.2 Problem Background

A review of research studies and literature has led to the conclusion that in the past few years, shared leadership has emerged at both the academic and industrial levels as organizations have begun to see the high level of influence and impact that it can have on a team. But one research field that has not been investigated is that of the relationship between shared leadership and the concept of Six Sigma methodologies, specifically with regard to the relationship(s) that internal and external team environmental conditions have on shared leadership in Six Sigma team environments. The research performed also has not yet investigated the relationship(s) between internal and external environmental conditions on the shared leadership dynamic in real-world Six Sigma teams as they relate to the team performance metrics in these project environments. More specifically, research has yet to be performed in the field of shared leadership in relation to Six Sigma project teams in the healthcare delivery industry; in conjunction with this deficit, research has yet to map out shared leadership through each phase of the Six Sigma Define, Measure, Analyze, Improve, and Control (DMAIC) methodology, which is the backbone process utilized by Six Sigma teams.

As a first step, my research focused on studying the relationship(s) shared leadership has with two critical input environmental conditions (internal team environment and external coaching) and two performance measures (project completion and customer satisfaction), in the context of the North Shore LIJ Health System (NSLIJ Health System). For my research study, Six Sigma teams from the NSLIJ Health System served as the data source for this research effort. It was critical to study shared leadership in relation to continuous project teams in NSLIJ Health System since this understanding provided the NSLIJ Health System with the ability to better understand how to most effectively establish shared leadership teams in the organization as well as the types of guidance and support a shared leadership team needed in order to complete Six Sigma projects.

1.3 Problem Statement

My research effort performed a longitudinal concurrent mixed-methods research study through the use of social network theory/analysis, in order to observe the relationships between the input environmental conditions and shared leadership in real-life organization and industry teams that utilize Six Sigma methodologies. It then studied these relationships in conjunction with a team's ability to complete its assigned project deliverables and to satisfy the customer's requirements. This research study also sought to map out shared leadership through each phases of the DMAIC methodology, which is the backbone process utilized by Six Sigma teams. Therefore, the problem statement was defined to incorporate the need for a longitudinal study by stating the following: In the context of NSLIJ Health System Six Sigma teams, there exists a relationship between shared leadership and each phase of the DMAIC structure. In addition, the input environmental conditions of "internal team environment" and "external coaching" have a relationship with the degree of shared leadership present in these team settings. There exists a simultaneous relationship between the degrees of shared leadership present in these team settings and two performance metrics, which include: the perceived effectiveness of a team's ability to complete the assigned project deliverables (i.e. project completion) and the perceived effectiveness of a team's ability to satisfy the requirements of the customer (i.e. customer satisfaction).

The key metrics that were utilized to measure the outcome of the research effort included: the level of centralization of the interactions among the team members and the perceived level of influence that each member has for each fellow team member (shared leadership measure), the level of satisfaction with the internal team environmental conditions (internal team environment measure), the level of internal team member satisfaction with the external environmental conditions (external coaching environmental measure), the perceived effectiveness of a team's ability to complete the assigned project deliverables (i.e. project completion) and the perceived effectiveness of a team's ability to satisfy the requirements of the customer (i.e. customer satisfaction).

1.4 Research Purpose and Contribution

This study provided the NSLIJ Health System with the knowledge and actions that must be taken in order to maintain a team's optimal degree of shared leadership as well as to define the necessary internal and external environmental conditions for success. This model could then be utilized by the NSLIJ Health System to predict the level of variables such as internal and external environmental conditions that can help to maximize a team's performance and degree of shared leadership. It can also help develop guidelines and principles that organizations and managers/leaders can utilize when tracking the progress of a team's completion of a project as well as the development of its team environment. In conjunction, this study provided the NSLIJ Health System with a clear roadmap of shared leadership through each phase of the DMAIC methodology, which the health system utilizes to perform all of its Six Sigma projects.

By identifying the influences and relationships that both the internal and external environments have on the development of shared leadership in real life Six Sigma project environments, the NSLIJ Health System is now better equipped to evaluate a team's degree of shared leadership at any point in the Six Sigma cycle and determine if it is underdeveloped or out of control. If the team's degree of shared leadership was not at the proper level, this study provided support in finding methods that the NSLIJ Health System could utilize to alleviate the situation. Understanding the influences and relationships that both the internal and external environments had on the development of shared leadership enabled management to more effectively guide a team, thereby

ensuring the optimal level of shared leadership, driving both efficacy and efficiency within the scope of the project.

This research not only provided several benefits for the NSLIJ Health System (as outlined above), but since the chosen research topic has not been investigated in the healthcare delivery field, this study also provided a significant first step towards establishing research efforts in this field. In addition, since this study used concepts and methods from social network theory (analysis), it provided benefits to research fields such as social science, leadership development, and organizational development that utilize social network theory (analysis) methods and concepts. It also provided new avenues of research for healthcare delivery. Though all of the results and findings from this research effort were specific to the NSLIJ Health System, this research effort was able to develop generalizations that can be applied to other healthcare delivery organizations as well as other Six Sigma team environments in different industries. While specific findings and conclusions may not apply, the methodology and approach served as a baseline for future research efforts. Researchers, other healthcare delivery organizations, or anyone working in Six Sigma team environments can utilize the concurrent mixed methods approach from this study in order to perform both organization-specific and generalizable research studies.

In order for shared leadership to emerge in real-life organizations and industries, two sets of activities must take place. First, team members must offer leadership and seek to influence the direction, support, and motivation of the group. Secondly, the team as a whole must be willing to rely on leadership being provided by multiple team members, not just a single source. In order for each of these sets of behavior to occur, members must understand and believe that "offering influence to and accepting it from fellow team members are welcome and constructive actions" (Carson et al., 2007, p. 1232). Based on these two sets of behaviors, Carson et al.'s research found two critical variables that could impact the development of shared leadership in teams. The first variable is known as "internal team environment" and accounts for the support that aids in the development of shared leadership over a period of time. The second variable is known as "external coaching," which involves the level of supportive coaching that is provided by some type of external leader (Carson et al., 2007, p. 1232). But Carson et al.'s research has shown

that these two variables have neither been extensively studied nor linked to the development and evolution of shared leadership throughout the execution of a project.

Therefore, the main goal of this research effort was to identify the relationship(s) that the internal team environment and external coaching variables have on the degree of shared leadership in the context of Six Sigma teams from the NSLIJ Health System. Within that environment, the research sought to ascertain the relationship(s) that these variables have with two performance metrics: the perceived effectiveness of a team's ability to complete the assigned project deliverables (i.e. project completion) and the perceived effectiveness of a team's ability to satisfy the requirements of the customer (i.e. customer satisfaction). The main goal of this research also sought to understand additional factors or issues that affected the five pre-defined hypotheses as well as the five variables studied in the research. The internal team environment and external coaching variables were chosen as the variables of interest in this study since review of research studies and literature has shown that these two variables have not been thoroughly researched with respect to Six Sigma teams from the healthcare delivery field. Indeed, these two variables were theorized to be the factors that had the highest potential of having a relationship with the shared leadership variable in Six Sigma teams.

This section of the dissertation has presented the motivation of the research, goals and contribution, and the problem statement for the research. The body of the dissertation is comprised of five remaining chapters. Chapter Two outlines the theoretical background as well as relevant theories and models that will be required to support the research effort. Chapter Three provides an in-depth review of the research effort's intentions, problem statement as well as hypotheses. It also details the specific factors of the research design methodology that were used to execute research, including: type of research design, data source and the requirements for data source, data collection, pre-analysis tasks, and analysis methods. Chapter Three also highlights the research execution and research management plans that outlined the steps, schedule, and resources that I used to execute the research study. Chapter Four presents the quantitative and qualitative analysis performed for the research effort, while Chapter Five discusses the findings and results from the execution of the analysis methods. Chapter Six focuses on discussing the

conclusions, contributions to body of knowledge and to the NSLIJ Health System, limitations of the research, and recommendations for future research.

CHAPTER 2

BACKGROUND OF THE STUDY

2.1 Summary of Background Research & Gap Analysis

The literature review highlights the relevant research previously performed on shared leadership, the significance and effectiveness of shared leadership in team environments, the relationship that shared leadership has with similar constructs as well as modern theories of leadership, the relationship between shared leadership and team performance, developing shared leadership in teams (internal team environment), the impact of external coaching, the basics of Six Sigma, and the basic history of the NSLIJ Health System and Six Sigma efforts in the health system. The information in this section outlines the requirements needed to foster shared leadership as well as the two environmental conditions (internal team environment and external coaching), necessary to develop and maintain a shared leadership environment.

The "Relevant Theories and Models" section describes the relevant theories of social networks, metrics associated with their analyses, and additional benefits of social network analysis. It shows that social network analysis is highly applicable to study the topic of shared leadership. It has been effectively used in past research efforts, many of which have focused on shared leadership or similar topics. This part also details the process of developing a network/sociogram as well as how to collect the data that is needed to develop these diagrams. In addition, this section outlines several different measures, at both the individual and network levels, that have been used in past research efforts to measure the effectiveness or performance of a variable. The most commonly utilized whole network metric is known as team centralization; this concept is the most widely used tool in any research effort involving social science or the study of human interaction (Freeman, 1979).

Gap analysis has shown that in the past few years, shared leadership has emerged at both the academic and industrial levels as organizations have begun to see the high level of influence and impact that it can have on a team. One research field that has not been investigated is the relationship between shared leadership and Six Sigma methodologies with regard to the effect that internal and external team environmental conditions have on

the shared leadership variable within the team environments. Previous research also has not yet investigated how this relates to the team's performance metrics in these project environments. More specifically, research has yet to be performed in the field of shared leadership/Six Sigma relationship in the healthcare delivery industry. Furthermore, research has yet to map out shared leadership through each phase of the DMAIC methodology, the backbone process utilized by Six Sigma teams.

As a first step, my research focused on studying the relationship(s) shared leadership has with two critical input environmental conditions (internal team environment and external coaching) and two performance measurements (project completion and customer satisfaction), within the NSLIJ Health System. This is a critical area to study shared leadership in relation to continuous project teams since this understanding will provide the NSLIJ Health System with the ability to learn how to most effectively establish shared leadership teams in the organization as well as the types of guidance and support a shared leadership team may need in order to complete Six Sigma projects. This research not only provided several benefits for the NSLIJ Health System (as outlined in Chapter One), but since the chosen research topic has not be investigated in the healthcare delivery field, this study also provides a significant first step towards establishing research efforts in this field.

Even though all of the results and findings from this research effort will be specific to the NSLIJ Health System, by evaluating the external validity (i.e. the estimated truth of conclusions that involve generalizations; also known as the degree in which the conclusions from a research study would hold for other people in other places and at other times) (Trochim, 2006). of the findings and conclusions from this study, this research effort will be able to develop generalizations that will be accurate to some degree of validity, which in turn, can be utilized by other healthcare delivery organizations as well as other Six Sigma team environments (across different industries). In addition, even though the findings and conclusions will not be able to be fully generalizable to all healthcare delivery organizations or Six Sigma team environments (i.e. since the data are coming from one source), the methodology and approach can serve as a baseline for future research efforts. The concurrent mixed methods approach proposed in this study effort can provide a template for future research endeavors in this

field; researchers or other healthcare delivery organizations or Six Sigma team environments can utilize the proposed concurrent mixed methods approach from this study in order to both perform organization-specific and generalizable research studies.

2.2 Literature Review

2.2.1 Shared Leadership

"Leadership" is best defined as "a process whereby an individual influences a group of individuals to achieve a common goal" (Northouse, 2007, p. 3). It has four main components: "leadership involves influence; leadership is a process; leadership involves goal attainment; and leadership occurs in a group context" (Northouse, 2007, p. 3). The idea of leadership is easy to understand, but difficult to practice since it involves the idea that behavior comes first, followed by skills (Chapman, 2006). Sylvester and Jasmine Renner's research shows that leadership is a difficult concept to practice since being a leader involves the critical ability to possess an "unusual degree of power to create the conditions under which other people must live and move....leaders must take special responsibility...lest the act of leadership create more harm than good" (Renner & Renner, 2006, p. 1). The act of leadership is one that can be performed with many different styles or approaches; it both affects and is affected by followers. It is a term that is interactive and involves being readily available to all people (Rubenstein, 2003, p. 3).

Shared leadership has several definitions, which differ in context and application. Most of the research into leadership and leadership development has focused on the individual traits, skills and effectiveness that an individual must develop/possess in order to be an effective leader. However, this research has lacked an evaluation of the properties that groups should possess in order to be effective and to allow a leader to be effective. Leadership revolves around the idea of influence; it uses influence to convince other people to understand and follow, and to determine how to accomplish the tasks that need to be done. In a similar vein, shared leadership requires that all team members accept the accountability and responsibility of the leadership role in the team setting. Shared leadership refers to a collective responsibility, in which team members work as one unit in order to achieve a vision or shared set of goals. This type of undertaking not only requires the team members to operate as team, but also requires them to act as both followers and leaders. They must push themselves to exceed the expectations of the

group since this model needs every member's participation and contributions to be at their fullest potential (Koschzeck, 2009). In this model, research identifies that shared leadership involves a "coordinated, purposeful, voluntary, vertical and horizontal distribution and acceptance of decision-making, influence, and responsibility" (Koschzeck, 2009, p. 13).

The most common factors associated with shared leadership are shared responsibility, influence, accountability, and decision-making (also known as shared power), all of which are necessary for an organization to remain competitive at every level of today's business and engineering worlds. The use of shared leadership enables individuals to increase their levels of empowerment, effectiveness, decision-making, and accountability/responsibility, and results in increased job satisfaction, improved communication, shared sense of purpose and vision, and improved employee turnover (Koschzeck, 2009). When using a shared leadership model, the overall benefit is that "the more people believe that they can influence and control the organization, the greater organizational effectiveness and member satisfaction will be" (Koschzeck, 2009, p. 14). Through the use of this understanding, one can conclude that if members are empowered to be responsible for the leadership role in a team, they will support the goals, vision, and objectives of the organization.

But just like many business concepts, shared leadership appears to have a few negative aspects. One of the most critical negative factors is that a lack of trust among team members can cause the formation of factions, each with their own agenda and goals/objectives. In addition, this type of environment could result in a more lengthy decision-making process, especially if team members lack patience or if members lack a team-focus to group process (these two factors could lead to lack of commitment and poor decision making). In both cases, the lack of trust and internal group conflict can act as barriers to effective implementation and use of shared leadership. Another factor that appears to be a negative aspect of shared leadership is the idea of over-relying on collaboration among team members, which could result in a team's "inability or avoidance of critical decision-making, and not taking charge might lead to giving too much responsibility to people who are not capable or ready" (Kouzes & Posner, 2002, p. 100).

As explained in the beginning of this section, leadership involves a high level of influence in order to convince others to understand and agree regarding the tasks that need to be done and how to accomplish these tasks. Leadership must also be viewed as the "process of facilitating individual and collective efforts to accomplish shared objectives" (Koschzeck, 2009, p. 13). Research has also found that shared leadership involves the idea of influence sharing and distribution of leadership; but the biggest eye opener when reviewing the research into shared leadership is that it must be viewed as a process and not a one-time event in history (Koschzeck, 2009).

Research has found that in order to fully develop and understand the concept of how leadership can be shared among team members, one must utilize Yukl's (1989) definition of leadership, which defines leadership as "[the] influence processes involving determination of the group's or organization's objectives, motivating task behavior in pursuit of these objectives, and influencing group maintenance and culture" (p. 5). In the simplest form, shared leadership is "a condition in which teams collectively exert influence and leadership is distributed among all team members depending on their skills, abilities, and the task" (Adams, Matkin, & Zafft, 2009, p. 273). But by utilizing the idea that leadership involves an influence factor, research commonly defines shared leadership in the following manner, "as an emergent team property that results from the distribution of leadership influence across multiple team members" (Carson et al., 2007, p. 1218).

Based on this definition of shared leadership, research has shown that shared leadership is created when individual team members engage in activities or tasks that influence the team and other team members in areas such as direction, support, or motivation; but that shared leadership is also created through the series of interactions that members have with each other, such as the sharing and negotiation of leadership responsibilities. The structure that is created by this process can be considered a leadership network that provides influence and shapes both the team member and team outcomes and activities (Carson et al., 2007).

Review of past research on leadership indicates that shared leadership can be thought of in terms of either "the strength of influence (i.e., its quality or effectiveness) or the source of influence (i.e., single versus multiple team members)" (Carson et al., 2007, p. 1219). Based on the definition of shared leadership above, it can be seen that this

definition focuses on multiple sources of influence and "refers to widespread influence within teams rather than to specific leadership behaviors, formal positions, specific types of influence, or the effectiveness of the leadership exhibited by these sources" (Carson et al., 2007, p. 1220). Based on these ideas, many researchers believe that "shared leadership can be conceptualized along a continuum based on the number of leadership sources (i.e. team members) having a high degree of influence in a team" (Carson et al., 2007, p. 1220).

In cases towards the low end of the continuum, team members follow a leadership structure with one individual in control or one source of influence; at the opposite end, leadership is distributed among team members and most (if not all) members provide leadership influence to one another. At the high end of the continuum, the source of leadership is distributed among team members and it is not concentrated on a single individual or member; in this sense, in shared leadership environments, members both lead and follow each other in such a way that "at a given time, members are both providing leadership for certain aspects of team functioning and also responding to the leadership provided by other team members in different areas" (Carson et al., 2007, p. 1220). In a shared leadership environment (where teams have high levels of shared leadership), it can also be assumed that teams may shift/rotate leadership over a period of time, in order to provide different members with the opportunity to provide leadership "at different points in the team's life cycle and development" (Carson et al., 2007, p. 1220).

2.2.2 The Relationship between Shared Leadership and Similar Constructs

For reference, shared leadership is a term that is known by many names, including distributive leadership, co-leadership, collective leadership, shared governance, shared power, and blended leadership (Koschzeck, 2009). But even more important, it is critical to explain the relationship that shared leadership has with similar constructs, including self-management (team autonomy), team empowerment, emergent leadership, cooperation, and team cognition (including transactive memory systems and team mental models) (Carson et al., 2007).

Research has shown that the basic definition of shared leadership (defined by Adams et al. (2009) in the above section) is related to self-managed teams (SMTs) primarily since shared leadership is an important condition in the SMT environment that can

determine and influence the level of effectiveness for the team. In research and real-world applications, shared leadership is a concept and condition that is often synonymously utilized with self-managing teams, also known as team autonomy. Self-managing teams are also known as self-regulating teams and in this type of team environment, a "manager or leader determines the overall purpose or goal of the team, but the team is at liberty to manage the methods by which to achieve that goal" (Thompson, 2008, p. 9). In addition, Chatfield defines self-managing teams as "a group of people working together in their own ways toward a common goal which is defined outside the team" (Chatfield, 2011, para. 3). Wageman's research has found that effective self-managing teams display seven specific features: clear direction, a team task, rewards, material resources, authority to manage their work, goals, and strategic norms" (Wageman, 1997). According to Hackman (1987), self-management or team autonomy should be described as "self-managing and autonomous team designs...in which team members have greater responsibility for setting their own goals, monitoring their own progress, and making their own decisions than do team members in manager-led teams" (p. 325).

Thompson (2008) also points out that the effective use of self-managing teams can often provide significant benefits for a team and organization, including: improved quality, savings, productivity, reductions in employee absenteeism and turnover, and employee morale. While the use of self-managing teams enables a team to build commitment, be more autonomous, and improve morale, this type of environment also has its downsides. The main disadvantage of using self-managing teams is that managers or external leaders usually have much less control over the products and process, which in turn make it difficult for the manager or leader to assess the success or progress of the team. Another disadvantage to consider when using self-managing teams is that this type of team usually requires more time to complete the work (Thompson, 2008).

Previous research has shown that shared leadership is an important condition in the SMT environment since it can determine and influence the level of effectiveness for the team, but as shown above, the definition of shared leadership should be modified when one considers leadership to involve an influence factor Carson et al. (2007). This research further indicated that shared leadership is related to self-management since they share many similar foundational principles, but Carson et al.'s (2007) research qualifies this,

saying that although self-managing team designs may promote the development of shared leadership through increased self-management (Manz & Sims, 1987), or through heightened trust or autonomy (Langfred, 2004), such designs in themselves do not necessarily result in leadership influence being widely distributed in a team, as other factors, such as the internal team environment and external coaching, may also influence shared leadership (Wageman, 2001).

In this sense, the main difference from the shared leadership definition (which sees leadership as involving an influence factor) and self-managed teams is that in shared leadership environments, leadership is not only seen as accepting responsibility or accountability for some of the leadership roles or functions, but that the leadership function also includes a specific level of influence that a team member exerts on his or her fellow members and the team as a whole. In this sense, shared leadership members are not only given more responsibility for the execution of the project (as seen in SMTs), they are also given more authority and influence over the leadership role and responsibility.

Therefore, the term shared leadership is very similar to self-managed teams, but when the shared leadership definition is expanded to include the idea that leadership involves an influence factor, shared leadership becomes a more advanced version of self-managed teams since leadership in shared leadership environments includes all members of the team accepting responsibility and accountability for leadership functions/tasks. In these environments, leadership is also gauged by the level/degree of influence that fellow team members perceive each member of the team to have. In summary, many of the facets and principles of shared leadership and self-managed teams are the same, but the main difference between my definition of shared leadership and self-managed teams is that shared leadership team members must be more driven and committed to the team environment. Based on this definition of shared leadership, a given member's degree/level of leadership is not only dependent on his or her acceptance and handling of their portion of the leadership roles and responsibilities, it also includes the level or degree of influence that fellow team members perceive the team member in question to have. Therefore, shared leadership team environments can be argued to be self-managed teams in which members have higher levels of leadership since the members are

measured on multiple factors of leadership, including level of influence, which is not typically seen in normal self-managed team environments.

Research shows that team empowerment is considered a motivational construct and should be defined as "the collective experience of heightened levels of task motivation as a result of team members' assessments of their team's tasks as providing them with high levels of meaningfulness, autonomy, impact, and potency" (Kirkman & Rosen, 1997, p. 135). Research also shows that from a dynamic point of view, team empowerment can be seen as an "emergent state that precedes or follows team processes, depending on the stage of a team's development and performance cycle (Marks, Mathieu, & Zaccaro, 2001, p. 360). Therefore from this point of view, one can conclude that the concept of team empowerment can (and may) facilitate the development of shared leadership in teams by providing motivation for team members in order to encourage them to exercise some degree of influence. Conversely though, Carson et al. (2007) points out that "shared leadership may also lead to greater team empowerment by heightening members' sense of meaningfulness, autonomy, impact, or potency, depending on the stage of a team's development" (p. 1221). But in any situation, Carson et al.'s research points out a critical finding, in which it states "however, a team may experience a high level of empowerment yet still have a strong external leader providing most of the leadership influence, with very little shared leadership exhibited by team members" (Carson et al., 2007, p. 1221).

The concept of emergent leadership is one that can be defined as "group members exerting significant influence over other members of their group although no formal authority has been vested in them (Goktepe & Schneider, 1983). In terms of the relation between shared leadership and emergent leadership, research by Bales (1953) on teams and groups found that "two informal leaders often emerge in leaderless groups: one focused on the group task, and one concentrating on relational issues" (p. 124). The early research by Bales is very similar to the research performed on shared leadership since shared leadership research usually involves "leadership...provided informally by a group member (known as an 'emergent leader') in addition to or instead of being provided by a formally appointed leader" (p. 125); an example of this research can be seen by Johnston & Wheelan (1996). But emergent leadership research and shared leadership research is also very different since research on emergent leadership focuses on the traits of

individuals and groups that "predict informal leadership emergence, as well as narrowly considering only one or two persons as emergent leaders and ignoring the leadership influence of others" (Carson et al., 2007, p. 1221). Carson et al. summarizes a comparison between emergent leadership and shared leadership by showing that shared leadership is distinct from emergent leadership since shared leadership "can take place in a team with or without a designated leader, can be either formal or informal, and addresses the distribution and sharing of leadership among all team members, in contrast to only one or two leaders" (Carson et al., 2007, p. 1221).

In terms of the relationship that shared leadership has with cooperation, it is known that shared leadership is highly related to but very distinct from team processes such as cooperation. The idea of cooperation refers "to team members working with and/or assisting other team members with their tasks" (Bell & Kozlowski, 2003, p. 340). Even though this type of behavior is directly related to being an effective member of a team, this behavior does not "involve the active influence that is essential to leadership" (Carson et al., 2007, p. 1221). For example, in order to demonstrate this concept, a study by Ziegert (2005) has shown that there exists only a moderate correlation between the concept of shared leadership and cooperation.

Research into shared leadership has shown that this concept is similar but distinct from team cognition constructs and concepts such as team mental models (TMMs), which are defined as "shared understandings about the attributes of a team or its task at hand" (Cannon-Bowers, Converse, & Salas, 1993, p. 230) and transactive memory systems (TMSs), which are defined as "structures through which members can collectively encode, store, and retrieve information and expertise" (Wegner, 1986, p. 200). The most significant conceptual distinction between these constructs and the idea of shared leadership is that shared leadership strongly involves the idea of collective influence, but these team constructs are mainly concerned about team cognition; research shows that these distinct differences can readily be seen in the type of measurements approaches utilized for each concept and construct. In this sense, research highlights that shared leadership evaluates the distribution and centralization of leadership among team members while measures for the TMM construct "assess the similarity and accuracy of individual mental models within a team" (Marks, Mathieu, & Zaccaro, 2000, p. 362);

measures for the TMS construct "team-level systems for utilizing and integrating individually and collectively held expertise" (Lewis, 2003, p. 600). Research by Klimoski and Mohammed (1994) has shown that these three concepts are distinct but that TMS and TMM constructors are facilitated through the use of shared leadership, mainly due to the "continual influence based interactions and social exchanges that occur as team members share leadership responsibilities" (p. 425). But on the other side of the spectrum, Carson et al. (2007) also found that "through effective coordination of expertise and the development of mutual understandings, TMSs and TMMs likely enable the emergence of shared leadership" (p. 1221).

2.2.3 The Relationship between Shared Leadership and Modern Theories of Leadership

Any researcher in the field of leadership or team development understands that there are several modern theories and models (approaches) to leadership, which detail how leadership can/should be approached in different situations or applications, depending on the needs of that situation or application. But when discussing the concept of shared leadership, there are a few approaches from modern theories of leadership that are critical to the effectiveness of a shared leadership environment. The most effective "leadership" definition was found to be "leadership is a process whereby an individual influences a group of individuals to achieve a common goal" (Northouse, 2007, p. 3). In addition, according to Northouse, leadership has four main components: "leadership involves influence; leadership is a process; leadership involves goal attainment; and leadership occurs in a group context" (Northouse, 2007, p. 3). The shared leadership model, as discussed in Northouse's book, is a type of framework that enables the study of the systematic factors that can contribute to a group's outcomes or overall effectiveness; within this model, the main role of leadership is to "help the group accomplish its goals by monitoring and diagnosing the group and taking the requisite action" (Northouse, 2007, p. 234 - 235).

In this model, researchers have focused on the idea that one must understand the role of leadership within teams and how leadership helps to shape the team environment as a whole; in addition, these researchers have determined that in order to ensure team success and effectiveness, teams and organizations need to understand the necessary functions of

leadership and the fact that the functions of leadership can be performed by the formal team leader (internal or external) and/or shared by the members of the team (Northouse, 2007). Therefore, based on these notions, shared leadership models focus on leadership as the primary component of ensuring team success and effectiveness. Based on the structure of the shared leadership approach, there are a few theories of leadership that have influenced the foundational aspects of the shared leadership approach and model. The theories of leadership that are the most influential and important for the shared leadership model include: trait approach, skills approach, situational leadership, path-goal theory, leader-member exchange theory, and transformational leadership.

Since the shared leadership approach involves the concept that leadership is distributed between the formal leader and the team members, the trait approach is an important concept to understand, since this concept is heavily dependent on identifying the traits that would enable a person to be successful in a leadership role. For example, research presented by Northouse has shown that there are five critical traits that successful leaders possess: intelligence, self-confidence, determination, integrity, and sociability (Northouse, 2007). The presence of these traits (among others) is believed to influence how effective a person is at handling a leadership role. The reason why this approach is important to the shared leadership model (to a degree) is that since the leadership role is distributed among the members of the team, this signifies that it is important for the members to possess the traits outlined above in order to ensure that these members will have the ability to effectively handle the leadership role. The absence of these traits (to any degree in any member) may prove to be detrimental to the success of a team using this leadership model since the absence of these traits in any one member will effect his/her ability to be an effective leader and in turn this will affect the team's ability to be successful in the project.

The skills approach is also important to shared leadership; the skills approach to leadership is a leader-centered perspective that indicates that a person's ability to be an effective leader is dependent on three people skills, those being: technical (problem solving, knowledge), human (social judgment, social performance), and conceptual (cognitive ability, motivation) (Northouse, 2007). Note that in order to decipher between the trait and skills approach to leadership, Northouse defined traits to be "who leaders

are" and skills to be "what leaders can accomplish" (Northouse, 2007, p. 41). In a similar manner as the traits approach, the presence of these three skills is believed to significantly affect the degree of an individual's success in a leadership role. The skills approach is also important to consider in the shared leadership model (to a degree) since the distribution of leadership among the members of the team presupposes that the members have the skills necessary to be effective in their leadership roles.

This approach plays a role in the shared leadership mentality since the absence of these skills (to any degree) can prove to be detrimental to the success of a team; the absence of these skills in any one member will effect his/her ability to be an effective leader and in turn this will affect the team's ability to be successful in the project. Overall, it is important for researchers to consider the relationship that the trait and skills approaches have with shared leadership. Organizations that want their projects to be successful often utilize a shared leadership approach and therefore need to be sure that the members have the traits and skills necessary to be effective in the leadership role. If the members lack any of these skills, the organizations or leaders need to take the proper action (i.e. training) to ensure that the members develop these skills.

The situational leadership approach is critical to the foundations of shared leadership, especially in terms of how the situational leadership approach relates to the role of the formal leader, who has the critical role of being a coach, resource, delegator, and director all at one time. In the situational leadership approach, leadership is seen to be composed of both a directive and a supportive dimension and in this approach each dimension is applied appropriately in a given situation (Northouse, 2007). Research has shown that the situational leadership approach is closely related to the style approach, since the approach focuses on the behavior of the leader and the style approach focuses on two types of behaviors: task behavior and relationship behavior. The style and situational approaches are related since in the situational approach, the directive dimension is defined to involve task behaviors and the supportive dimension is defined to include the relationship behaviors (Northouse, 2007).

The situational leadership approach specifies that there are four leadership styles that a leader can utilize, but the use of these differing styles often depends on the situation and its variables. These four styles are dependent on the level of directive behavior and

supportive behavior the leader needs to utilize in the situation. The four leadership styles outlined in the situational leadership approach include: directing (high directive and low supportive behavior), coaching (high directive and high supportive behavior), supporting (high supportive and low directive behavior), and delegating (low supportive and low directive behavior) (Northouse, 2007). The situational leadership approach is important to the shared leadership model since the shared leadership requires the leader (formal or team member) to have the ability to assess the situation of the team (i.e. diagnose the problems and performance in the team and then take appropriate action to improve these problems or performance levels) and then take the proper action to improve the team effectiveness and success.

Northouse pointed out "effective team performance begins with the leader's mental model of the situation" (Northouse, 2007, p. 209); his book indicates that "this model reflects not only the components of the problem confronting the team but also the environmental and organizational contingencies that define the larger context of team action" (Northouse, 2007, p. 209). From this perspective, the leader develops a model of the team's problem(s) and the solutions available based on the context of the situation, given the organizational and environmental constraints (Northouse, 2007). The research by Northouse also found that in a shared leadership environment, in order for a leader to respond effectively and properly, the styles and behaviors have to be flexible and they have to reflect the needs of the situation and context. How a leader assesses a situation and determines the proper style of leadership is very similar for both the situational leadership approach and the shared leadership approach; both of these approaches require the leader to assess the situation in terms of the context and problems and then select the appropriate level of directive and supportive behavior in order to help the team fix problems and improve its effectiveness. From this perspective, the leader(s) in the shared leadership environment will select one of the four leadership styles outlined in the situational leadership approach, those being: directing, supporting, coaching, or delegating.

The main difference between the situational leadership approach and the shared leadership approach is that the shared leadership approach involves the idea that the formal leader and all members have a responsibility, since the leadership role is

distributed among the team, to continually assess (monitor) the progress of the team and select the styles of leadership that will help improve the team's level of effectiveness; the situational leadership approach is a leader-centered perspective and this approach usually only requires one leader (i.e. the formal leader) to assess the situation and select the proper leadership style since the members do not have a leadership role in traditional team environments where the situational leadership approach is utilized.

The path-goal theory relates to how leaders guide and motivate their subordinates to accomplish designated goals; the main goal of this theory is to "enhance employee performance and employee satisfaction by focusing on employee motivation" (Northouse, 2007, p. 127). Any project or team has a set of goals and a path it must complete in order to achieve that goal. This theory states that a leader's role is to motivate employees by making the path clearer and to remove obstacles and roadblocks that could be preventing the team from attaining their goal (Northouse, 2007). This theory has been developed in order to help leaders understand how they can help their subordinates achieve the team goals by selecting behaviors and actions that are suited to the needs of the subordinates and the situation at hand. The theory outlines that a leader should select the type of behavior, consisting of directive, supportive, participative, and achievement oriented, that will help remove obstacles from the team's path towards attaining the goal, but that the type of behavior selected should reflect the needs of the subordinates and the situation at hand. The path-goal theory is somewhat important to shared leadership since both approaches focus on the leader(s) identifying problems or obstacles that may be hindering the effectiveness of the team and then selecting a leadership style or behavior that will help remove those obstacles and help the team to improve its effectiveness and attain its goals.

Many theories and approaches are leader-centered or context (situation) based, but the leader-member exchange theory (LMX) is an important theory that relates to shared leadership since LMX is an approach that focuses "on the interactions between leaders and followers," which is a significant factor and characteristic of shared leadership environments (Northouse, 2007). LMX places a critical focus on the leader-follower relationship and stresses the importance of this relationship as a critical component of the leadership process. Research presented by Northouse (2007) has shown that "good

leader-member exchanges resulted in followers feeling better, accomplishing more, and helping the organization prosper" (p. 171); research outlined in Northouse's book also presents that a strong emphasis has included the idea that leaders should try to develop high-quality exchanges with all of their subordinates. Leadership develops over time and includes a stranger phase, acquaintance phase, and partner phase. By taking on and fulfilling new role responsibilities, followers move through these three phases to develop mature partnerships with their leaders. These partnerships, which are marked by a high degree of mutual trust, respect, and obligation, have positive payoffs (Northouse, 2007, p. 171) for the individual and the organization.

The LMX concept is highly applicable to shared leadership since the shared leadership model stresses the interactions and relationships that develop between the leader(s) and members. This is very similar to the principles of LMX, but in shared leadership, the leader-follower relationships will be multi-directional since members are no longer only followers, they are also leaders. The relational ties in shared leadership are very complex, since members will have relationships with members (as followers or leaders) in many directions, but the basic need for evolving these relationships is the same as it is with LMX theory. In both shared leadership and LMX theory, the members want to evolve their relationships (maturity) with the fellow members/leaders since this will provide many payoffs to both the individual members and the team itself; the matured relationships will help to further improve the effectiveness and cohesion of the team environment. The only main difference between LMX and shared leadership is that the relationship (relational ties) in shared leadership environments are much more complex since members are both leaders and followers (subordinates) and these relational ties will usually be more multi-directional since members are interacting on a much more evolved level (to a greater degree) than interaction levels in LMX team environments.

Transformational leadership refers to the idea that leadership is process "whereby a person engages with others and creates a connection that raises the level of motivation and morality in both the leader and the follower" (Northouse, 2007, p. 176); research indicates that this type of leader is "attentive to the needs and motives of followers and tries to help followers reach their fullest potential" (Northouse, 2007, p. 176). Based on this definition of transformational leadership, shared leadership is similar to

transformational leadership since both approaches seek to create special relationships and connections between the leaders and followers, which result in both motivational and morality improvements as well as effectiveness improvements for all parties. In the shared leadership environment, the leadership role is distributed between the members and members are encouraged to interact with their team members on a higher level, since a higher level of team member interaction is the only means by which a team can be successful in a shared leadership environment. By interacting more and more with their fellow members, a team's level of connection and interdependency among each of its members increases, helping in the development of the special connections and relationships.

These special relationships have shown to result in higher levels of trust, dependability, and cohesion between team members, which helps to improve a team's level of motivation and effectiveness. In shared leadership environments, since members act as both followers and leaders, the team develops a special level of trust, in which all members have the ability to influence and motivate members towards improving their performance and evolving their role in the team environment. This is similar to the principles of transformational leadership, especially since both concepts involve a degree of influence that a leader has over the followers in the team environment. The main difference between transformational leadership and shared leadership is that the levels of influence and the amount of interactions are higher in a shared leadership environment mainly since members are followers and leaders, which has a significant effect on the multi-directional ties that a shared leadership environment displays when compared to the relational ties and levels of influence seen in a traditional transformational leadership environment.

Overall, research has helped to understand that there are several leadership approaches and theories that have some relationship (some relationships are stronger than others) to shared leadership and these theories/approaches have impacted how the shared leadership approach has evolved and grown over time.

2.2.4 Significance and Effectiveness of Shared Leadership in Team Environments

The previous section of this paper has outlined the benefits and advantages of utilizing shared leadership in team environments as well as the relationship that shared leadership has with similar constructs, but there has also been a lot of critical research that has looked into the significance of shared leadership as well as the effectiveness of utilizing shared leadership in team environments. In terms of empirical studies, Kocher et al. (2006) found that shared leadership teams exist in over 54.5% of U.S. firms, since decisions made by shared leadership teams were a proven method of providing benefits to a company. That research also found that decisions made by shared leadership teams are expected to not only be better than ones made by individuals, but often be more easily accepted by the masses (Kocher et al., 2006). The study performed by these researchers found that when faced with the option to use single individual decision-making methods versus a shared leadership decision-making method, over 60% of the subjects preferred the latter. Many of the subjects detailed that they would prefer it since they expect better decisions from a shared leadership team versus decision made by a team led by a single individual. Researchers also found that decisions made in a shared leadership decision format were much more effective and successful when compared to the decisions made by teams led by a single individual (Kocher et al., 2006). Overall, this research effort empirically found that decisions from shared leadership teams outperform decisions from individually-led teams and that team members report much higher satisfaction and commitment to the decisions when they have an added input to the decision compared to levels of commitment that team members have towards decisions made by traditional teams (Kocher et al., 2006).

An empirical study performed by Yang (2010) studied two significant forms of decision-making styles in teams: shared leadership decision-making and single leader decision-making (also known as the traditional style of decision-making in teams). Both of these methods are quite different since one method accounts for the input from team members while the other does not. In addition, they are significantly different in the way that authority is applied to the final decision. Her research found that both of these methods are opposites of each other when considering the amount of group input and influence over the decision-making process as well as the quality of the decisions. Yang's (2010) research review has found that shared leadership decision-making is directly

linked to "higher satisfaction within a group, higher interest in working with that group on future tasks, and greater acceptance of decisions" (p. 348). Results from Yang's data collection showed that single leader decision-making is faster than shared leadership decision-making, but that the latter was found to lead to higher quality decisions since it typically results in buy-in and support from all members. In addition, the results from her data collection pointed out that shared leadership decision-making was rated higher for quality of design choice, decision-making process, and in terms of efficiency. Overall, shared leadership decision-making was found to be the better decision-making method in teams since it was more effective in terms of decision quality, efficiency, and process, even though the decision-making time is slower (Yang et al., 2010, p. 349). Another significant empirical study was performed by Meyers (1997) who involved a longitudinal study of three teams; her research pointed out that as teams develop in a shared leadership environment, they begin to adopt a more shared decision-making model as well as shared style of leadership. Meyer's empirical study found that the development of shared leadership is a complex process and although shared decision-making is affected by a team's internal and external environmental conditions as well as several other variables, teams that made the most effective decisions were teams that utilized the consensus decision-making method (Meyers, 1997).

One final significant empirical study was performed by Gelzheiser et al. (2001), in which they studied the development of shared leadership and shared decision-making in three teams over the time period of two years. Gelzheiser et al. (2001) identified that there was variability in shared leadership across the three teams studied. Two of the teams were found to have high levels of shared leadership as well as shared decision-making and positive group process procedures since all of the members were actively involved and contributed to the team in a positive manner. One of the teams was found to utilize a traditional style of leadership (and decision-making), which resulted in it being much less productive when compared to the other two teams.

Review of the data from the first team observed has shown that the team and external leader were functioning very well. Everyone participated in the shared leadership and decision-making processes, which enabled the team to reach major decisions in a short time frame (Gelzheiser et al., 2001). The relationship between the internal and external

factors was also very strong. The external leader was able to provide his support and input into the team decisions without deterring any of the members from expressing their opinions or participating in the decision-making process. The team appeared to move quickly through the development of the team-decision making method methodology and resulted in primarily utilizing the consensus decision method. Members found that the consensus method was most closely related to shared decision-making and the requirements of shared leadership. The external leader was a strong outlet for support and aided the team in developing its internal environment as well as motivating the members. As a result, members knew their opinions were valued and were more willing to share in the responsibilities of leadership and decision-making (Gelzheiser et al., 2001).

Data from the second team indicated that the external leader and internal team members utilized shared leadership strategies and were moderately successful in having active participation from all members. All members had a high level of input and actively took part in making all decisions (Gelzheiser et al., 2001). The external leader was a significant driving force in pushing the members to take part in the shared leadership and decision-making processes and actively pursued sharing his influence and power in order to have all members increase their levels of participation and involvement. But there was strain on the internal-external relationship, since some members were reluctant to actively take part in the shared leadership roles out of fear that some conflict with the external leader would arise. Nevertheless, the team was effective in determining several significant decisions within this environment. The team's internal environment was much evolved and many members believed that there was a strong commitment by all members, as well as a strong relationship with their external leader (Gelzheiser et al., 2001).

In the final (third) team observed, the researchers found that the external leader utilized a domineering form of leadership, which resulted in dissention in the team and ineffective results. The dissention from the team was obvious since the members expressed concern that the external leader was too involved and not providing the team with any autonomy; members stated that "he needs to step back so people realize he's a member, not the leader of the team" (Gelzheiser et al., 2001, p. 282). Therefore, it was concluded that in this environment, the traditional style of leadership (and decision-

making) was the dominant strategy and it produced limited effective decisions. The team sought to have a shared leadership environment, but it was not possible due to the external leader.

2.2.5 Shared Leadership and Team Performance

According to research, team performance goes hand in hand with shared leadership. Team performance generally includes efficiency and effectiveness, in which efficiency means "using minimum input to attain maximum output and doing the thing right" while effectiveness means "attaining to organization's objective and doing the right thing" (Carson et al., 2007, p. 1224). Team performance is known to contain a wide array of styles, in which it introduces both tangible and intangible benefits. Research into team performance indicates that it is difficult to define team performance with only one criterion, especially since research suggests that "performances have some indicators that include overall performance, employee productivity, operation time, customer satisfaction, resource operation, decision quality and so on" (Kirkman & Rosen, 1997). For the purposes of this study, the definition of team performance is: "an organization's final outcome that involves tangible and intangible one[s]" (Lewis, 2003, p. 601).

The concept of shared leadership is an important and intangible resource that is available to teams and through this meaning, it should improve team performance on complex tasks; Carson's research believes the following kind of scenario (Carson et al., 2007, p. 1224):

> When team members offer their leadership to others and to the mission or purpose of their team, they should experience higher commitment, bring greater personal and organizational resources to bear on complex tasks, and share more information (Katz & Kahn, 1978). When they are also open to influence from fellow team members, the team can function with respect and trust and develop shared leadership that in turn becomes an additional resource for improving team process and performance (Day et al., 2004; Marks et al., 2001). This intangible resource, which is derived from the network relationships within the team, results in greater effort, coordination, and efficiency. (Nahapiet & Ghoshal, 1998).

Evidence indicates that there have only been a few empirical studies in which shared leadership has been the primary source of leadership, but Carson et al. (2007) points out that the results of these few studies are promising. Liu (2005) also points out that most of the existing leadership theories study the individual leader and team performance, but there are only a few research efforts that focus on studying the effect of shared leadership on team performance. Liu's research believes that four viewpoints can be identified from the existing shared leadership research, and that these four viewpoints explain the relationship between shared leadership and team performance (Liu & Wei, 2005). Liu's research points out the following:

> First, George and Bettenhausen (1990) suggested that employee's attitude to identify the leader has negative relation with employee's turnover. So we can expect that team adopts shared leadership, team members share their authority that will establish employee's identify to their leader and not only decrease employee's turnover but also have more willing to do more effort. Second, Zaccaro et al. (2001) also indicated that leadership processes (e.g. information search and structuring, information use in problem solving) will influence team performance through team cognitive processes, team motivational processes, team affective processes and team coordination processes. According to this light, we suggest that distributing the authority to team members will have motivation effect. Members may feel that they are valued in the organization and they will work more efficiently. Furthermore, when leadership is distributed to all team members, every member also must take more responsibilities. Thus, members will be under more pressure to perform better. Finally, greater team shared leadership is also expected to correspond with decreased shirking because employees have greater commitment and feelings of personal ownership (Pearce and Ravlin, 1987) and it may help team create better performance. (Liu & Wei, 2005, pp. 4-5)

Based on this information, Liu found that shared leadership and team performance must be studied at the team level since shared leadership belonged to the team level of leadership, in which the individual(s) within the team shared leadership and were interdependent (Liu & Wei, 2005). Liu & Wei found that shared leadership must be

studied and treated differently than individual leadership, since shared leadership was much more complicated; Liu and Wei's review of research found that Katzenbbach and Smith (2005) believed that shared leadership has a positive effect on team performance (Kirkman & Rosen, 1997).

In addition, Liu & Wei's (2005) review of research found that the relation between "between shared leadership and team effectiveness were significant but in different cultures, individual characteristics within the team will cause different effects on leadership behavior" (Wageman, 1997, p. 61). Based on all of this information and past research, Liu concluded that interactions amongst team members could have unpredictable effects on team performance and that when different subordinates face the same type of leadership style, they may respond in completely different ways (i.e. some subordinates might accept the leader, which could result in good performance, while others may not accept the leader, which in turn could result in poor performance) (Liu & Wei, 2005).

Carson's review of research into the relationship between shared leadership and team performance has identified the following research efforts as important milestones towards explaining the overall relationship between the two concepts:

> Avolio and colleagues (1996) explored shared leadership among teams of undergraduate students and found a positive correlation with self-reported effectiveness. Pearce and Sims (2002) studied the relationship between shared leadership and change management team effectiveness at a large automotive manufacturing firm and found shared leadership to be a more useful predictor than the vertical leadership of appointed team leaders. Sivasubramaniam and colleagues (2002) found that team leadership, defined in a manner similar to previous definitions of shared leadership as the collective influence of team members on each other, was positively related to both team performance and potency over time in a sample of undergraduate business students. Pearce, Yoo, and Alavi (2004) studied shared leadership in virtual teams engaged in social work projects and again found that shared leadership was a stronger predictor of team performance than vertical leadership. Ensley, Hmielski, and Pearce (2006)

> also found shared leadership to be a stronger predictor than vertical leadership of new venture performance in a sample of top management teams.
>
> Finally, there is also indirect support for shared leadership predicting team performance. Taggar, Hackett, and Saha (1999) examined emergent leadership within teams and found that team performance was greatest when other team members, in addition to the emergent leader, demonstrated high levels of leadership influence. Failure of even a single member to exhibit leadership behavior was found to be detrimental to team performance. Although shared leadership was not formally defined or measured, these findings seem to support the notion that shared leadership may result in greater effectiveness than the emergence of a single internal team leader. (Carson et al., 2007, p. 1224)

All of this research suggests that the degree of shared leadership present in a team environment is positively related to the degree of team performance.

2.2.6 Developing Shared Leadership in Teams (Internal Team Environment)

Research has found that in order to fully develop and understand the concept of how leadership can be shared among team members, one must utilize Yukl's (2006) definition of leadership, which says that it "influence[s] processes involving determination of the group's or organization's objectives, motivating task behavior in pursuit of these objectives, and influencing group maintenance and culture" (Carson et al., 2007, p. 1221). By utilizing the idea that leadership involves an influence factor, research performed by Hoffman & Morgeson defines shared leadership as, "an emergent team property that results from the distribution of leadership influence across multiple team members" (Hoffman & Morgeson, 1999, p. 255). Shared leadership is created in two ways: when individual team members engage in activities or tasks that influence the team and other team members in areas such as direction, support, or motivation as well as through the series of interactions members have with each other, which involve the sharing and negotiation of leadership responsibilities. The structure that is created by this process can be considered a leadership network that provides influence and shapes the team member, outcomes, and activities (Dixon, Mehra, Robertson, & Smith, 2006).

Review of past research on leadership indicates that this concept can be thought of in terms of either "the strength of influence (i.e., its quality or effectiveness) or the source of influence (i.e., single versus multiple team members)" (Dixon et al., 2006, p. 236). This definition focuses on multiple sources of influence and refers "to widespread influence within teams rather than to specific leadership behaviors, formal positions, specific types of influence exhibited by these sources" (Carson et al., 2007, p. 1222).

Some research pinpoints a very interesting belief that "shared leadership can be conceptualized along a continuum based on the number of leadership sources (i.e., team members) having a high degree of influence in a team" (Carson et al., 2007, p. 1223). In cases at the low end of the continuum, team members follow a leadership structure with one individual in control or one source of influence, while at the high end of the continuum, leadership is distributed among team members and most (if not all) members provide leadership influence to one another. Here the source of leadership is distributed among team members and it is not concentrated on a single individual or member; members both lead and follow each other in such a way that "at a given time, members are both providing leadership for certain aspects of team functioning and also responding to the leadership provided by other team members in different areas" (Carson et al., 2007, p. 1223). In a shared leadership environment where teams have high levels of shared leadership, it can also be assumed that teams may shift/rotate leadership over a period of time, in order to provide different members with the opportunity to provide leadership "at different points in the team's life cycle and development" (Carson et al., 2007, p. 1223). Data have also shown that the concept of shared leadership should be viewed as a "relational phenomenon involving mutual influence between team members as they work toward team objectives" (Carson et al., 2007, p. 1223). According to Yukl's research, the display of leadership influence takes place in the context of team member relationships and assumes the presence of "influences." The concept of shared leadership results in patterns of reciprocal influence, which in turn, further develop and reinforce existing relationships among members (Yukl, 2006, p. 103).

Carson et al.'s (2007) research has found that the first condition (input variable), internal team environment, consists of three dimensions: shared purpose, social support, and voice (Carson et al., 2007). These three dimensions have been found to represent

distinct concepts that are also "highly interrelated and mutually reinforcing, thereby representing a higher order construct" (Carson et al, 2007, p. 1223). These three dimensions work together to develop a team context that supports (and encourages) team members' willingness to offer leadership influence as well as to rely on the leadership influence of other team members. The first dimension is shared purpose and this dimension exists "when team members have similar understandings of their team's primary objectives and take steps to ensure a focus on collective goals" (Avolio, Jung, & Sivasubramaniam, 1996, p. 185). Members that have a common sense of purpose and goals are more likely to be motivated, empowered, and committed to their team and work. The increased levels of empowerment, commitment, and motivation that members develop when they have a shared purpose can aid members in increasing their willingness to share the team's leadership responsibilities. In addition, with shared purpose and goals among the members of the team, they will be more inclined to establish goals and take actions that support the activities of other members. This will result in a collective direction to team activities and facilitate both "goal-oriented leadership behaviors" (Avolio et al., 1996, p. 185).

The second dimension is known as "social support," which is defined as "team members' efforts to provide emotional and psychological strength to one another" (Carson et al., 2007, p. 1224). In this dimension, members provide support to other members through encouragement and recognizing accomplishments at both the individual and team levels. This positive reinforcement helps to develop an environment where members feel that their input and opinions are listened to and valued. By actively working in a team and feeling supported by other members, the team members will more likely be willing to work in a cooperative manner and develop a shared sense of responsibility and commitment to team outcomes. In addition, other research has found that "social support is associated with group maintenance and culture, leader support/supportive behaviors, relational leadership, and developing and maintaining a team by providing "interpersonal glue" that helps builds a strong internal social network" (Seers, 1996, p. 155).

The third dimension is "voice" and is best defined as "the degree to which a team's members have input into how the team carries out its purpose" (LePine & Van Dyne,

1998, p. 110). In this dimension, voice is typically associated with the "interaction facilitation /participative" behaviors in teams and these types of behaviors usually result in higher levels of social influence among the team members through the use of increased engagement and involvement. In addition, the dimension of voice is often associated with member participation in decision-making and "constructive discussion and debate around alternative approaches to team goals, tasks, and procedures" (DeDreu & West, 2001, p. 1195). This association often results in improving the amount of collective influence, commitment, and involvement relative to important team decisions. A high level of voice in a team environment can support a team in developing an environment where people "engage in mutual leadership by being committed to and becoming proactively involved in helping the team achieve its goals and objectives and constructively challenging each other in pursuit of group goals" (DeDreu et al., 2001, p. 1195).

The three dimensions of this condition work together in to develop an internal team environment that consists of shared understandings about team goals and purpose(s), high levels of involvement, challenge, and cooperation, and a sense of recognition and importance.

2.2.7 External Coaching

Past research on shared leadership has found that external coaches play a critical role in the development of team member motivation and member capability to lead themselves and become self-directed. According to various researchers, the role of external team leaders has been defined as "a direct interaction with a team intended to help team members make coordinated and task-appropriate use of their collective resources in accomplishing the team's task" (Hackman & Wageman, 2005, p. 276). Research has identified various forms of team coaching, mainly distinguishing between forms that are "more supportive and reinforcing of a team's self-leadership and those that focus on identifying team problems and engaging in active task interventions that interfere with the team's autonomy and self-management" (Hackman & Wageman, 2005, p. 277). The use of supportive coaching can help external leaders contribute to the development of shared leadership in several ways. For example, by engaging in behaviors such as reinforcing, encouraging, and rewarding "instances in which team members demonstrate leadership...supportive coaching fosters a sense of self-competence and

team independence among team members" (Wageman, 2001, p. 567). If members are able to believe that they have high levels of autonomy and have high self-confidence in their skills for managing the work of their team, research shows that they should be more likely to display leadership. As a means of support for this first reason, Wageman identified a positive relationship between supportive coaching by an external leader and self-management by team members (Wageman, 2001, p. 568).

External coaching can also aid in building a shared commitment to the team and "...can reduce free riding and increase the likelihood that team members will demonstrate personal initiative" (Hackman & Wageman, 2005, p. 281). A third way it can be used by external leaders to foster shared leadership is by providing teams suggestions about task strategies that ensure that activities are aligned with work requirements and demands, supportive coaching can provide team members "greater clarity on how to best manage their work and processes...thus team members are more likely to influence each other because they share this understanding" (Carson et al., 2007, p. 1225).

2.2.8 The Relationship between the Internal and External Environmental Conditions

A review of past research points out that external coaching may indirectly influence shared leadership when the concept is considered as a functional approach to shared leadership. It can be argued that when a team has a supportive internal environment, coaching by an external source (leader) would most likely be redundant with the internal environment and as a result, the external coaching would not be as significant to the emergence of shared leadership among the members of the team.

The team environment where members lack a sense of shared purpose, do not encourage full engagement/participation, and members do not provide social support, is the type of functional leadership realm where external coaching would thrive and be critical to the development of shared leadership among team members. In this type of environment, an external leader who focuses on "building collective commitment to a team and its work, assisting the team with aligning activities with task requirements, and fostering independence" (Hackman & Wageman, 2005, p. 283) will help develop members who have the consultative and motivational skills that enable shared leadership, but have not been sufficiently developed through internal team practices. External

coaching can also aid members in understanding "the different skills and capabilities of team members and how they can be integrated to address the demands of the team task" (Wageman, 2001, p. 570). This level of understanding can help the team members to develop and engage in internal leadership tasks and activities in a coordinated manner, which would result in the "emergent pattern of shared leadership" (Carson et al., 2007, p. 1226). In this type of understanding, supportive coaching by an external leader can aid in the emergence and development of shared leadership in a team that has yet to develop an advanced level of shared purpose, voice, and social support. This relationship suggests that "team coaching by an external leader interacts with the internal team environment in predicting shared leadership" but that coaching by an external source is "more strongly related to shared leadership when the internal team environment is unsupportive" (Carson et al., 2007, p. 1226).

2.2.9 Shared Leadership & Team Decision-Making Approaches

A key requirement for any team is the concept of decision-making (Northouse, 2007). A team decision is described as "a decision that would not have been thought of by an individual alone; is a sound solution to the problem; is a decision based upon input, as unbiased as possible, from each team member; and addresses the team's goal for the decision-making process" (Foundation Coalition, 2001, p. 5). A decision is made through the use of a five-step procedure: state the problem, identify alternatives, evaluate the alternatives, make a decision, and implement the decision (Business Analysis Made Easy, 2006), although high-performing teams recognize that modification may be necessary to meet their specific needs as no one model fits all situations.

There are seven proven methods of rational team decision-making: decision made by authority without group discussion (single individual leader decision method), decision by expert, decision by averaging individuals' opinions, decision made by authority after group discussion, decision by minority, decision by majority vote, and decision by consensus (Resource International, 2009). A decision made by a single authority without group discussion exists when a single leader makes all the decisions without the consultation of the group members. It has been found that this method is appropriate in situations where there is little time available to make a decision, there is a requirement for

a routine decision, or in an environment where the team commitment required to apply the decision is low (Resource International, 2009).

A decision by expert exists when an expert is selected from the group and the expert considers the issues as well as makes the decisions. It appears that this decision method is applicable to situations where there is a clear choice for the selection of the expert, the results are highly dependent on a specific expertise, or in an environment where the team commitment required for executing the decision is low.

A decision made by authority after group discussion is a method in which the team develops ideas and has discussions about these ideas, but the final decision is made by the designated leader. In this environment, the leader presents the issue to the team, listens to the ideas and inputs from the members, and then makes the final decision by him/her but with the input from the members. This method appears to be most applicable to decisions where there exists a clear consensus on authority, time is available for members to interact but not to make any team decisions, or in an environment where the team commitment required to implement the decision is moderately low.

A decision by averaging individual's opinions exists when team members are asked separately to provide his/her opinion on a decision and once all inputs are collected, the results are averaged. It has been determined that this method is appropriate in situations in which active team participation is needed but lengthy interaction is not possible, time is highly limited for a decision to be made, or in an environment where the team commitment required to execute the decision is low.

A decision by minority involves the idea that members, who constitute less than 50% of the team, make the decision. This method is most applicable in situations where there is a clear choice of the minority group, as well as when time prevents the convening of the whole team or in an environment where the team commitment for applying the decision is moderately low.

A decision by majority vote is the most commonly utilized method in the U.S. It typically involves a period of team discussion until 51% (or more) of the team members are able to agree on a decision. This decision method is applicable when the group consensus is one that supports a voting process, there is a time constraint on making a

decision, or in an environment where the team commitment required for applying the decision is moderately high.

Decision by consensus is a methodology that arrives at a collective decision through an effective communication process, which involves all members having the chance to talk and be listened to in order to value all input. It is a method in which most of the participants agree to the option being discussed. In addition, each member who is dissenting to the alternative is asked to speak about their dissent. Key factors in this method involve listening and having serious consideration for the minority's dissents/input (Resource International, 2009). This process is typically successful since the dissention is able to educate and possibly change the decision (Resource International, 2009). It is typically employed in environments where the team has a sufficient background/experience in achieving a consensus in teams, time is available for a consensus to be reached by the team, or in an environment where the team commitment required to execute the decision is high.

Cervone (2005) found that in order for any team to make an effective decision, it must have a sound methodology that the team can use in order to achieve a decision (p. 31). In order for a team to develop a sound decision-making methodology, the external leader must provide the guidance and experience that the team needs to help the members learn about decision-making and how effective decisions can be made in their team environment. Cervone's (2005) research also touches upon the fact that there is a delicate relationship between the external leader and the internal behaviors and actions of the team (Cervone, 2005). The basic finding from this research study is that a team decision-making process must be supported by a sound methodology and by the external leader. If these elements are present, the team should have the necessary tools and support to handle any type of decision, regardless of the decision's complexity (Cervone, 2005).

Caress and Scott (2005) found that shared decision-making empowers all staff members in the processes. Using this method not only provides members with a framework of how to work together in order to make effective decisions in a timely manner (Caress & Scott, 2005), but also with an environment where all aspects are changed from a single leadership perspective to a team-oriented perspective (Caress & Scott, 2005). This type of governance provides members with a sense of empowerment

since they have a collective responsibility and accountability to complete the project at hand, with only support from an external leader. In order for a shared governance environment to exist, members need to rely on each other and share the responsibilities of leadership, especially the decision-making responsibility. Researchers were able to determine that some type of relationship should exist between the components of shared leadership and shared/team decision-making.

Shared decision-making, also known as worker involvement, results in "improved productivity, quality, job satisfaction, organizational commitment, and better acceptance of change among others" (Taveira, 2008, p. 509). In this study, Taveira's research found that participation was positively and statistically significant in relation to job performance satisfaction. Taveria also found that group efforts typically generate more effective solutions that would not be produced by the same individuals if they were working independently. A team's superior outcomes are due to a greater pool of knowledge, mutual influence on each member's thinking, and the interaction process among team members (Taveira, 2008). One of the key elements in utilizing worker involvement is the support from external leaders and top management. This element was found to be essential for the team's functioning. Taveira's research concluded that management support (i.e. external coaching) is one of the fundamental conditions for implementation of any type of worker involvement initiative. His research also found that management support is critical during the internal team development portion of a project and concluded that the lack of external leadership/support is a critical impediment to team effectiveness and achievement (Taveira, 2008).

Research by Jones and Roelofsma (2000) distinguished teams through the term differentiation, which involves the degree of task specialization, independence, and autonomy of the team members. Teams that have a high level of differentiation are most closely related to shared leadership since they have high levels independence, autonomy, and task specialization. Teams that have a high level of differentiation have a high level of shared decision-making since the members are willing to commit to the team and work as a team (i.e. high level of internal team environment). Jones and Roelofsma (2000) also found that a team's level of team effectiveness is dependent on "the degrees to which team members actively engage in decision-making relevant to the accomplishment of the

task" (p. 1133). In order to operate effectively, these types of teams need to be well coordinated, have the ability to adapt to change, manage their internal resources, have a strong base of outside support from a leader, and have a strong environment that is based on trust and commitment.

In one final general study, Kocher et al. (2006) found that teams existed in over 54.5% of U.S. firms and that decisions made by teams are expected to not only be better than ones made by individuals, but often be more easily accepted by the masses. The study performed by these researchers found that, when faced with the option to use single individual decision-making methods versus a shared decision-making method, over 60% of the subjects preferred the latter. In addition, the researchers found that decisions made in a team format were much more effective and successful when compared to the decisions made by single individuals (Kocher et al., 2006). Overall, this research effort found that decisions made by teams outperform decisions made by individuals and members report much higher satisfaction and commitment to the decisions when they have an added input to the decision (Kocher et al., 2006).

2.2.10 Continuous Improvement and Basic Methodology

Continuous improvement is a concept that seeks the on-going improvement of services, products, and/or processes; in this philosophy, the efforts seek either "breakthrough" improvements, which occur all at one time or "incremental" improvements, which occur over time (and not all at once). Even though the concepts of continual improvement and continuous improvement are typically utilized interchangeably, it is important to note that there is a distinction between the two concepts. Continual improvement is a broad term utilized by Deming (2011) in order to refer to general "processes of improvement and encompassing "discontinuous" improvements – that is, many different approaches, covering different areas" (American Society for Quality, 2011, para. 6). But continuous improvement is different since it is considered a subset of continual improvement, "with a more specific focus on linear, incremental improvement within an existing process;" continuous improvement is also considered to be very closely related to techniques of statistical process control (American Society for Quality, 2011, para. 7).

The foundational basis for continuous improvement is a four-step quality model known as the Deming cycle, also known as the Shewhart Cycle (American Society for Quality, 2011, para. 2); this model is based on four steps, known as "plan, do, check, act" or PDCA. In the "plan" stage of the Deming cycle, an opportunity is identified and a plan for change is developed; when the "do" stage of the model is performed, the plan for change is implemented on a small scale. After the second stage is complete, the "check" stage of the Deming cycle involves the use of data in order to analyze the results of the change as well as to assess whether the change made a difference (positive or negative difference). The final stage of the Deming cycle is known as "act" and it involves, if the change was found to be successful, implementing the change on a wider scale and continuously assessing the results of the change; if the change was not found to be successful, the Deming cycle begins from the start and the plan stage is executed once more in order to find a solution (i.e. change) that can help achieve the desired results. The Deming cycle will continually recycle until a solution (change) is implemented at a wide scale and after the implementation, the solution will be continuously assessed in order to verify the success of the change.

Even though the Deming cycle (or PDCA cycle) is the foundation of the continuous improvement methodology, there are also other common concepts that are widely referred to as continuous improvement methodologies. These include Six Sigma and Lean, but these place a special emphasis on employee involvement and teamwork, measuring and systematizing processes, and reducing variation, defects, and cycle times in the processes and systems (American Society for Quality, 2011, para. 4). While the Lean and Six Sigma concepts differ especially in terms of application (focus) and purpose, they share many of the same tools, techniques, traits and are often utilized simultaneously with each other. Both concepts have strengths and weaknesses and by working in collaboration with each other, continuous improvement teams often achieve better results and are more effective and efficient in obtaining a timely result for the problem at hand.

The Lean concept and approach is typically viewed in the following manner "we will not put into our establishment anything that is useless" (American Society for Quality, 2011, para. 1). The concept of Lean involves the use of a set of techniques and tools that

have different applications but have the same underlying goal and principle, which is the "elimination of all non-value-adding activities and waste from the business" (American Society for Quality, 2011, para. 1). In the realm of Lean enterprises, this concept is extended throughout the whole value stream or supply chain with the understanding that the "leanest factory cannot achieve its full potential if it has to work with non-lean suppliers and subcontractors" (American Society for Quality, 2011, para. 2). According to the Lean philosophy, there are seven types of waste, including: overproduction, transportation, inventory, motion, waiting (i.e. time in queue), non-value-adding processes, and costs of quality (i.e. scrap, rework, and inspection) (American Society for Quality, 2011, para. 3).

Six Sigma is a methodology, set of tools, as well as a fact-based and data-driven philosophy of quality improvement that focuses on the value of defect prevention instead of defect detection. It is a concept that "drives customer satisfaction and bottom-line results by reducing variation and waste, thereby promoting a competitive advantage. It applies anywhere variation and waste exist, and every employee should be involved" (American Society for Quality, 2011, para. 1). The concept of Six Sigma is often defined to be a philosophy, methodology, or a set of tools, but all of these definitions share common themes, which include (American Society for Quality, 2011, para. 4):

- Use of teams that are assigned well-defined projects that have direct impact on the organization's bottom line;
- Training in "statistical thinking" at all levels and providing key people with extensive training in advanced statistics and project management. These key people are designated black belts;
- Emphasis on the DMAIC approach (define, measure, analyze, improve and control) to problem solving;
- A management environment that supports these initiatives as a business strategy.

Supporters of this viewpoint define Six Sigma as a set of quantitative and qualitative tools used by an expert to drive process improvement. These tools include: control charts, failure mode and effects analysis, flowcharting, and statistical process control (SPC) (American Society for Quality, 2011, para. 6). From a philosophical standpoint, Six Sigma is a philosophy that all work can be viewed as processes that can be "defined,

measured, analyzed, improved, and controlled;" in this sense, this definition indicates that processes require inputs (x) and they produce outputs (y) and therefore, this viewpoint believes that if you can control the inputs, you can also control the outputs (i.e. such that y = f(x)) (American Society for Quality, 2011, para. 5). The final viewpoint considers Six Sigma to be a methodology, in which the rigorous approach known as DMAIC (Define, Measure, Analyze, Improve, and Control) is followed in order to achieve process improvement. From this perspective, the DMAIC approach outlines the steps a Six Sigma team or practitioner would follow in order to achieve process improvement. This approach begins with identifying the problem and ending with the implementation of long-term solutions.

2.2.11 History of the NSLIJ Health System and Continuous Improvement

The NSLIJ Health System was founded in 1997 after the North Shore Health System and the LIJ Medical Center merged, resulting in a health system that consists of 15 hospitals, the Feinstein Institute for Medical Research, home care network, hospice network, rehabilitation and skilled nursing facilities, and a series of ambulatory care centers. The headquarters of the NSLIJ Health System is currently located in Great Neck, New York, but the system provides service to people throughout the New York City and Long Island area, and is known to be the largest integrated health system in New York State based on patient revenue, and the second-largest, based on number of beds, (non-profit) secular health system in the United States. The health system currently consists of more than 43,000 employees and is the largest employer in the Long Island region. The current President and CEO of NSLIJ Health System is Michael Dowling and he has held this post since January 2002; one of the main initiatives that Michael Dowling pioneered in the health system is the creation of the Center for Learning and Innovation (CLI), which is the corporate university segment of the health system.

CLI was created in 2002 and since then, it has become the largest corporate university in the healthcare delivery industry. Since its inception, CLI has generated many initiatives, including: course offerings, administrative, and clinical fellowship programs, organizational development efforts, operational performance solutions, and university affiliations. The CLI approach to education and performance improvement utilizes a blended learning perspective, which involves an experiential based approach that

combines team-based and case learning methodologies as well as simulation, gaming, reflecting debriefing, interactive technology, role playing, and group activities; these methods are utilized by the CLI team in order to accomplish the goal of retention and application of knowledge in the workplace. CLI consists of three major subgroups: the Patient Safety Institute (PSI), Division of Improvement Sciences (DIS), and Corporate University.

The DIS segment of CLI is responsible for providing support to managers throughout the health system who seek to analyze and improve their processes as well as perform continuous improvement projects throughout the health system; in this environment, managers throughout the health system send their teams to DIS in order to learn several DIS methodologies, which in turn allow the teams and managers to bring these techniques and concepts back to the work sites in the health system for implementation. The DIS team at CLI plays a significant role in providing process improvement throughout the health system, especially in terms of financial savings, increases in revenue, and increases in patient safety, improved employee and customer satisfaction, and enhancements in the way the organization performs. The two main methodologies that the DIS team from CLI uses to perform continuous improvement projects include Lean and Six Sigma; in each of these project environments, members of the DIS team act as mentors and guides for the continuous improvement teams in order to provide them with the skills and guidance required to complete continuous improvement projects according to the defined methodologies and principles. Note that within the DIS group, there are five Blackbelts and two Master Blackbelts. The leader of the DIS team is a Master Blackbelt, whose responsibility is to oversee all of the continuous improvement projects that are mentored and performed by group's Blackbelts. In addition, the overall director of CLI is responsible for providing direction and leadership to all of the departments and initiatives within the CLI organization; the director also provides support in terms of identifying and selecting candidate projects for the improvement process flow, which is highlighted below in this section.

In 1995, General Electric (GE) became one of the main adopters of the Lean and Six Sigma methodologies and, with the help of GE Healthcare, the Lean and Six Sigma initiatives were implemented into the CLI organization of the NSLIJ Health System in

2003. Since then, they have resulted in many trained members throughout the health system, including: over 100 health system members trained to be Whitebelt change facilitators, 72 health system members trained to be Greenbelts, 24 health system members trained to be Blackbelts, and four health system members trained to be Master Blackbelts. The NSLIJ Health System approach to continuous improvement has lead to improvements and positive changes in the following areas of healthcare delivery: improving handoff communication, reducing surgical site infections, preventing avoidable heart failure hospitalizations, decreasing Central-Line-Associated Bloodstream Infections (CLABS), and decreasing sepsis-associated mortality. Since the introduction of the DIS group and the continuous improvement initiative, the NSLIJ Health System has performed over 75 improvement projects and these projects has resulted in millions of dollars in financial savings as well as a significant amount of benefits including increased patient and staff satisfaction and productivity.

The NSLIJ Health System selects candidate projects for Six Sigma efforts through the collaboration with the hospitals and the other medical facilities in the health system. Based on the collaboration between the system's facilities, a team of Black Belts from the DIS team reviews the list of concerns and then assigns the methodology that will help to find solutions for the project. They also assign a DIS mentor that will serve as coach for the Six Sigma team. After the project has been identified and assigned, the team from the candidate facility (i.e. the facility where the project is being performed) is selected by the facility's administrators and the Black Belt mentor from the DIS team. In the NSLIJ Health System, based on the defined DMAIC improvement process, the typical Six Sigma project lasts approximately 12 months since the DIS team spends time mentoring the improvement teams through each step of the DMAIC improvement process.

Approximately one month is dedicated to each of the first four phases of the DMAIC process (i.e. total of five months from start of the Define phase to the Improve phase, or one month for each of the four DMAI phases of the DMAIC process) in order to learn the tools and methodologies of each of the first four phases of the process and then to execute the tools of the phase in order to satisfy the deliverables that are required for each phase. One month is spent on reporting out (and developing a summary white paper) on the results of the project and following up on the outcomes of the project. In the final phase

of the DMAIC process, which is the Control phase, the teams are taught the tools and methodologies of Control phase and then teams are given six months to complete the Control phase, "report out" on the phase and to develop their sustainability plan for the project. In all, the entire DMAIC process in the NSLIJ Health System requires approximately 12 months, in which four to five months is dedicated to the DMAI phases of DMAIC and six months are dedicated to the Control phase (final phase of DMAIC) and completing the sustainability plan for the project.

As the improvement teams begin the DMAIC improvement process, the DIS provides educational courses and training at each stage in order to prepare the teams to complete the phases of the methodology. In this environment, prior to the team progressing into the next phase of the DMAIC process, the DIS teams provide educational courses into the next phase and after these educational training sessions are complete, the improvement teams are given up to one month (for the DMAI phases of DMAIC) and up to six months (for the Control and sustainability plan for the project or the final phase of the DMAIC process) to complete the phase of the process that they were just trained on in these educational training sessions. For example, prior to completion of the analyze phase of the DMAIC process, an improvement teams must complete a three day training of the analyze phase, given by the DIS mentors, and after this training is complete, the team has up to one month to complete the work for this phase. In this environment, prior to the team progressing into the next phase of the DMAIC process, a team must "report out" on the deliverables due for that phase in order to be authorized by their external coach and sponsor to progress into the next phase of the project. For simplicity, the DMAIC improvement process at NSLIJ Health System is executed in the following manner:

- Step 1: Team is trained on the "define" phase of DMAIC and then given approximately one month to complete the "define" phase deliverables.
    - Typical duration to complete phase: one month.
- Step 2: Team "reports out" on the findings and deliverables of the "define" phase and is authorized to progress into the "measure" phase. Team is trained on the "measure" phase of DMAIC and then given approximately one month to complete the "measure" phase deliverables.
    - Typical duration to complete phase: one month.

- Step 3: Team "reports out" on the findings and deliverables of the "measure" phase and is authorized to progress into the "analyze" phase. Team is trained on the "analyze" phase of DMAIC and then given approximately one month to complete the "analyze" phase deliverables.
    - Typical duration to complete phase: one month.
- Step 4: Team "reports out" on the findings and deliverables of the "analyze" phase and is authorized to progress into the "improve" phase. Team is trained on the "improve" phase of DMAIC and then given approximately one month to complete the "improve" phase deliverables.
    - Typical duration to complete phase: one month.
- Step 5: Team "reports out" on the findings and deliverables of the "improve" phase and is authorized to progress into the "control" phase. Team is trained on the "control" phase of DMAIC and then given approximately up to six months to complete the "control" phase deliverables, perform sustainability measurements / develop the sustainability plan, and to develop a white paper to outline the entire project journey.
    - Typical duration to complete phase: up to six months.
- Step 6 (Takes Place Up to Six Months After the Improve Phase): Team "reports out" on the findings and deliverables of the "control" phase and sustainability plan as well as providing a white paper in order to formally close out the project (project closure).

The defined DMAIC improvement process outlined above is performed for all improvement projects that occur in the NSLIJ Health System by the DIS team. The continued use of training throughout the entire improvement process and use of "report outs" for each phase of the process symbolizes that each phase builds on the foundations and deliverables from the preceding phases; in this sense, the "report outs" provide the sponsors and external coaches with the ability to review the progress of the projects and ensure that the project teams are sufficiently prepared, in terms of deliverables and project completion, to warrant the authorization to proceed to the subsequent phase. The external coaches and sponsors understand that in Six Sigma projects, the deliverables and

tasks from each phase of the process build on one another and during the "report out" segments of the process, this understanding helps the external coaches and sponsors to determine if the project teams are sufficiently prepared to proceed to the next phases, based on the reported findings by the teams during the "report outs." In this environment, throughout the process, the Six Sigma teams in these environments define the challenge, take baseline measurements, determine an action plan, put it into effect, and measure the resulting changes. Additionally, throughout this process, the DIS team provides mentorship and guidance by assigning one mentor for each Six Sigma team. These DIS team mentors also provide support by monitoring the progress of Six Sigma changes for at least one year after the change was implemented into the facility or health system. The defined DMAIC improvement process is applied to all improvement projects that occur in the NSLIJ Health System and it is a method of thinking that has been adopted (or currently is being adopted) throughout all facilities and members of the health system.

This section has reviewed the relevant research on shared leadership, the significance and effectiveness of shared leadership in team environments, the relationship that shared leadership has with similar constructs and modern theories of leadership. Additionally, it has discussed the relationship between shared leadership and team performance, developing shared leadership in teams (internal team environment), the impact of external coaching, the basics of continuous improvement, and the basic history of the NSLIJ Health System and continuous improvement efforts in the health system. The information provided here has outlined the requirements needed to foster shared leadership as well as the two environmental conditions, internal team environment and external coaching, which need to be in place in order to develop and maintain a shared leadership environment.

Shared leadership in teams is made up of these two environmental conditions and it is critical that they are accounted for as a team adopts the shared leadership model. It has been shown that the internal team environment variable has three dimensions which work together in order to develop an internal team environment: shared understandings about team goals, high levels of involvement, and a sense of recognition and importance. The external coaching (external condition) has been found to be a critical component of shared leadership since the support and guidance provided aids the team in developing its

shared leadership environment and the external leader provides the team with support to aid them in gaining more self-confidence in the leadership role. Based on this analysis, it appears that there is a direct relationship between these two conditions since an external leader provides more guidance and support. The result should be the improvement and further development of a team's internal team environment condition.

2.3 Relevant Theories and Models

2.3.1 Social Network Theory

Previous research has concluded that the concept of shared leadership should be viewed as a "relational phenomenon involving mutual influence between team members as they work toward team objectives" (Carson et al., 2007, p. 1220). Since shared leadership is based on interactions and influences that are being distributed and displayed by several sources, social network analysis/theory is applicable to this field of study as it provides both a theoretical and analytical approach to studying relationship structures in teams. Social network analysis evaluates the "patterns of relationships among individuals such as advice, information, and friendship networks and emphasizes the relationship as the unit of analysis" (Carson et al., 2007, p. 1224). The concept of shared leadership results in patterns of reciprocal influence, which in turn, further develop and reinforce existing relationships among team members. According to Yukl's (1989) research, the display of leadership influence takes place in the context of team member relationships and assumes the presence of "influences;" based on this information, it appears that social network analysis is appropriate for observing the relations and interactions that occur in teams. In addition, the social network methodology allows the researcher to evaluate multiple sources of leadership influence at one time as well as allowing the researcher to have the ability to "model patterns of influence within a team and preserve rich data about the actual distribution of influence" (Carson et al., 2007, p. 1224).

A social network is a type of structure that it is made up of individuals or organizations, which are called nodes. These nodes are connected to one or more other nodes by a specific type of interdependency. The concept of social network analysis is a methodology that views social relationships (among nodes) in terms of network theory. In its simplest form, this methodology utilizes network theory to create social networks/diagrams, which are maps of all relevant connections between all of the nodes

being studied. Within the concept of social network theory, there are many metrics that can be used to describe the relationships between the connections and nodes.

Mayo, Meidl and Pastor's (2002) research shows that a social network approach to shared leadership needs to account for the development of two aspects, those being "the nature of the leadership network and the distributional properties that describe the leadership networks as a whole system" (Mayo et al.,2002, p. 4). A social network is defined as a "set of individuals with a routine and established pattern of interpersonal contacts that can be identified as members of a network exchanging information, resources, influence, affect, or power" (Mayo et al., 2002, p. 4). Groups are represented as a collection of lines connected through the use of lines. The result is a diagram known as a "sociogram," which "represents the network of relations among group members that can be analyzed using the methods and techniques of social network analysis" (Mayo et al., 2002, p. 4).

The basic building block of any social network is the link (also known as the tie). This tie is a relational unit that can exist only if two individuals (nodes) are considered together. The basic premise of these ties is that the content of these relations defines the nature of the network. The relational links between actors/nodes can be described in two dimensions: strength and symmetry. The concept of "strength" refers to the "frequency with which the two individuals exchange information or influence" (Freeman, 1979, p. 217). The second dimension, symmetry, refers to "the extent to which the relationship is bi-directional." One should note that the symmetry dimension is a critical aspect of ties in networks of influence, since many relations tend to be asymmetrical.

After understanding the basics of how to construct a sociogram or leadership network, the next step in social network analysis is to develop questions (i.e. surveys) that help to outline the leadership behaviors that team members (and teams) display in the team setting. When carrying out these surveys/questions, there are two aspects that are critical to the execution of the conceptualization. The first aspect is that leadership needs to be considered as an attribution made "about the intentions of an agent of influence" (Mayo et al., 2002, p. 9). The second aspect is to understand how team members perceive each other "for an influence attempt to be considered part of leadership, it has to be perceived by the receiver of influence as an act of leadership" (Mayo et al., 2002, p. 9). In

order to perform rating surveys, the researcher needs to establish a rating scale. Based on past research, the most common approach to establishing a rating scale in a social science study is that the scale is set from one through five, with zero representing "never or almost never" and five representing "frequently or almost always" (Mayo et al., 2002, p. 8).

In the next phase of social network analysis, the data collected through a researcher's survey/questions are used to generate matrices of each team in order to outline how each member perceives the leadership characteristic of their fellow team members. These matrices can be utilized to generate the leadership network representation of the team, but it can also be used to calculate the individual and group-level measurements that are needed to gauge each team's level of shared leadership (Ensley, Pearson, & Pearce, 2001, p. 3). The data can be represented in a sociogram/network by having the points represent the team members and the links representing the leadership relations (i.e. level of influence/interaction). In order to efficiently translate the matrices of data, the data need to be dichotomized in order to represent the network data of shared leadership. During past social network analysis efforts, in the matrices, any value of three or less is considered zero (i.e. values of one, two, and three would be assigned a value of zero) and values greater than three are given the value of one (i.e. a value of four and five would be assigned a value of one). In this sense, the valued network data are being translated into a binary network of data where the research will only count the presence (i.e. strength) of the relationship.

It should be noted that "the circles are nodes representing team members. Arrows represent leadership relations: An arrow pointing from one member (A) to another (B) means that member B is perceived as a source of leadership by member A. Two-headed arrows means that two individuals perceive one another as a source of leadership" (Borgatti, Everett, & Freeman, 1992, para. 2). The sociograms in Figure 1 outline examples of teams that have demonstrated different levels of shared leadership.

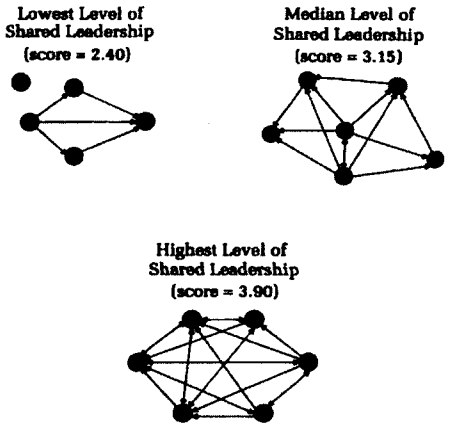

Figure 1. Examples of Sociograms

2.3.2 Network Metrics

Mayo et al.'s research (2002) details many different metrics that can be used to describe a social network as well as an individual's position in relation to the whole network. One of the main methods is known as network centrality. The term centrality is used as "a proxy for an individual's influence in the social system...network centrality refers to individuals' performance in the social system" (Freeman, 1979, p. 225). Within the concept of centrality, there are several forms of measurement, but the most effective are degree, closeness, and betweenness centrality.

Degree centrality involves "the number of links that a person has with other members of the group...the more links, the more central he is in the group" (Freeman, 1979, p. 225). Out-degree links involve the links reported by the focal person and in-degree links refer to the links reported by other group members about the focal person. In influence (interaction) networks, out-degrees are nominations (i.e. he/she influences me), while in-degrees are choices (i.e. "I have been selected as someone who influences other team members)" (Freeman, 1979, p. 225). Closeness is a "measure of centrality that accounts for both direct and indirect links;" it represents ease of access to other actors (Freeman, 1979, p. 225). Betweenness refers to the "extent to which one individual is between two other individuals who are not connected to each other" (Brass & Burkhardt, 1992, p. 200). In this sense, a high score represents that the person mediates the relationships of a high number of nodes/actors. Some research suggests that this metric indicates how much power a person has in the network. The closeness centrality measure represents

independence from others. The idea of betweenness centrality is that it is more of a measure of dependence on others.

Whole network measures are commonly used to describe variables at the system or organizational level, since some concepts are more effective if they are described in terms of a whole network metric. According to Mayo et al., density refers to the "number of links in the network as a proportion of the number of possible links" (Mayo et al., 2002, p. 11). In this sense, networks that are dense suggest that there are greater numbers of interactions among members of the network. A second measure on the group level is known as centralization, which refers "to the degree to which all members of the network are equally central in the network" (Brass et al., 1992, p. 200). In networks that are highly centralized, all members take part and are connected to similar number of nodes in the network. For a network that is less centralized, it tends to be more hierarchical, since one or a few actors are central and the remaining members are connected to only the central actors.

Past research efforts have detailed that the most applicable form of network measure for social science or the study of human interaction is the idea of team centralization, which is a measure of compactness. It details the type of distribution of the network ties as well as whether the links are focused around specific focal nodes. This type of measurement, with respect to individuals' centrality in the network, can be a powerful tool when it comes to conceptualizing the concept of shared leadership (Mayo et al., 2002, p. 11). With this type of study, all members in a given network take part in an equal manner; one should expect the highest level of shared leadership. However, in cases where the leadership behaviors are focused around one or a few nodes, it is common to call the leadership network highly centralized, since one or more individuals have become the central (informal) leaders, while the remaining members are acting as followers (Mayo et al., 2002, p. 11). Therefore, based on this understanding, the concept of centralization is a measure "of variability and dispersion of individuals' centrality," (Mayo et al., 2002, p. 11) which, in turn, can be used as a measurement of leadership discrepancies within the team.

In any research study that utilizes the concept of team centralization, a two-step procedure needs to be completed. In the first step, the research must identify individuals'

centrality in the leadership networks. In the second step to the process, the dispersion of the individual centrality indexes needs to be computed. It is important to understand that "individual centrality is a structural characteristic of individual members that indicates that the actor is at the center of the social system" (Mayo et al, 2002, p. 11). In some cases, the centrality, when in the form of directed relations measurements, also gauges the prestige, which represents actors with many in-degrees (i.e. choices). The idea of prestige "is a structural attribute of each individual; it refers to his/her level of prominence and importance in a social system" (Andrews & Ibarra, 1993, p. 285). In this research, prestige (or individual centrality) is a relational attribute of a team member, and it can be used to gauge a member's contribution to the leadership function of the team.

The matrices that are formed (from the development of sociograms or networks) can be used to determine the individual centrality of the team members. The sum of the rows in each of the matrices will represent the "total leadership influence attributed to each member" (Freeman, 1979, p. 230). In this sense, the values calculated here are the "in-degrees" (in network terms) and they represent the individual centrality and a member's status within the team. After the individual centralities are calculated, the dispersion of the individual centrality indexes will need to be calculated for each team. The idea of team centralization "represents the inequality with which group members participate in the leadership process. A team centralization measure expresses how tightly the team is organized around its more central individuals" (Freeman, 1979, p. 230). The variance is the most widely utilized method to measure dispersion of individual centrality. The common formula that is utilized to execute the variance of centrality ($(S_C)^2$) is:

$$S^2_c = [\sum_{i=1}^{g} (C_D(n^*) - C_D(n_i)] / (g-1)(g-2) \qquad \text{(Eq. 2.1)}$$

In this formula, $C_D(n_i)$ represents the in-degree centrality of individual I, the $C_D(n^*)$ is the maximum observed value and g is the number of team members. This index will vary from zero to one, in which a value of zero team centralization represents that the "status of all individuals in the group is spread equally (condition of maximum shared leadership) and the value of one team centralization indicates that the status in the team is centralized around a single member (condition of minimum shared leadership)"

(Freeman, 1979, p. 230). The values calculated represent the degree of shared leadership, which is a property of the group and a group-level metric. In shared leadership environments, the lower the variance, the greater the degree of shared leadership in the team.

2.3.3 Additional Benefits of Social Network Analysis

Social network analysis can help explain various metrics such as betweenness, closeness, and centrality. It can also provide a researcher with many additional benefits and information. First off, the use of social network analysis can help a researcher to understand if a team's leadership is centralized or decentralized. The use of social network analysis and leadership networks can provide a team with the ability to understand how leadership either becomes centralized or decentralized in the team environment. Overall, this benefit means that social network analysis can help to identify different models or types of leadership environments and it can help to determine different models of how teams share leadership (Trochim, 2006).

Social network analysis can also help to understand the relation and interaction of different shared leadership concepts. Since shared leadership typically *emerges,* it raises the question of whether centralization of one leadership function or type can also result the in centralization of other leadership types (Trochim, 2006). In addition to this information, social network analysis can help to identify the relationship and interaction that a leadership network has with other networks such as friends, communication, or status in the organization. This information can help the researcher to determine if other networks are more or less conducive to the emergence and sustenance of shared leadership (Trochim, 2006).

Some research studies attempt to control or limit various factors in order to ensure that they do not impact the variables of interest. These control factors include: team size, project demands, gender diversity, race diversity, team member experience level, and project duration. The use of social network analysis should enable a researcher to understand how these various factors affect the development of the variables of interest; social network analysis can help to determine how these various factors relate to or impact the development of the variables of interest.

The use of social network analysis in a research design can also provide more information because the networks developed for each team may push a researcher to investigate teams further and consider other factors that they originally did not account for in the design and/or statistical analyses. For example, if social network analysis helps a researcher notice that a team's leadership network is centralized or very focused on one or two members, then they may investigate the factors that result in these members being more central than other members (Trochim, 2006). The researcher might then discover that other factors such as charisma, attitude, or level of commitment have an impact on how central a member is in a leadership network. In turn, the researcher may begin to consider different avenues of factors and models, such as transformational leadership and transactional leadership. These different avenues may push one to pursue new areas of research and this would be a very strong benefit since the researcher may have the ability to identify new areas of research and it would aid him or her in furthering the research experience and knowledge base in these fields (Wageman, 2001). Overall, social network analysis may present new avenues of research and new direction in terms of considering new factors that can impact leadership development.

One key piece of additional information that social network analysis can bring to a study is that it can show a researcher all of the interrelational ties that exist between members of a team. The network measurements (centrality, betweenness, and closeness) provide a measure of a team as a whole and make it difficult to observe changes at the individual/component level, but the social network itself can provide a researcher with a graphical depiction of how members relate to each other and the true nature of how members perceive their fellow team members (Wageman, 2001, p. 567). By evaluating how a team's social networks change over the life of a project, a researcher can understand how the individual relational ties further develop (or diminish) and how members may change their perceptions of their fellow members as a project progresses. In a way, social network analysis provides a researcher with the ability to gain insight into team members' thinking and understand their perspective when it comes to identifying how leadership is distributed in their team environment (Wageman, 2001, p. 567). In this sense, social network analysis helps a researcher understand what a member may be thinking (at least in terms of how they perceive their fellow members) and how

they may approach the shared leadership environment. The graphical depiction of a social network is also an additional benefit since it provides a researcher with the ability to efficiently understand how a team's leadership network is developed and it provides them with a visual means of identifying patterns and relationships between members and the team as a whole (Wageman, 2001).

Social network analysis provides two additional benefits: it is guided by formal theory organized in mathematical terms and it is grounded in systematic analysis of empirical data (Wageman, 2001). Another critical piece of information that social network analysis provides a researcher is that it allows the researcher to identify strengths and vulnerabilities in a team's environment, providing insight as to the best ways to launch or improve a shared leadership environment. The concept of social network analysis also helps a researcher to identify the members or areas of the team environment that are either isolated or non-participative. By identifying these areas, a researcher will be able to determine go-forward plans or recommendations about how the team in question can improve its degree of shared leadership as well as how those isolated areas can become more involved in the leadership process (Wageman, 2001).

2.4 Research Overview and Research Hypotheses

The main goal of my research was to identify the relationship(s) that the internal team environment and external coaching variables had on the degree of shared leadership in the context of Six Sigma teams from the NSLIJ Health System. I also sought to ascertain the relationship(s) that these variables had with two performance metrics: the perceived effectiveness of a team's ability to complete the assigned project deliverables (i.e. project completion) and the perceived effectiveness of a team's ability to satisfy the requirements of the customer (i.e. customer satisfaction). The main goal of this research also sought to understand additional factors or issues that affected the five pre-defined hypotheses as well as the five variables studied in the research. The internal team environment and external coaching variables were chosen as the variables of interest in this study since review of research studies and literature has shown that these two variables have not yet been researched in an in-depth manner with respect to shared leadership and Six Sigma teams from the healthcare delivery field.

Based on these research goals, I defined my problem statement to incorporate the need for a longitudinal study by stating the following: In the context of NSLIJ Health System Six Sigma teams, there exists a relationship between shared leadership and each phase of the DMAIC structure. With respect to the NSLIJ Health System Six Sigma teams, the input environmental conditions of "internal team environment" and "external coaching" have a relationship with the degree of shared leadership present in these team settings. Simultaneously, there exists a relationship between the degrees of shared leadership present in these team settings and two performance metrics: the perceived effectiveness of a team's ability to complete the assigned project deliverables (i.e. project completion) and the perceived effectiveness of a team's ability to satisfy the requirements of the customer (i.e. customer satisfaction). From this problem statement, the following conceptual model of shared leadership in NSLIJ Health System Six Sigma teams is shown below in Figure 2 (note the bi-directional arrows that indicate two-way relationships).

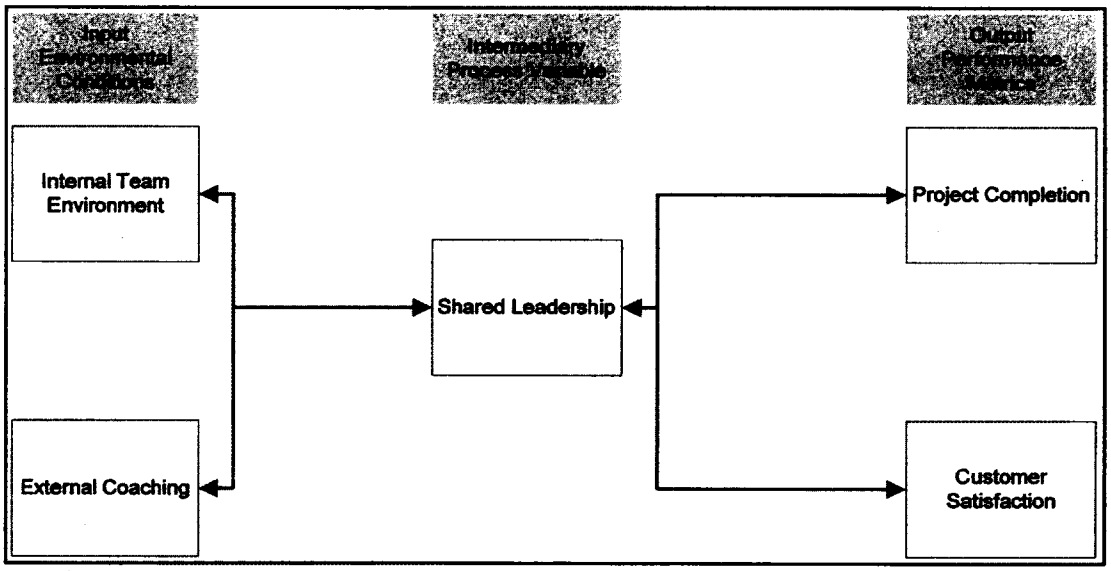

Figure 2: Conceptual Model of Shared Leadership in NSLIJ Six Sigma Teams

Based on the problem statement and the conceptual model and in the context of NSLIJ Health System Six Sigma teams, the following five hypotheses have been defined:

Hypothesis #1: To examine whether there is an increase in shared leadership from Time Point #1 (Define phase) to Time Point #4 (Improve phase) of the DMAIC structure.

Hypothesis #2: To examine if there is a relationship between shared leadership and the internal team environmental condition at each phase of the DMAIC structure.

Hypothesis #3: To examine if there is a relationship between shared leadership and the external coaching environmental condition at each phase of the DMAIC structure.

Hypothesis #4: To examine if there is a relationship between shared leadership and the project completion performance metric at each phase of the DMAIC structure.

Hypothesis #5: To examine if there is a relationship between shared leadership and the customer satisfaction performance metric at each phase of the DMAIC structure.

CHAPTER 3

METHODOLOGY

3.1 Overview of the Key Research Components

The subsequent sections of Chapter Three highlight the specific details of the key components of the research design that I developed for my research focus. This section provides a high-level overview (summary) of the key components of the chosen research design. The key components are highlighted and briefly described below:

- Data Source: Six Sigma Teams from the NSLIJ Health System (healthcare delivery). **See Sections 3.2 and 3.9.**
    - Sample Size: Eight Six Sigma Teams (out of a population, *N*, of 16 teams)
    - Alpha value of 0.05 and power level of 0.92.
    - Defined DMAIC structure and methodology that is applied to all Six Sigma teams.
    - Standard Team Size: Four internal members and One external coach.
    - Defined selection criteria to aid in selecting the teams that will take part in the study.
        - Defined criteria for internal members.
        - Defined criteria for external coaches.
        - All teams have controlled size, project demands, and project duration.
    - Standard Project Duration is Four-Six Months for the DMAI phases.
    - Based on Eight subject teams: 32 total internal members and 8 total external coaches.
- Type of Research Design: Concurrent Mixed Methods Approach based on longitudinal design & descriptive statistics. **See Section 3.3.**
    - Number of Treatments: One
        - The criteria and requirements utilized by the DIS and CLI management for the selection of internal members and external coaches of Six Sigma teams as well as the other critical elements of the health system's DMAIC process (i.e. project duration, team

size, and project demands) will serve as the treatment for the Six Sigma teams that are asked to participate in this research study.

- Number of Time Points: Four
  - Location of Time Points: Data to be collected at the "reports out" of the following phases of the NSLIJ Health System DMAIC Six Sigma methodology: Define, Measure, Analyze, and Improve
- Number of Goals/Objectives: One Main Research Goal
- Number of Defined Hypotheses: Five Hypotheses Based on Problem Statement and Defined Goal
- Subject Teams will be assigned to the One Treatment, which is the structure and elements of the Six Sigma DMAIC process utilized by the NSLIJ Health System for Six Sigma projects.

- Pre-Project Verification and Validation Plan: Perform Pilot Study on a sample of Two Six Sigma teams from Wave #2 of 2011. The pilot study will check for validity of the measurement tool(s) and research design. **See Section 3.4.**
- Key Metrics: The level of centralization of the interactions among the team members and the perceived level of influence that each member has for each fellow team member (shared leadership measure), the level of satisfaction with the internal team environmental conditions (internal team environment measure), the level of internal team member satisfaction with the external environmental conditions (external coaching environmental measure), the degree of project completion for the team's assigned project deliverables and the degree of customer satisfaction. **See Section 3.5.**
  - Variables of Interest:
    - Internal Team Environment
    - External Coaching
    - Degree of Shared Leadership
    - Project Completion
    - Customer Satisfaction

- Method of Data Collection: Surveys that contain both qualitative and quantitative questions. **See Section 3.6.**
    - Expected Duration of Data Collection: approximately 12 months based on length of the DMAIC process from the subject data source. Data collection will occur in two waves, in which data are collected for six months (January 2012 through June 2012) for four subject teams and then another six months for the second set (August 2012 through January 2013) of four subject teams. Note that in the subject data source, projects are done in sets of four and are performed in two waves, for a total of eight projects
    - Surveys to be administered through hard copy (i.e. paper) at each specific report out session.
    - Data will be entered and coded to ensure participant privacy and confidentiality.
    - Data will be stored and maintained in Microsoft Excel spreadsheets, which will be password-protected to ensure participant privacy and confidentiality.
- Pre-Analysis Tasks. **See Section 3.7.**
    - Using social network analysis to develop team centralization metric and social networks (leadership networks) for each team.
    - Development of team-level composite/aggregates for each variable.
    - Interrater Agreement Index to justify use of team-level aggregates.
- Analysis Methods. **See Section 3.8.**
    - Quantitative: Use of Repeated Measures ANOVA (Backup is Non-Parametric Wilcoxon Matched-Pairs Signed-Rank Test)
        - Hypothesis #1: Repeated Measures ANOVA Method.
            - Based on Normality Test:
                - If normal data, Repeated Measures ANOVA Method.
                - If non-normal data: Wilcoxon Matched-Pairs Signed-Rank Test.
        - Hypothesis #2:

        - Based on Normality Test of Data:
            - If normal, then Paired T-Test.
            - If non-normal data: Wilcoxon Matched-Pairs Signed-Rank Test.
    - Hypothesis #3:
        - Based on Normality Test of Data:
            - If normal, then Paired T-Test.
            - If non-normal data: Wilcoxon Matched-Pairs Signed-Rank Test.
    - Hypothesis #4:
        - Based on Normality Test of Data:
            - If normal, then Paired T-Test.
            - If non-normal data: Wilcoxon Matched-Pairs Signed-Rank Test.
    - Hypothesis #5:
        - Based on Normality Test of Data:
            - If normal, then Paired T-Test.
            - If non-normal data: Wilcoxon Matched-Pairs Signed-Rank Test.
- Qualitative: Coding/Textual Analysis of Leadership Networks & Qualitative Survey Questions (Identify Themes and Ideas for All Variables Based on Mixed (Open & Closed) Questions).

The subsequent sections of Chapter 3 (presented in Sections 3.2 – 3.9) highlight the specific details of the key components of the research design.

3.2 Data Source

3.2.1 Key Information for Data Source & Participating Teams

The data source that was chosen for this research effort was real-world industry sponsored data. Research has shown that industry (real-world) data can be more easily generalized for the purpose of drawing conclusions and determining new findings. I determined that based on the needs of my study and the availability of data from different sources, my source data would be Six Sigma teams. Based on my research, Six Sigma

teams are present in many different environments, implying that the data would be available for me to utilize for my study. I have found that Six Sigma teams are currently being utilized in the following fields and these are fields that I had the resources to support (i.e. I had contacts in these industries that were able to provide me with support on this study): defense manufacturing, electronics manufacturing, medical supply manufacturing, and healthcare service delivery.

Six Sigma teams were determined to be a perfect fit for this study since these teams often utilize the shared leadership methodology and the internal team members are often given the opportunity to have high levels of autonomy. Additionally, in many Six Sigma teams, there is often an external coach or project sponsor who has the primary responsibility of providing support and guidance for the internal members of the team. Furthermore, Six Sigma teams often follow a similar improvement methodology, which revolves around the DMAIC process; the use of a common methodology enables me to collect data from sources that are performing similar project tasks and have similar tasks types (i.e. problem solving, action-oriented, etc). In this case, Six Sigma teams tend to be problem solving oriented in that they focus on a project where there is a defined problem and their main focus is to solve the problem.

After performing further research into the industries outlined above, I decided that the healthcare delivery industry (i.e. hospitals, etc) was the field that would be utilized for my study's data collection since it is a field that has not been investigated with respect to the development of shared leadership in Six Sigma teams. It also has the most readily available data for Six Sigma teams that regularly use similar methodology and approaches to Six Sigma projects. The Six Sigma teams in the healthcare delivery industry focus on the main issue of performance improvement and cost-savings; all of the projects performed in this environment focus on these main objectives. Six Sigma teams in the healthcare delivery environment utilize the shared leadership principles and are almost always given high degrees of autonomy. Additionally, Six Sigma teams in healthcare delivery environments are also designed to have one dedicated external customer/coach, whose main responsibility is to provide support and guidance for the Six Sigma team as it executes the improvement cycle.

Six Sigma teams from the healthcare delivery field, specifically the NSLIJ Health System, served as the data source for this research effort. More specifically, I focused on the Six Sigma teams from the DIS group in the CLI at the NSLIJ Health System. The details on the history of the health system and DIS team are explained in the literature review section of my proposal, but at the host organization/data source, there are five Blackbelts and two Master Blackbelts. In the most direct sense, the goal of the DIS group is to perform Six Sigma projects in order to streamline operations and reduce operating expenses for the facilities within the health system.

The projects that are performed in the NSLIJ Health System are based on two sets of principles: shared leadership principles (their approach is known as the term "shared leadership") and a common Six Sigma DMAIC procedure and timeline (as outlined in the literature review section of the proposal). Based on this selection, I discussed my study with the supervisor of the DIS team and the various Six Sigma teams currently in the organization and was authorized to study the Six Sigma teams from the NSLIJ Health System as my source for data. I was also authorized to work with the various improvement teams as they begin new projects in the organization and I was granted permission to distribute surveys to each team member (internal and external) throughout the different segments of the project in order to observe how the teams utilized and developed shared leadership in their project environments. Additionally, the DIS team supervisor held meetings and distributed memos to her internal and external coaches (Blackbelt mentors) in order to explain the expectations of this study as well as their role in collecting the data.

The DIS team supervisor and organization fully supported my research study since both believed that the findings from this study would help to further improve the organization's approach to team work in shared leadership environments as well as evolve the organization's improvement methodology, which would in turn reduce costs for the organization and improve both performance and customer satisfaction. After evaluating the circumstances with the DIS team supervisor, I determined that there were 16 Six Sigma projects planned for the coming year that I could utilize to collect data for my research. I therefore determined that the sample population (N) is 16 teams, but due to the time constraints and the intensity of the data collection and analysis tasks of this

study, from this population I needed to select a smaller sample to use as the subject teams. The findings from this sample were utilized to make conclusions and findings for the population as a whole. All of the teams and members selected by the health system were subjected to the same DMAIC structure and methodology utilized by the health system, including selection requirements for each member type, the project duration (project timeframe), the team size, and the project demands.

Research into the Six Sigma projects in the healthcare delivery business sector has shown that teams that take part in these improvement projects typically consist of highly trained technical personnel, including: Six Sigma Greenbelts, Six Sigma Blackbelts (newly assigned to the role), nurses, physicians, clinicians, operations managers, and engineers. These various personnel focus on "operations" or "improvement" and each of these members (i.e. industrial engineers) typically have at least three years of work experience in the healthcare delivery field. Internal members of Six Sigma teams in the NSLIJ Health System are selected by the DIS and CLI management through the use of different criteria in order to ensure appropriate experience and capacity for success in Six Sigma environments. The DIS and CLI management utilize the following criteria and requirements in order to select internal team members:

- Must be highly trained or technical in the healthcare delivery field (i.e. nursing, medical, operations management, engineering)
- Must be trained (or in process) or certified (or in process) as a Six Sigma Greenbelt or Blackbelt
- Each member must have at least three years of work experience in the healthcare delivery field
- Team must consist of four internal members and one outside member (external coach)
- Can be any gender as well as any race/ethnic group
- Must adhere to the Six Sigma methodology/approach as defined by the NSLIJ Health System
- Must be willing to adhere and accept shared leadership approach and principles.

With regard to the external coach/sponsor, evidence shows that in the healthcare delivery industry, Six Sigma projects are typically monitored and overseen by one external coach/sponsor, who has the responsibility of providing support to the team as needed but also provides status updates to the executive management of the organization. In these project environments, the external coach/sponsor is usually an experienced Six Sigma Blackbelt or Master Blackbelt, whose experience primarily lies in industrial engineering (by degree or by experience) or operational performance improvement. Evidence shows that these external coaches/sponsors typically have a long history of work experience in the process improvement field, but they usually have at least three years of management/leadership experience in the healthcare delivery field.

In addition, in this team environment (healthcare) and project task type, research shows that the external leader/sponsor is truly external to the team, such that they provide guidance and support to the internal team members (strictly on a consulting basis), but the team retains the autonomy to assess the project problem and take the action that it deems appropriate. In this role, the external coach/sponsor is truly seen as one that only provides support and resources as needed and largely allows the team to be its own entity and complete the project on its own (but reassures the team that it has the external sponsor as an outlet/resource). This external coach/sponsor also has the responsibility of assessing the performance of the team's solution to the problem, in terms of customer satisfaction and quality of project in terms of: timeliness, cost effectiveness, and quality.

External coaches/members of Six Sigma teams in the NSLIJ Health System are selected by the DIS and CLI management through the use of specific criteria in order to ensure appropriate experience and capacity for success in Six Sigma environments. The DIS and CLI management utilize the following criteria and requirements in order to select external coaches/team members:

- Must be highly trained or technical in the healthcare delivery field (i.e. nursing, medical, operations management, engineering)
- Must be trained (or in process) or certified (or in process) as a Six Sigma Blackbelt or Master Blackbelt
- Team must be involved in a real-world project for Six Sigma and the project must be being performed in the healthcare delivery business sector

- Must have at least three years of management/leadership experience in the healthcare delivery field
- Must adhere to the Six Sigma methodology/approach as defined by the NSLIJ Health System
- Must be willing to adhere and accept shared leadership approach and principles.

In addition, another critical factor to account for from this data source was the length of time (project duration or project timeframe) required to complete projects in the Six Sigma team environment from the NSLIJ Health System. As explained in the literature review section of the proposal, in the NSLIJ Health System, based on the defined DMAIC improvement process, the typical Six Sigma project lasts approximately 12 months. The DIS team spends time mentoring the improvement teams through each step of the DMAIC improvement process. Approximately one month is dedicated to each of the first four phases of the DMAIC process so that participants can learn the tools and methodologies of each phase, and then execute in order to satisfy the required deliverables for each phase. One month is spent on reporting out (and developing a summary white paper) on the results of the project and following up on the outcomes of the project. In the final phase of the DMAIC process, which is the Control phase, the teams are taught the tools and methodologies of Control phase and then given six months to complete the Control phase, "report out" on the phase and to develop their sustainability plan for the project.

In all, the entire DMAIC process in requires up to approximately 12 months at NSLIJ Health System, four-five of which are dedicated to the DMAI phases of with approximately six months dedicated to the Control phase (final phase of DMAIC) and sustainability plan for the project. This defined DMAIC improvement process outlined above is performed for all improvement projects that occur in the NSLIJ Health System that are performed by the DIS team. It is a method of thinking that has been adopted (or currently is being adopted) throughout all facilities and members of the health system. Since this same methodology is utilized for all improvement projects perform by the DIS

team, all of the teams that are managed or mentored by the DIS team are subjected to the same project duration or project timeframe.

The size of the Six Sigma teams from the NSLIJ Health System is another critical factor to account for from this data source. In the NSLIJ Health System, Six Sigma teams are limited to specific team sizes: four internal members and one external coach who act as a mentor for the internal members of the team. The internal members of the team are typically Greenbelts or new Blackbelt while the external coach is a Master Blackbelt or an experienced Blackbelt.

The project deliverables in Six Sigma teams from the NSLIJ Health System are also consistent. Again, all of the Six Sigma projects that are mentored or performed by the DIS team are subjected to the same DMAIC structure (training and execution). So while the goals, objectives and complexity of the Six Sigma projects may differ, the project deliverables for each team are the same throughout each phase of the DMAIC process. For example, in the "define" phase of the DMAIC structure in the NSLIJ Health System, Six Sigma teams are required to complete the following project deliverables: project charter with problem statement, goal statement, and business case; stakeholders' analysis; Critical to Quality (CTQ) tree; and high level process map or Supplier, Input, Process, Output, and Customer (SIPOC) diagram.

Just as the Define phase has key deliverables, each phase of the DMAIC structure in the NSLIJ Health System has defined project deliverables that a team is required to complete. The completion of these deliverables might prove to be more complex for some teams that others, especially based on project difficulty and goals/objectives of the project, but each team is required to complete the necessary deliverables at each phase in the DMAIC structure in order to meet the requirements of their sponsor and external coach. Therefore, any team that performs a Six Sigma project in the DMAIC structure in the NSLIJ Health System, for each phase of the structure, a team's deliverables will be the same as their fellow teams, regardless of project complexity or differing goals and objectives.

The criteria and requirements utilized by the DIS and CLI management for the selection of internal members and external coaches of Six Sigma teams as well as the other critical elements of the health system's DMAIC process (i.e. project duration, team

size, and project demands) serves as the treatment for the Six Sigma teams that were asked to participate in this research study. Note that once internal and external coaches are selected by the DIS teams and assigned to a Six Sigma team, the teams remained the same for the duration of the Six Sigma project. All of the teams and members selected by the health system were subjected to the same DMAIC structure and methodology utilized by the health system, which included selection requirements for each member type, the project duration (project timeframe), the team size, and the project demands.

Therefore, the elements of the health system's DMAIC structure could be controlled by me and the influence of these factors on the five main study variables were able to be minimized (controlled). This helped to provide a clear insight into the relationships that the five main study variables have with each other. Since the factors described above are "controlled" through the DMAIC structure and methodology utilized by the NSLIJ Health System, these factors did not provide any influence on the development of the five variables being studied in the design nor did they affect the relationships that the five main variables have on each other.

After selecting the subjects that would comprise each team, I informed both the internal and external coaches about the purpose of the study, their role in the study, and what they needed to do in order to contribute to the study. Specifically, I explained the surveys, how they were to be completed, and how often. To account for ethical and moral considerations, the selected team members were required to complete and sign "informed consent" forms that outlined the major factors and aspects of the study. See Appendix C for sample of the consent form for main study and Appendix D for sample of consent form for the pilot study).

3.3 Research Design

Keeping in mind the purpose and intentions of my research focus, I determined that a mixed-method research approach (quantitative and qualitative) was the most applicable method to use when performing research in this field of study. This was due to the fact that the proposed research sought to examine the relationships between the five variables being studied in this design. This required both qualitative and quantitative data to be collected in order to accurately develop any patterns or relationships that existed between the five main study variables. The mixed research methods approach also allowed me to

utilize both deductive and inductive processes in order to examine the set of pre-specified hypotheses. As subsequent sections of the study show, the data collection method captured both qualitative and quantitative data from each member of the subject teams at each time point, thereby providing me with the ability to perform a comprehensive analysis of the hypotheses and research questions.

A longitudinal study approach allowed me to collect data for each of the five variables as teams progressed through the common Six Sigma methodology and procedure present in the NSLIJ Health System. Data were collected at four time points for all team members, both internal and external. Specifically, the surveys were administered at the "report out" phases for each of the steps of the DMAIC process that the NSLIJ Health System uses within its Six Sigma project life cycle. Note that the control phase of the procedure and the "report out" from the control phase were considered to be out of scope for this research study since the report out for this phase is held six months after the Improvement phase. Collecting data from this phase falls out of the desired data collection period of the research study and collecting data at this phase would have increased the length of the study from four-five months to 12 months). Research of previous projects within the NSLIJ Health System has shown that teams have typically completed at least 90% of the project by the time they reach the Control phase. The incremental development of shared leadership after the "report-out" at the Improve phase is negligible.

The data collection was performed in two waves (groups), each wave consisting of four Six Sigma projects, for a total of eight teams. Wave #1 contained four teams that performed Six Sigma projects from January 2012 through June 2012. Based on the report out schedule for these projects, data for these teams were collected between February 2012 and May 2012. Wave #2 contained four teams that performed Six Sigma projects between August 2012 and January 2013. Based on the report out schedule for these projects, data for these teams were collected between September 2012 and December 2012. To summarize:

- Time Point #1 (i.e. period #1): Data collected at the Define Phase "report out" of the DMAIC improvement process, highlighted in the literature review

- Time Point #2 (i.e. period #2): Data collected at the Measure Phase "report out" of the DMAIC improvement process, highlighted in the literature review
- Time Point #3 (i.e. period #3): Data collected at the Analyze Phase "report out" of the DMAIC improvement process, highlighted in the literature review
- Time Point #4 (i.e. period #4): Data collected at the Improve Phase "report out" of the DMAIC improvement process, highlighted in the literature review.

At each time point, surveys were used to gather the necessary data and information from all subject teams for each variable of interest. The corresponding calculations (composite calculations, social network metric calculations and networks) were then performed. The results of these calculations were then used to test the five hypotheses and to explore the qualitative nature of these variables. The qualitative data collected from each time point allowed me to perform coding/textual analysis and to identify patterns and relationships between the five variables. Both the qualitative and quantitative analyses served as the basis for exploring the five hypotheses and the two research objectives of my study.

After the teams were selected, the teams were be assigned to the one treatment, which is the structure and elements of the Six Sigma DMAIC process utilized by the NSLIJ Health System for Six Sigma projects. As the previous section detailed, all of the teams and members selected by the health system will be subjected to the same DMAIC structure and methodology utilized by the health system, which includes the factors of: selection requirements for each member type, the project duration (project timeframe), the team size, and the project demands. Therefore the elements of the health system's DMAIC structure should be able to be controlled by me and the influence of these factors have on the five main study factors should be able to be minimized (controlled), which in turn helps to provide a clearer picture into the relationships that the five main study factors have with each other. Since the factors described above are "controlled" through the DMAIC structure and methodology utilized by the NSLIJ Health System, these factors should not provide any influence on the development of the five variables being studied in the design nor should these factors contribute any influence on the relationships that the five main variables have with each other. Therefore, these factors

should not prove to be any issue (or should be minimized) during the execution of the research design/study.

3.4 Pilot Study

The first step in the execution of this study was to perform a pilot test on a smaller population in order to evaluate the validity of the measurement tool(s) and research design. This allowed me to identify any problematic areas such as basic procedure and data collection methods that needed to be redesigned or improved. In addition to helping me identify deficiencies, the pilot study provided the opportunity to make necessary changes or improvements, thereby ensuring the effectiveness of the design's parameters prior to large scale implementation.

Specifically, the pilot study was performed on two subject teams from the second Wave of projects executed in 2011. Like the others, each of these teams was comprised of four internal members and one external coach. These two teams were selected for the pilot study since they delayed in completing the phases of their projects due to logistical issues within their hospital settings and personal issues involving the team members. Both teams had completed the Define and Measure phases of their projects, but were put on hold as they approached the Analyze phase.

The pilot study, therefore, collected data for these two teams as they completed the Analyze and Improve phases of the DMAIC process, resulting in a total of two time points for each subject team. The pilot study was executed in accordance with the specific design parameters (data collection methods) outlined for the main study. The effectiveness and validity of the measurement tools and research design were assessed through two mechanisms: (1) interviews/feedback data provided by the pilot participants about measurement tools and research design, and (2) the evaluation of the completed surveys and research design, including: spreadsheet templates and design, procedures for data entry, procedures for development of leadership networks, and verification of any formulas for the design. Note that the due to the complexity of the quantitative data being collected in the research design as well as the question of normal versus non-normal data for each of the factors, the analysis methods chosen for this research study were evaluated during the pilot testing period. In the main study, prior to the analysis methods being executed, all of the data collected from the surveys were tested for normality. By

performing the pilot study on a smaller subset of the sample size, I was able to assess the validity of the research design and measurement tool(s).

3.5 Operational Definitions of Research Variables

"Operational definition" defines and identifies the specific observable conditions and/or events and tells the researcher how to measure that condition or event. Due to the criticality and the significance of operational definitions, an operational definition must be a clear and concise detailed definition of a measure; in this sense, one must see an operational definition as a method to define a variable or term in terms of the specific process that was utilized to determine the variable's/term's presence and quantity (i.e. one must define the variable in terms of the operations that count as measuring it).

As a reminder, the variables of interest discussed in this study are: shared leadership, internal team environment, external coaching, project completion, and customer satisfaction. The key metrics used to measure these variables were the level of centralization of the interactions among the team members and the perceived level of influence that each member has on each fellow team member (shared leadership measure), the level of satisfaction with the internal team environmental conditions (internal team environment measure), the level of internal team member satisfaction with the external environmental conditions (external coaching environmental measure), the perceived effectiveness of a team's ability to complete the assigned project deliverables (i.e. project completion) and the perceived effectiveness of a team's ability to satisfy the requirements of the customer (i.e. customer satisfaction). Table 1, below, outlines the conceptual definition, operational definition, measurement tool, and data source (internal or external coach) for each of the variables of interest.

Table 1. Operational Definitions for Research Study Variables

Variable	Conceptual Definition	Operational Definition	Measure-ment	Data Source
Internal Team Environ-ment	Consists of three dimensions: shared purpose, social support, and voice. The three dimensions work together to develop a team context that supports (and encourages) team members' willingness to offer leadership influence as well as to rely on the leadership influence of other team members.	Levels of satisfaction for the team members (internal) in reference to the three dimensions of internal team environment (shared purpose, social support, and voice).	Survey at Each Time Point	Internal Team Members
External Coaching	A direct interaction with a team intended to help team members make coordinated and task-appropriate use of their collective resources in accomplishing the team's task.	Levels of satisfaction and the relationship (support) that internal team members believe exist with their corresponding external leader/coach.	Survey at Each Time Point	Internal Team Members
Shared Leadership	An emergent team property that results from the distribution of leadership influence across multiple team members. Leadership is a process whereby an individual influences a group of individuals to achieve a common goal. Leadership has four main components: it involves influence; it is a process; it involves goal attainment; it occurs in a group context.	Perceived level of influence that each member has on their fellow team members and the number of interactions, dependencies and centrality found between team members. Calculated through the use of the team centralization metric outlined the in social network theory section of Chapter Two.	Survey at Each Time Point	Internal Team Members
Project Completion	A team's final outcome that includes its ability to complete the tangible and intangible deliverables at each milestone in a project. This variable involves how effective a team is at completing the assigned project deliverables.	The perceived effectiveness of a team's ability to complete the assigned project deliverables. The level of perceived effectiveness from the external customer/leader perspective (will be based on the defined deliverables and requirements of the assigned project).	Survey at Each Time Point	External Coach or Customer
Customer Satisfaction	A team's ability to satisfy the customer's demands and requirements by providing high quality deliverables in an efficient and timely manner at each milestone in a project. This variable involves how effective a team is at satisfying the requirements of the customer.	The perceived effectiveness of a team's ability to satisfy the requirements of the customer. The level of perceived effectiveness from the external customer/leader perspective (gauge will be based on the defined deliverables and requirements of the assigned project).	Survey at Each Time Point	External Coach or Customer

3.6 Data Collection Method

3.6.1 The Use of Survey Research in Research Design

Survey research was chosen as the data collection method for my research study since it allowed me to effectively answer the research questions and test the defined hypotheses. In the field of leadership research, the use of surveys provides the researcher with the ability to obtain useful information at both the individual and team-levels. In this study, it allowed me to execute the desired concurrent mixed methods research design by incorporating both quantitative and qualitative questions into the surveys.

Qualitative questions allowed the participants to have the freedom to answer in a variety of ways (allowing me to identify trends or patterns) while quantitative questions restricted the responses to discrete values that were useful in calculations and measurements. Survey research also provides the flexibility to account for survey respondents who do not complete a survey in its entirety or for respondents who withdraw from the study.

3.6.2 Variables Being Studied Through Internal Team Member Data

During this study, the internal members of each team served as the data source as for three of the five variables in question: "shared leadership," "internal team environment," and "external coaching" variables.

The shared leadership variable was defined in terms of the number of interactions, dependencies and the degree of centrality found between team members (these internal interactions can be one way or two way interactions), as well as the perceived level of influence that each member exerted on his or her fellow team members. The level and intensity of interactions and influence for each team member was based on the perceptions of the other members; the level of interaction and influence gauged for a particular team member provided sufficient data to calculate the individual in-degree centrality for each member of the team (based on the inputs from the fellow members). The individual in-degree centralities found for each member provided the basis for calculating the team's centralization value. Note that the team centralization metric (for each team) was calculated in accordance with the procedure outlined in the previous section. At each time point, team members were required to complete a survey in which they were asked to quantitatively rate their peers and external leaders/coaches on a scale

of one, "not at all," to five, "to a very great extent" on the following question: "To what degree does your team rely on this individual for leadership?"

The survey also contained four qualitative questions that allowed the team members to express their opinions and feelings about the shared leadership variable within their team environment. These mixed (open and closed) questions served as the basis for identifying modes of thinking and patterns among team members and the teams themselves. Each qualitative question was designed in such a manner that the three most common responses (based on historical experience and input from past Six Sigma teams from the health system) were available for the respondent to choose from. For those respondents that did not wish to choose any of the three pre-defined answers, there was an "other" box and a comment line where they could choose to provide their own free response to the question at hand. For each qualitative question, the instructions specified that the respondent should only choose one response (i.e. either one of the three pre-defined options or the "other" response and then provide his/her free response). Limiting a respondent selection to only one response provided much more clarity when the qualitative analysis was performed and specific themes were identified for each question. The survey designed for the "shared leadership" variable is shown in Appendix A; it presents both the quantitative and qualitative questions that were asked for each participant at each time point. Each internal team member of a subject team, at each measurement time point, was required to complete this survey.

The internal team environment variable was defined based on levels of satisfaction for the internal team members with respect to the three dimensions of internal team environment (shared purpose, social support, and voice). Each of these dimensions were measured through surveys designed to address the core principles of each dimension. The responses from each team member were combined with those of the others in order to develop an aggregate measure of the team's internal team environment metric. As in past studies, team members were asked to rate their team's internal environment on ten different aspects using a Likert scale ranging from one, "strongly disagree," to five "strongly agree." These ten aspects/factors were classified into three (3) specific subscales, corresponding to the shared purpose, social support, and voice dimensions. Voice was measured through the use of four items based on previous work by VanDyne

and LePine (1998) and DeDreu and West (2001); the shared purpose and social support scales were developed to fit the specific needs of my research study. The survey was designed such that the subscales could be aggregated to the team level and then the scores could be averaged in order to create a single measurement that represented the measure of a team's "internal team environment" (Carson et al., 2007, p. 1228).

In addition, the survey also contained four qualitative questions that allowed the team members to express their opinions and feelings about the internal team environment variable in their team environment. These questions served as the basis for identifying modes of thinking and patterns among team members as well as teams as a while unit. The goal here was to gather additional information that could not be derived from the quantitative portion of the survey. Again, each qualitative question was designed in such a manner where the three most common responses were supplemented with an "other" box and a comment line for respondents to provide their own free-form answers to the question at hand. The survey designed for the "internal team environment" variable is shown in Appendix A; it presents both the quantitative and qualitative questions that were for each participant at each time point. Each internal team member of a subject team, at each measurement time point, was required to complete this survey.

The external coaching variable was defined in terms of the levels of satisfaction and the relationship (support) that internal team members believed existed with their corresponding external leader/coach. They were given surveys designed to gauge their feelings towards the level of external coaching that they received from the external leader/coach. The responses from each team member were combined with those of the others in order to develop an aggregate measure of a team's external coaching metric. For the external coaching input variable, team members were asked to rate the specific level of supportive coaching that was provided by their external leader (supervisor or end user) using a three-item scale. The items on this scale included: "expresses his/her confidence in the capabilities of our team," "effectively motivates and guides our team toward accomplishing challenging goals for this project," and "is sensitive to the needs of our team and tries to help us however he/she can" (Carson et al., 2007, p. 1228). These items were used to capture the consultative and motivational functions of the external leader, both of which are believed to be critical in "fostering both commitment to a team and

independence" (Carson et al., 2007, p. 1226). For these items, the team members were asked to rate each item on a scale ranging from one ("strongly disagree") to five ("strongly agree"). The survey was designed such that the items can be aggregated to the team level and then the scores can be averaged in order to create a single variable that represents the measure of a team's measure of "external coaching."

In addition, the survey also contained four qualitative questions that allowed the team members to express their opinions and feelings about the external coaching variable in their team environment. These questions served as the basis for identifying modes of thinking and patterns among team members and the teams themselves. They also served to gather additional information that could not be derived from the quantitative portion of the survey. Once again, each qualitative question was designed in such a manner that respondents were provided with the three most common responses and an "other" box and a comment line for free-form answers. For each qualitative question, the instructions specified that the respondent should only choose one response (i.e. either one of the three pre-defined options or the "other" response and then provide his/her free response). Limiting a respondent selection to only one response provided much more clarity when the qualitative analysis is performed and specific themes were identified for each question. The survey designed for the "external coaching environment" variable is shown in Appendix A; it presents both the quantitative and qualitative questions that were asked for each participant at each time point. Each internal team member of a subject team, at each measurement time point, was required to complete this survey.

3.6.3 Variables Being Studied Through External Leader/Coach Member Data

The level of project completion and customer satisfaction on assigned project deliverables was determined by measuring the perceived level of effectiveness from the external coach perspective. In other words, the external coach was surveyed in order to gauge the level of project completion, based on the defined deliverables and requirements of the assigned project. For both of these variables, the end users (external coaches or project sponsor) were asked to rate the teams' effectiveness in terms of project deliverables, presentation, helpfulness of recommendations, and ability to work effectively in the shared leadership environment.

The survey consisted of eleven items, the first four of which were used to gauge the degree of project completion present in the subject team. The remaining seven items gauged the degree of customer satisfaction in the subject team. Each external coach was required to rate the team on each dimension with a single item using a five-point Likert scale ranging from one (extremely ineffective) to five (extremely effective). The survey also contained eight qualitative questions that allowed the external coaches to express their opinions and feelings about the "project completion" and "customer satisfaction" performance metrics as well as the team environment overall These questions served as the basis for identifying modes of thinking and patterns among the external coaches. As for the team members, the external coaches were asked to choose from among the three most common answers or to provide their own free-form answer by checking the "other" box. The survey designed for the "project completion" and "customer satisfaction" performance metrics/variables is shown in Appendix B; it presents both the quantitative and qualitative questions that will be asked for each participant at each time point. Each external coach of a subject team, at each measurement time point, will complete this survey.

3.6.4 General Information for Data Collection Method

The surveys for all of the variables of interest were completed via hard copy (i.e. paper format) at each specific "report out" session. The questions (both qualitative and quantitative) relating to each variable outlined in Appendices A and B were adapted to a formal format and these two surveys were administered to all participants (internal and external) at each time point in the study. Note that there will be one survey for variables being studied through internal member data and one survey for the variables being studied through external coach data. Additionally, all surveys were personalized for the team that is provided the data at any given time. In other words, the team members' names, as well as that of the external coach, appeared on each survey. This proved to be useful when team members are asked to gauge the degree of shared leadership for each of their fellow team members (i.e. the shared leadership variable; see the shared leadership survey in Appendix A), as it helped them avoid confusion.

In order to evaluate the validity of the survey data received from each participating team member, all of the surveys contained a validation question, which stated the

following "We are checking the validity of this survey, for this purpose please leave this question blank." Each survey contained this question, the objective of which was to ensure that the respondents were not rushing through the survey questions and randomly selecting any value. The use of this question in each survey helped me to validate the accuracy of the surveys for use in the analysis segment of the research study. Refer to Appendices A and B to review how these validation questions were designed into the surveys. In order to minimize the potential threat of bias and tainted data, external coaches were not made aware of the specific measurements and questions being gauged in the surveys that were administered to the internal team members. The reverse is also true.

During the data collection and analysis segments of the study, in order to adhere to privacy requirements as well as the ethical and moral conditions of both Old Dominion University and the NSLIJ Health System, all data collected from each of the teams and team participants were coded in order to ensure that participant information and responses were unidentifiable for results and documentation purposes. To ensure privacy and confidentiality, all surveys and data collected were administered via hard copy (paper) survey and the hard copy originals were stored in a secure filing cabinet, to which only the researcher has access. At the proper time (at the completion of the study), the actual surveys completed by the participants were destroyed using paper shredders. All data collection and results that were maintained and presented (i.e. in the dissertation paper and presentation/defense) have been anonymized.

The data from the surveys were entered and coded into spreadsheets for storage and security. The spreadsheets and the folder location were then password protected in order to ensure participant privacy and confidentiality. It should also be noted that the information/data collected from this study was only to complete this research effort; the information/data will not be shared with any other researcher, person, or organization that is not associated with the study. Data are reported in statistical format; results from specific participants are not reported on and will not be shared with other parties or research participants. The data were used to develop high-level statistics that in turn tested the hypotheses of the study. For the purposes of data management, the data will be stored electronically for a period of five years and then deleted from storage; the actual

surveys completed by the participants were destroyed after the study was completed through the use of paper shredders.

3.7 Methods for Data Calculations (Pre-Analysis Tasks)

3.7.1 Development of Social Networks/Leadership Networks and Team Centralization Metric

As explained in the previous section, survey data for the shared leadership variable was collected at each of the four time points and then used to calculate the team centralization metric and leadership networks/diagrams for each team throughout the Six Sigma process. The following procedure was used to convert the survey data into the necessary binary data that served as the basis for defining each team's leadership network at the relevant time points.

Based on the survey information from the respondents, the quantitative data collected at each time point and for each team were used to generate matrices (sociograms) for each team; these matrices, in turn were used to generate the leadership network representation of the team. They were also used to calculate the individual and group-level measurements that were needed to gauge each team's level of shared leadership (Mayo et al., 2002, p. 5). As in previous social network analyses efforts, values of three or less (i.e. values being one, two, or three) were considered to be zero and values greater than three (i.e. values being four or five) were given a value of one. In this way, the data are converted into a binary set where only the presence (i.e. strength) of the relationship is counted. From these binary matrices, leadership networks were generated according to the following notations and rules: the circles in the networks represent individual team members. Arrows represent leadership relations and an arrow pointing from one member (A) to another (B) means that member B is perceived as a source of leadership by member A. Two-headed arrows means that the two individuals perceive one another as a source of leadership. In all, four leadership network diagrams were developed for each of the eight teams (one at each time point) for a total of 32 leadership networks.

All substantive analyses in the study utilized the dichotomized (binary) data to calculate the centralization score, which served as the main method of measuring the degree of shared leadership in a team's environment. The team centralization metric calculated for each team at each time point throughout the study was used to gauge the

teams' level of shared leadership and to execute the subsequent hypothesis testing for the study. It should be noted that a team's centralization metric was calculated in accordance with the procedure and formulas presented in the relevant models/theories portion of this paper (see "Relevant Theories and Models" section). The team centralization measurements were then combined to form an overall representation of the team's shared leadership throughout the project life cycle.

The method and concepts discussed above outline the manual procedure that one must typically follow in order to generate leadership networks and to calculate the team centralization metrics for each team at each time point. For purposes of this study, a combination of software was used in order to generate leadership networks through the use of computers. The use of software allowed me to efficiently generate the leadership networks for each team at each time point, which in turn allowed me to completely execute the tasks of this study (i.e. data collection through analysis) in an effective manner. The software chosen was Microsoft Excel and UCINET 6, a package offered through Analytic Technologies (http://www.analytictech.com/). Microsoft Excel is a critical program that served as the tool used to collect the necessary data from the subject teams and convert it into binary form; it also served as the tool that calculated the team centralization value for each subject team at each time point. These centralization values were then to generate the leadership networks. The template was developed in a way that allows the user to automatically calculate the team centralization measure for any team at any point in the study. This template worked in conjunction with the UCINET 6 software and was used on all subject teams.

UCINET 6 is unique software dedicated to the generation and analysis of social networks. It allows users to input survey data from each team member and generates the necessary matrices that result in the leadership networks for a subject team. It provides an efficient method of generating the leadership networks based on the input matrices and enables a researcher to perform a wide array of analysis and metric generation, including the calculation of team centralization metrics for all of the leadership networks in the study. UCINET 6 also allows the user to develop leadership graphs/networks for each subject team, based on the input data and the use of team centralization.

3.7.2 General - Development of Team-Level Aggregates

For my research study, subjects were required to complete a survey at each time point that highlighted the five variables studied. Information was taken from each member of each team and this data was converted into a composite measure for each variable and team being studied throughout all of the time points (Trochim, 2006). Note that I had to approach the conversion from two angles since I obtained survey data from both the internal team members (on the internal team environment) and the external coach (on the project completion and customer satisfaction dimensions). Again, the study was comprised of eight teams, each consisting of four members and one external coach.

The first approach addressed the internal variables of interest ("internal team environment," "external coaching," and "shared leadership") and was measured using the survey from the internal members of the team. The generation of a composite of the individual data revolved around the need to generate team-level composites/aggregates for each team at each time point. The second approach addressed the external variables of interest ("project completion" and "customer satisfaction") and was measured through the external coach data. The generation of a composite of the individual data here revolved around the need to generate team-level composites/aggregates for each team at each time point.

Microsoft Excel was used to calculate the team-level composites/aggregates for each variable of interest at each time point. Specifically, the "Aggregate" function enabled me to calculate all of the necessary team-level values. It allows the user to select the specific function (count, sum, average, etc) that they would like to perform on sets of data. For the purposes of my study, all team-level aggregates were calculated utilizing the average and sum features of the Microsoft Excel "Aggregate" function. Note that in all calculations, team members were given equal weight in calculating the team-level aggregates.

Table 2 presents a summary of the different team-level scaled composites for each of the five variables of interest. Note that the figures and table have been generated to reflect the data source and measurement parameters being followed for this study: four members and one external coach per team and eight teams, studied at four different time points.

Table 2: Summary of Team-Level Composites/Aggregates for Key Variables

Variable	Number of Member (Individual) Scores	Number of Team-Level Composites Values	When Hypothesis Testing Was Performed (All 5 Hypotheses)
Internal Team Environment	128 Scores (4 Members x 8 Teams x 4 Time Points)	32 Scores (8 Teams X 4 Time Points)	At Completion of Data Collection Period
External Coaching	128 Scores (4 Members x 8 Teams x 4 Time Points)	32 Scores (8 Teams X 4 Time Points)	
Shared Leadership	128 Scores (4 Members x 8 Teams x 4 Time Points)	32 Scores (8 Teams X 4 Time Points)	
Project Completion	32 Scores (1 Coach X 8 Teams x 4 Time Points)	32 Scores (8 Teams X 4 Time Points)	
Customer Satisfaction	32 Scores (1 Coach X 8 Teams x 4 Time Points)	32 Scores (8 Teams X 4 Time Points)	

3.7.3 Interrater Agreement Index – Justification for Team-Level Aggregates

In order to develop team-level aggregates based on individual team member responses, the research study needed to calculate the interrater agreement. This agreement provided a justification for the aggregation of the individual members' data into a team-level aggregate. Based on the research design and the information provided in Table 2, an interrater agreement index was calculated for the internal team environment and external coaching variables, since these team-level composites were represented by an aggregate of the survey responses collected from each individual member from each of the four member teams that took part in the research study. Note that shared leadership did not need to have an interrater agreement index calculated for it since the values of the shared leadership variable were based on a pre-defined formula, as described in the literature section of this dissertation. Additionally, the project completion and customer satisfaction variables did not require an interrater agreement index for each measure since these two measures were based on data collected from one external coach (per team). The values given by each external coach became the team-level aggregate for each of the respective teams that the external coaches were assigned to. This is explained in detail in the next section.

The interrater agreement index, notated as r_{wg}, is a measure that can be utilized to represent how well survey responders agree with each other with respect to either a particular survey question or the survey as a whole. The interrater agreement is used by researchers to justify the aggregation of the individual data into a team-level aggregate; it is a technique that researchers use to assess the agreement "among the judgments made by a single group of judges on a single variable in regard to a single target" (Demaree et al. 1993, p. 306). The interrater agreement index is calculated using the following formula:

$$r_{wg} = 1 - (S_x^2 / \sigma_E^2) \qquad \text{(Eq. 3.2)}$$

In this formula, the S_x^2 term is the observed variance "on rating variable x, with x representing, for example, judgments of the overall publishability of a single manuscript by a set of reviews and editors" (Demaree et al., 1993, p. 308). The S_x^2 term is known as the error variance since this term captures the measurements that may occur between each rater and only occurs when there is variation in errors. If $S_x^2 = 0$, this signifies that the raters are in complete agreement with each other; when $S_x^2 > 0$, this implies that there is lack of agreement among the raters. The σ_E^2 term is known as the expected variance of the variable, which is the benchmark value that reflects the expected value of S_x^2 in a condition or scenario "in which judgments are due exclusively to random measurement error" (Demaree et al., 1993, p. 308). For each variable, the appropriate value of the σ_E^2 term is set based on the review of previous research designs and the expectations of the principal investigator. The calculated interrater agreement index will be between zero and one, where a value of zero signifies that there is no agreement between the raters and a value of one indicates that there is perfect agreement between the raters. After an interrater agreement index is calculated, its value needs to be compared against a minimal acceptable level, which is set based on review of previous research in the field (that also utilized the interrater agreement index) and the discretion of the principal investigator. The comparison of the calculated interrater agreement index against the minimal acceptable level will determine if it is valid (justified) for the individual raters' data to be aggregated into a team-level aggregate. For both variables, based on research into

previous designs, the minimal acceptable level will be defined to be 0.70. The calculated indices for this study needed to be greater than 0.70 in order to justify the aggregation of individual data.

For each time point and for each team, the interrater agreement index had to be calculated for both the internal team environment and external coaching variables. For the internal team environment variable, the interrater agreement index was calculated at each time point and for each team. This generated four indices per team throughout the study and a total of eight indices per time point (there were eight teams, as with one per team per time period) resulting in a total of 32 indices for the entire study. The same approach was also taken with respect to the external coaching variable, generating the same four indices per team and eight indices per time point (there were eight teams, as with one per team per time period), for a total of 32 indices for the entire study.

3.7.4 Internal Team Member Data Variables – Calculation of Team-Level Aggregates

For the "internal team environment" variable, at each time point, the team-level aggregate was calculated by executing the following procedures for each member of the participating teams:

1. For each member:
    a. Input all of the data from the respondent's survey into Microsoft Excel.
    b. Sum the score for the variable.
    c. Calculate the average by dividing the sum score for the variable by 10, (the number of questions in the survey for this variable), obtaining a value between one and five.
    d. Repeat until all team members had their average values between one and five.
2. For the team-level aggregate:
    a. Sum the average scores (four per team) calculated for each of the team members.
    b. Calculate the average of the averages (for the team) by dividing the sum of the average scores by four (the number of members in a team), obtaining a value between one and five.

The resulting values, ranging from one to five, reflected the pre-defined Likert scale that was used on the survey to gather the data for the internal team environment variable. A value of one indicated a low level rating of the internal team environment variable while a value of five indicated a high level rating of the internal team environment variable. These values corresponded with the "strongly disagree" and "strongly agree" survey responses. This process was performed at each time point and for each team, generating four team-level aggregates per team for the whole study (i.e. there will be eight team-level aggregates per time point since there are eight teams and there will be 32 team-level aggregates for the whole study since there are four time points). Note that all of these values were considered ordinal data since the values were based on data from a survey that had a pre-defined scale, which in turn were based on a relative order of magnitude from this scale.

For the "external coaching" variable, at each time point, the team-level aggregate was calculated by executing the following procedures for each member of the participating teams:

1. For each member:
    a. Input all of the data from the respondent's survey into Microsoft Excel.
    b. Sum the score for the variable.
    c. Calculate the average by dividing the sum score for the variable by three (the number of questions in the survey for this variable) obtaining a value between one and five.
    d. Repeat until all team members in the team had their average values between one and five.
2. For the team-level aggregate:
    a. Sum the average scores (four per team) calculated for each of the team members.
    b. Calculate the average of the averages (for the team) by dividing the sum of the average scores by four (the number of members in a team) in order to obtain a value between one and five.

The resulting values, ranging from one to five, reflected the pre-defined Likert scale that was used on the survey to gather the data for the external coaching variable. A value of one indicated a low level degree of the external coaching variable while a value of five indicated a high level degree of the external coaching variable. Again, these values corresponded with the "strongly disagree" and "strongly agree" survey responses. This process was performed at each time point and for each team, generating four team-level aggregates per team for the whole study (i.e. there will be eight team-level aggregates per time point since there are eight teams and there will be 32 team-level aggregates for the whole study since there are four time points). Note that all of these values were considered ordinal data since the values were based on data from a survey that had a pre-defined scale, which in turn were based on a relative order of magnitude from this scale.

The team-level aggregate for the "shared leadership" variable was calculated by taking the survey data and the team centralization metrics in accordance with the procedure outlined in the theories/model portion of this study. The team centralization metric, based on the individual centralities of each team member within a given team, served as the team-level aggregate for the shared leadership variable for a team at each time point. The team centralization metric varied from zero to one, with a value of zero team centralization representing that the "status of all individuals in the group is spread equally (condition of maximum shared leadership) and a value of one team centralization indicating that the status in the team is centralized around a single member (condition of minimum shared leadership)" (Freeman, 1979, p. 230). The values calculated represented the degree of shared leadership, which is a property of the group and a group-level metric. In shared leadership environments, the lower the variance, the greater the degree of shared leadership in the team.

Note that the values calculated from the formula discussed in the theories/model section of the dissertation were dependent on the number of team members that made up the team. Since all of the teams selected for the research study had four team members, the values for this variable were limited to [0.000, 0.167, 0.333, 0.500, 0.667, 0.833, and 1.000]. This process was performed at each time point and for each team in order to generate four team-level aggregates per team (eight per time point) and a total of 32 team-level aggregates for the whole study. All of these values were considered ordinal

data since the values were based on data from a survey that had a pre-defined scale, which in turn were based on a relative order of magnitude from this scale. This data are also considered ordinal because the formula utilized to calculate the values of this variable has a set number of allowable values (see above) that are driven by the number of team members that make up a team.

With eight teams, four time points and three internal variables, there were a total of 96 team-level aggregates for the internal team member data These team-level aggregates were used to perform the hypothesis testing on the five hypotheses and research questions at the end of the study (Trochim, 2006).

3.7.5 External Coach Data Variables – Calculation of Team-Level Aggregates

Recall that each subject team had only one external coach. Therefore, the individual data collected from the one external coach served as the entire basis for calculating the team-level aggregate. In other words, the individual value on the survey was equivalent to the team-level aggregate since there was only one external coach per team. For the "project completion" variable, at each time point, the team-level aggregate was calculated by executing the following procedures for each member of the participating team:

1. For the team-level aggregate (based on one individual respondent):
    a. Input all of the data from the respondent's survey into Microsoft Excel.
    b. Sum the score for the variable.
    c. Calculate the average by dividing the sum score for the variable by three (the number of questions in the survey for this variable), obtaining a value between one and five.

The resulting values from this procedure, ranging from one to five, reflected the pre-defined Likert scale that was used on the survey to gather the data for the project completion variable. Once again, a value of one indicated a low degree of the project completion variable, while a value of five indicated a high degree of the project completion variable. These values corresponded with the "extremely ineffective" and "extremely effective" answer choices on the survey. This process was performed at each time point and for each team, generating four team-level aggregates per team, eight team-level aggregates per time point, and a total 32 team-level aggregates for the entire study. Note that all of these values were considered ordinal data since they were based on data

from a survey that had a pre-defined scale, which in turn were based on a relative order of magnitude from this scale.

In terms of the "customer satisfaction" variable, at each time point, the team-level aggregate was calculated by executing the following procedures for each of the participating team:

1. For the team-level aggregate (based on one individual respondent):
    a. Input all of the data from the respondent's survey into Microsoft Excel.
    b. Sum the score for the variable.
    c. Calculate the average by dividing the sum score for the variable by seven (the number of questions in the survey for this variable) obtaining a value between one and five.

As for the other variables, the resulting values from this procedure, ranging from one to five, reflected the pre-defined Likert scale that was used on the survey to gather the data for the customer satisfaction variable. A value of one indicated a low level degree of the customer satisfaction variable while a value of five indicated a high level degree of the customer satisfaction variable. This process was performed at each time point and for each team, generating four team-level aggregates per team, eight team-level aggregates per time point, and 32 team-level aggregates for the entire study. Note that all of these values were considered ordinal data since the values were based on data from a survey that had a pre-defined scale, which in turn were based on a relative order of magnitude from this scale.

In summation, since the proposed study had four time points being measured, there were a total of 64 team-level aggregates (four time points, eight team, and two variables) based on external coach data. These team-level aggregates were to perform the hypothesis testing on the five hypotheses and research questions at the end of the study (Trochim, 2006, para. 8).

The team-level aggregates for each team served as the basis for calculating the descriptive statistics for each variable of interest at each time point. The mean and standard deviation of the team-level aggregates were also calculated. The team-level aggregates data and descriptive statistics served as the foundation for the inferential analysis that took place with the analysis methods (post data collection).

3.8 Analysis Methods

3.8.1 General Information & Reasoning for Analysis Task

Based on the needs and objectives of this study, it was determined that the analysis segment of the study would include two parts: a quantitative analysis to examine the pre-defined hypotheses and a qualitative analysis to examine the open and closed-ended questions from the surveys as well as the leadership networks generated for each team at each time point. The quantitative analysis was executed through the quantitative data collected for all teams at all time points; the purpose of the quantitative analysis was to evaluate the five pre-defined hypotheses and identify what relationships (if any) existed between the five variables studied in the research. The quantitative analysis sought to utilize the quantitative data to prove (or disprove) the relationship defined by the five hypotheses as well as identify the specific phases of Six Sigma where these relationships may or may not exist. Inferential statistical methods served as the basis for evaluating the five hypotheses and as the tools that allowed me to make credible and accurate conclusions about the five hypotheses.

The qualitative analysis included two sections, one which analyzed the data from the qualitative questions and a second section that focused on analyzing the leadership networks developed for each team at each time period. The purpose of the analysis of the data from the qualitative questions was to identify concerns, issues, trends, patterns, and justifications that could help support (and explain) the conclusions drawn from the quantitative analysis of the five hypotheses. The purpose of the analysis of the leadership networks was to enable me to study the leadership interactions that each member had with each of their team members and the changes of these interactions from time period to time period. The ability to see how interactions change within a team as the team progresses from time period to time period is a unique feature of social network theory (i.e. leadership networks); this is not a feature that is readily available with other leadership analysis methods. An additional purpose of analyzing the leadership networks is that it also enabled me to understand how the concerns, issues, trends, patterns, and justifications identified from the analysis of the qualitative data impacted (and helped to explain) the conclusions drawn from the quantitative analysis of the five hypotheses.

When the results of all three segments of the analysis were woven together, this offered robust and accurate answers to not only the research hypotheses but also helped to achieve the main goal of the research. The quantitative analysis provided the identification of any relationships between these five variables and where they existed in the DMAIC process. But the two pieces of the qualitative analyses performed helped to not only identify the concerns, issues, trends, patterns, and justifications that impacted the five variables (and hypotheses), but to also understand how these concerns, issues, trends, patterns, and justifications impacted the five variables (and hypotheses). The qualitative pieces of the analysis helped to shed light on how and why the conclusions for the five hypotheses turned out the way they did in the study.

Please note that all statistics were generated through the use of Microsoft Excel or Minitab software in order to efficiently complete the data collection task of the study.

3.8.2 Quantitative Analysis

In order to examine the five defined hypotheses and the research objectives, hypothesis testing needed to be performed on the quantitative data for each variable at each time point. Research into statistical testing methods and in-depth discussions with the Biostatistics team from the NSLIJ Health System were performed to determine the most applicable statistical testing method(s) for each individual hypothesis. These methods were selected based on the type of hypotheses being examined, the type of data collected, and additional statistical parameters (i.e. independence versus dependence, etc.). For each hypothesis, the selected statistical method and "hypothesis testing" procedure is outlined and discussed below.

3.8.2.1 Hypothesis #1

Prior to performing the statistical analysis for hypothesis #1, line plots and graphical analysis were used to identify patterns or trends. Graphical analysis was performed on the data related to this hypothesis for visualization purposes and to identify any potential conclusions and relationships. After the graphical analysis was complete for each team, the statistical analysis was performed; the statistical analysis was the mechanism utilized to draw concrete conclusions about the findings for this hypothesis.

Based on research and discussions with the Biostatistics team at the NSLIJ Health System, Hypothesis #1 was examined through the use of Repeated Measures Analysis of

Variance (ANOVA). This was the most applicable statistical analysis method because ANOVA is commonly utilized to examine data and hypotheses in which the same subjects are used for each study treatment and when the same treatment or parameter has been measured under different conditions or time point for those, same subjects. Prior to beginning the Repeated Measures ANOVA, I performed a normality test in order to verify that the data was normal and that it met the assumptions (i.e. normality assumption) required utilizing Repeated Measures ANOVA.

If the normality test concludes that the collected data are normal and that the data satisfy the assumptions and requirements of the Repeated Measures ANOVA method, then the Repeated Measures ANOVA analysis will be executed on the data in order to examine hypothesis #1. If the normality test concludes that the collected data are not normal, hypothesis #1 will be examined through the use of the non-parametric Wilcoxon Matched-Pairs Signed-Rank Test statistical method. Note that the non-parametric Wilcoxon Matched-Pairs Signed-Rank Test method will only be utilized as a backup analysis method if the data are non-normal, since this will indicate that the Repeated Measures ANOVA method cannot be utilized to perform the analysis (due to the lack of normal data). Note that the Wilcoxon Matched-Pairs Signed-Rank Test is performed by evaluating the differences between data of paired samples (such as repeated measures or "before" or "after" measures) in order to determine if these differences are different than a median value. The procedure for the Wilcoxon Matched-Pairs Signed-Rank Test is as follows:

- Rank the absolute differences (i.e., rank order the absolute differences of the pairs).
    - Note: Do not include any "zero" differences (i.e., pairs with equal members, x=y).
- Attach the original signs to the rank numbers.
    - Note: All pairs with equal absolute differences (ties) get the same rank.
        - This implies that all are ranked with the mean of the rank numbers that would have been assigned if they would have been different.
- Determine the total number of pairs (N).
- Sum all positive ranks (known as W+).

- Sum all negative ranks (known as W-).
- The level of significance and calculated value for this test statistic can be calculated through the use of Minitab's non-parametric test statistics options. This information can be compared against the critical values and defined alpha value in order to determine statistical significance and a statistical conclusion.

But it should be stated, that in either case of normal or non-normal data and regardless of using the repeated measures ANOVA or the Wilcoxon Matched-Pairs Signed-Rank Test analysis method, based on how hypothesis #1 was defined, the following comparison tests will be performed on the time period data for the shared leadership variable:

- Comparison of Sequential Time Periods:
  - Time Period #1 vs. Time Period #2
  - Time Period #2 vs Time Period #3
  - Time Period #3 vs Time Period #4
- Comparison of Initial & Final Time Periods (Before And After Comparison):
  - Time Period #1 vs Time Period #4.

For each of these comparisons, the corresponding null hypothesis (H_0) and alternative hypothesis (H_A) will need to be defined in order for an accurate conclusion to be developed. In addition, in order to develop a conclusion for each of the comparisons being made for hypothesis #1, after the statistical analyses are complete for each of the above comparisons, each of these comparison (hypothesis) tests will be evaluated at the defined alpha value of 0.05 and the decision criteria for the acceptance or rejection of the null hypothesis (H_0) for each of these tests will be based on the p-values obtained from the comparison (hypothesis) tests. If the p-value of a test was found to be less than the alpha value of 0.05, then the null hypothesis would be rejected; if the p-value for a test was greater than the alpha value of 0.05, then the null hypothesis would be accepted. It should also be outlined that based on the setup of the statistical test chosen as well as the statistical power analysis performed for the sample size and analysis methods for the design, the results will have a confidence level of 95% (in accordance with an alpha value of 0.05). Therefore, the results (the acceptance or rejection of the hypothesis) of the analysis of this hypothesis is sensitive to a confidence level of 95% (i.e. I can be 95%

confident that the results produced the proper conclusion). These results will also have a power level 0.92, which signifies the probability of correctly rejecting the null hypothesis when it is false. The level of 0.92 implies that there is high confidence that the statistical results and interpretation were executed accurately.

All procedures will be completed in accordance with the process and formulas outlined above. In addition, note that Microsoft Excel and Minitab will be utilized to perform all hypothesis testing. In order to efficiently perform the statistical testing portion of the study; the various tests will be designed and developed in accordance with the formulas, procedures and parameters outlined above.

3.8.2.2 Hypotheses #2, #3, #4, and #5

Recall that Hypotheses #2 through #5 include analyzing the shared leadership variable against a second variable, including: internal team environment (Hypothesis #2), external coaching (Hypothesis #3), project completion (Hypothesis #4) and customer satisfaction (Hypothesis #5). Prior to performing the statistical analysis for Hypotheses #2 through #5, graphical analysis (through the use of line plots for each team) was used to identify any potential relationships that may exist between the shared leadership variable and the second variable of interest at each of the time periods. Graphical analysis was performed on the data related to these hypotheses for visualization purposes and to identify any potential conclusions and relationships. After the graphical analysis was complete for each team, the statistical analysis was performed; the statistical analysis was the mechanism utilized to draw concrete conclusions about the findings for these hypotheses.

Based on the how the variables were defined, note that a shared leadership value can take on a value between zero and one, while a internal team environment, external coaching, project completion or customer satisfaction value can take on a value between one and five. In order to evaluate the shared leadership variable against the second variables in Hypotheses #2 through #5, the values of the shared leadership had to be normalized to the same level as the second variables. In order to normalize the shared leadership values, each value was multiplied by five in order to transform the shared leadership values onto the same scale (one to five) as the internal team environment, external coaching, project completion or customer satisfaction factors.

After the shared leadership data was normalized, prior to testing the hypotheses, all of the factors needed to be evaluated for normality. The results of the normality tests (on each factor) determined which statistical test was appropriate to evaluate the hypotheses. For each hypothesis, if the two factors being studied were found to be normal, then the hypothesis was evaluated by utilizing the paired t-test. The paired t-test could be used since the data for each factor was matched and paired to the specific eight teams. If the paired t-test was selected as the appropriate statistical test for a hypothesis, it was executed in accordance with standard statistical protocol.

If the normality tests for the two factors were found to be non-normal, the hypothesis was evaluated by utilizing the Wilcoxon Matched-Pairs Signed-Rank Test. This test was appropriate since the data for each factor were matched and paired to the specific eight teams. Note that if the normality tests resulted in one factor being normal and one factor being non-normal (for any given hypothesis), it was assumed that the appropriate statistical test to evaluate the hypothesis would be the Wilcoxon Matched-Pairs Signed-Rank Test, since this is a nonparametric test that can account for the difference in normality between the two factors in the hypothesis. If the paired t-test was selected as the appropriate statistical test for a hypothesis, the Wilcoxon Matched-Pairs Signed-Rank Test was executed as per the standard statistical protocol as outlined in the previous section for the analysis of hypothesis #1.

If the Wilcoxon Matched-Pairs Signed-Rank Test was deemed to be the appropriate statistical test for the evaluation of a hypothesis, then based on how hypotheses #2 through #5 were defined, each hypothesis was analyzed by taking the difference between the shared leadership value (i.e. based on the normalized data) and the second factor of interest for each team. This procedure was performed for each time period and for each team. Therefore, at each time period, eight "difference" values were calculated (one value per team). It was determined that a difference between the factors being studied, was appropriate for these hypotheses since these hypotheses were defined such that an association (or relationship) was assumed between the two factors being studied in these hypotheses. The use of a "difference" between the two factors is a formal approach to testing for a relationship or association between two factors.

Regardless of the analysis use (the paired t-test or the Wilcoxon Matched-Pairs Signed-Rank Test), the following comparison tests were performed on the data for the shared leadership variable versus the second corresponding factor (depending on the hypothesis):

- Shared Leadership Variable Against Second Variable At Time Period 1.
- Shared Leadership Variable Against Second Variable At Time Period 2.
- Shared Leadership Variable Against Second Variable At Time Period 3.
- Shared Leadership Variable Against Second Variable At Time Period 4.

For each of these comparisons, the corresponding null hypothesis (H_0) and alternative hypothesis (H_A) had to be defined in order for an accurate conclusion to be developed. Conclusions for the comparisons made in hypotheses #2 through #5, were evaluated at the defined alpha value of 0.05. The decision criteria for the acceptance or rejection of the null hypothesis (H_0) for each of these tests was based on the p-values obtained from the comparison (hypothesis) tests. If the p-value of a test was found to be less than the alpha value of 0.05, then the null hypothesis would be rejected; if the p-value for a test was greater than the alpha value of 0.05, then the null hypothesis would be accepted. It should also be outlined that based on the setup of the statistical test chosen as well as the statistical power analysis performed for the sample size and analysis methods for the design, the results will have a confidence level of 95% (in accordance with an alpha value of 0.05). Therefore, the results (the acceptance or rejection of the hypothesis) of the analysis of these hypotheses are sensitive to a confidence level of 95% (i.e. I can be 95% confident that the results produced the proper conclusion). These results will also have a power level 0.92, which signifies the probability of correctly rejecting the null hypothesis when it is false. The level of 0.92 implies that there is high confidence that the statistical results and interpretation were executed accurately.

All procedures were completed in accordance with the process and formulas outlined above. In addition, note that Microsoft Excel and were used to perform all hypothesis testing.

3.8.3 Qualitative Analysis

The qualitative analysis segment of the study focused on two sets of data: the mixed (open and closed) response questions from the surveys and the qualitative information that could be extracted from the leadership networks developed for each team.

The qualitative analysis of the mixed (open and closed) response questions from the surveys was performed by quantifying the responses of the subject teams. For each qualitative question, the respondents were instructed to select one of four responses. The first three options were pre-defined responses with the fourth option being an "other" choice, in which the respondent could provide a free text response to the question. I was able to measure the frequency of each response and to calculate the percentage that each answer represented. I was also able to review the "free text responses for themes or patterns when the forth choice was selected. The quantification of the qualitative responses by the teams enabled me to identify the common patterns and themes that the teams (as a whole) identified for each of the factors at each of the time periods as well as the study as a whole.

For each question under each variable of interest, the percentage contribution (of the total responses) for each response option (choice A, B, C, or D) was calculated for the data collected at each time period as well as for the study as a whole. For example: for question #1, the internal team environment factor, the qualitative data could indicate the following: 25.00% of the teams (i.e. two teams) selected option A; 50.00% of the teams (i.e. four teams) selected option B; 12.50% of the teams (i.e. one team) selected option C, and 12.50% of the teams (i.e. 1 team) selected option D (i.e. the "free text" other option) as their responses to the question. This type of analysis was performed on all of the questions, for all of the variables being studied in the research study, and at all the time periods in order to identify common themes and patterns that were not only related to each factor or time period, but across the entire research study. Note that the qualitative analysis of the qualitative questions also included the generation of bar graphs in order to provide graphical representations of the qualitative analysis.

The qualitative analysis on the leadership networks were performed by analyzing the leadership networks for each team, for each time period, independent from the networks developed for the other participating teams. Note that in shared leadership environments,

the lower the variance, the greater the degree of shared leadership in the team. Recall that the values calculated from the formula discussed in the theories/model section of the dissertation were dependent on the number of team members that made up the team. Since all of the teams selected for the research study had four team members, the values for this variable were limited to [0.000, 0.167, 0.333, 0.500, 0.667, 0.833, and 1.000]. From this preset list of values, in order to accurately analyze the leadership networks for each team, a qualitative scale was defined for the shared leadership variable. Based on previous research efforts, the following qualitative scale was defined: a low value of shared leadership implied a value equal to [1.000, and 0.8333]; a moderate value of shared leadership signified a value equal to [0.667, 0.500, and 0.333]; and a high value of shared leadership implied a value equal to [0.167, and 0.000]. This scale was utilized to analyze the leadership networks developed for each of the subject teams.

In addition to the team's shared leadership value and interactions at each phase, for each team, the analysis evaluated each leadership network in accordance with the following guiding criteria and questions:

- The interactions among the team members that exist in the network.
- The interactions among the team members that do not exist in the network.
- Are the interactions centralized around one person in the team (i.e. Blackbelt or Greenbelt)?
- Are the interactions decentralized (i.e. equal) among the team members?
- Is there one member (or more) that is perceived as displaying very little to no leadership abilities?
- What observations about members or the team can be detected from the leadership network?

In addition, for each team, the qualitative analysis also included a comparison of the leadership networks (i.e. a comparison of changes between networks) in order to compare the networks with respect to the following guiding criteria and questions:

- Is there a difference in the interactions (amount, centralization, etc) between each of the networks?
- What type of changes in the networks can be detected when comparing the networks?

- What type of changes in leadership (individual and team-level) can be detected when comparing the networks?

The analysis of the networks from a time period perspective as well as from a comparative perspective (i.e. comparing the network from period i to the network from period i+1) was performed for all participating teams and for all time periods.

These analysis methods for both the mixed qualitative questions and the leadership networks proved to be insightful since they provided the ability to identify trends and themes for the study. These methods also allowed me to identify variables that could not be identified through the use of the quantitative measures. The themes and patterns identified here provided support in achieving the objectives and testing the hypotheses of the study. This analysis helped to effectively identify themes and trends for each variable and helped me understand they evolve throughout the life cycle of the project.

Note that all analyses were completed in accordance with the procedure outlined above. Microsoft Excel served as the software tool that was used to perform the qualitative analysis on both the leadership networks and the responses from the surveys. The data from each respondent at each time point was input into the Microsoft Excel spreadsheets and the software serves as the basis for performing the analysis methods as outlined above.

3.9 Research Study Sample Size

3.9.1 Sample Size Determination

The determination of the sample size was a critical step in preparing a research study as well as statistical testing; research has shown that one of the most credible and accurate methods for sample size determination in the realm of social science and leadership development involves studying the power of a "test of hypothesis." The power approach consists of four interrelated components, which influence the conclusions that a researcher might reach from a statistical test in a research study. The four components of the power approach include sample size (i.e. the number of units such as people accessible to the study), standard deviation, alpha level (α, also known as significance level) (i.e. the probability that the observed result is due to chance), and power (i.e. the probability that you will observe a treatment effect when it occurs) (Trochim, 2006).

Based on defining any of the three of the four components (or being given any three of the four), it is possible for a researcher to compute the value of the fourth. In the case of my research study, I utilized past research studies to examine the standard deviation, alpha level, and power level factors in order to calculate the proper sample size for my research study. In the case of my research study, I have defined three of the four components; I have defined the alpha (α) value to be on the range from 0.01 to 0.10, the power level to be between 0.80 to 0.95, and the standard deviation to be on the range from 0.01 to 0.05. The use of the three "power approach" components enabled me to calculate the proper sample size from the whole population (N) of the chosen data source (recall that N was defined to equal 16). Minitab was utilized to calculate the sample size for my proposed research study by inputting the various parameters into the "power analysis" function of the software. This power analysis was based on the following parameters:

- Alpha value (α) tested on range 0.01 to 0.10, but middle value of 0.050 will be utilized (the software program used to calculate sample size only allows the input of one alpha value).
- Power level tested on range 0.80 to 0.95 at 0.80, 0.85, 0.90, and 0.95 (the common values in this range).
- Standard deviation on range 0.01 to 0.05, but worst-case scenario of 0.05 will be utilized (the software program to calculate sample size only allows the input of one standard deviation value) due to planning for worst-case and being risk averse in planning for my research study.
- N set to be at 16 since this is the defined population size for entire data source (based on availability of data source).

From the analysis, it was determined that the most realistic sample size for my research study should be eight of the 16 teams from the available project team population. The sample population of eight teams provided my study with a significant sample size that was also realistic and practical; since the data collection for each team was very time consuming. Note that each team project required a long period (four-six months for the DMAI phases of the DMAIC process in the subject environment) of data collection. The use of an eight-team sample size enabled my study to have a significant

alpha (α) value (Type I error) of 0.05 (the confidence level would be 0.95), an effective power level of .92, and standard deviation range.

Based on these established values, my study was able to strike the balance between the alpha value and the power level and ensure that it was able to detect the relationships and properly determine that these relationships were not simply coincidental. Based on the statistical significance and supporting analysis that has been performed, it was determined that eight Six Sigma teams needed to be studied, achieving a statistical significance (alpha α level) of 0.05 and an actual power level of 0.92 (actual power).

CHAPTER 4

4. ANALYSIS & RESULTS

4.1 Analysis & Results – Pilot Test

The study executed on the two pilot Six Sigma teams enabled me to validate the measurement tool and research design for the main research project. Recall that the effectiveness and validity of the measurement tools and research design was assessed through two mechanisms. The first is interviews/feedback data provided by the pilot participants about the measurement tools and research design. The second is observations recorded by me, which included an evaluation of the completed surveys and research design, including: spreadsheet templates and design, procedures for data entry, procedures for development of leadership networks, and verification of any formulas for the design.

Interviews and feedback provided by each pilot participant enabled me to validate the surveys for both the internal and external coaches. This indicated that the surveys were not too difficult to complete. The content was easily comprehensible and the flow of the surveys was such that the respondents had no significant issues completing them. The feedback also indicated that the respondents believed that the inclusion of the operational definitions for each variable (on the surveys) was critical since these definitions helped to ensure that all the respondents were interpreting the terms and questions in the same manner. The respondents also indicated that the inclusion of the operational definitions also helped to clarify each variable and question in the surveys, thereby helping to improve precision and accuracy when completing them.

The feedback received from the respondents also indicated that each respondent understood the purpose of the survey, his or her role in the completing the surveys, and his or her role in the overall research project. The mixed methods approach was effective since the respondents had the ability to provide both quantitative and qualitative feedback through the open-ended questions. For the quantitative questions, review of the feedback indicated that the inclusion of the scale definitions for each factor was critical since these definitions provided clarification for the respondents in order to help them to accurately complete the survey questions. The respondents also believed that the use of a one to five

scale for each variable was sufficient and that the scale did not need to be changed or further defined. The pilot participants also believed that the quantitative questions were defined sufficiently and that there were a sufficient number of questions for each variable to help capture the data and information needed in order to analyze the variables being studied. Feedback indicated that for each qualitative question, the respondents believed that the pre-defined options that they could select captured many of the possible responses for the questions; they also indicated a belief that it was important for each qualitative question to include a "free text" option in case the pre-defined options did not provide the respondents with the response that they wanted to convey for a question. They felt that the inclusion of both pre-defined options and the "free text" options helped to ensure that all possible responses could be captured in each question.

The only significantly "negative" feedback from the pilot participants was that the surveys were tiresome to complete since there were many questions and sections. The respondents indicated that while the surveys were not difficult to understand or complete, they required approximately five to ten minutes to complete due to the large number of variables being studied. Based on their feedback, the respondents believed that no significant issues existed on the either the internal team member nor external coach survey and that no changes needed to be made to either survey.

The researcher also assessed the validity and effectiveness of the measurement tools and research design. The pilot test data were successfully translated from survey responses into Microsoft Excel format that enabled efficient analysis to be performed by me. The entry of data into the pre-defined spreadsheets enabled the research team to validate that the design and calculations built into the spreadsheets (such as calculation of average, standard deviation, etc.) were accurate and understandable. Most importantly, the data entered into the spreadsheet templates provided me with the opportunity to verify and confirm that the formula used to calculate the centralization (shared leadership metric) measurement for each team was accurate. Note that the quantitative raw data and individual line plots for all factors are attached in Appendix C and D, respectively.

Review of the quantitative survey data by me revealed that the surveys were able to capture the desired data and information required for each of the variables. Review of the quantitative data also indicated that the respondents did not have any significant issue(s)

with understanding and completing the survey at each time period. The quantitative data and measures were also found to be valid since the validity questions built into each survey indicated the respondents successfully followed the instructions of the survey and did not simply "circle any answer" for a question. The fact that the pilot participants did not trigger the validity questions signified that the respondents followed instructions and read through each question prior to selecting their answer. The review of the qualitative survey data by me revealed that the qualitative questions were capable of capturing the desired feedback and data that I needed in order to identify the themes and patterns for each variable at each of the time periods in the study. The qualitative survey data from the pilot participants indicated that the pre-defined options, for each open-ended question, were able to capture many possible responses for the question. This was critical for the respondents since the "free text" option was utilized by many of them during the pilot study. This revealed that the inclusion of pre-defined options as well as a "free text" option for each qualitative question enabled all possible responses and outcomes to be accounted for in each question. The inclusion of both pre-defined options and a "free text" option for each qualitative question resulted in a robust design for the qualitative segment of the research project.

The pilot data collection of the shared leadership variables enabled me to test the procedure that was established for developing the shared leadership matrices and leadership networks. The Microsoft Excel spreadsheets developed for the shared leadership variable were found to be designed accurately and these spreadsheets provided the team with the ability to record the data, creating shared leadership matrices, which in turn were used to formulate the leadership networks in the UCINET 6 software. The procedure to translate the shared leadership matrices from Microsoft Excel into the UCINET 6 software was found to be effective. Once the shared leadership matrices from the pilot teams were translated into the UCINET 6 data format, the procedure for the translation of shared leadership matrices into leadership networks was verified by developing the leadership networks for each of the pilot teams. The development of these leadership networks revealed that the defined procedure to translate the shared leadership matrices into sociograms was effective and that the software (UCINET 6) was capable of executing the procedure.

Overall, the pilot test's survey data did not reveal any significant deficiencies with respect to the measurement tools or research design (i.e. data spreadsheets, procedures for data entry, etc.). The pilot testing confirmed that the measurement tools and research design produced accurate results that captured the information and data required to properly analyze the five variables being studied by the research project. The use of both of these mechanisms enabled the research to identify any potential issues with the measurement tools and research design and to assess the validity and effectiveness of the design's parameters. Based on these analysis mechanisms, I concluded that the measurement tools and research design were valid and could be extrapolated to the larger scale for the entire research project.

Note that I investigated the pilot participant's concern that the "surveys are too long" and include "too many questions and/or sections" by reviewing the surveys to determine if questions or sections could be consolidated in order to reduce the time to complete the surveys. After reviewing the questions and sections of the surveys, it was determined that each question and section had a specific purpose and the consolidation of questions or sections would have jeopardized the integrity of the data, the variables studied, and the overall research project. Therefore, I decided to make no changes to the internal team member or external coach surveys; the surveys remained as originally designed by me.

Also note, as explained the research design section of the dissertation, that the due to the complexity of the quantitative data being collected in the research design as well as the question of normal versus non-normal data for each of the factors, the analysis methods chosen for this research study were not evaluated during the pilot testing period. In the main study, prior to the analysis methods being executed, all of the data collected from the surveys were tested for normality.

4.2 Pre-Analysis Calculations – Main Study

Prior to performing analysis on the quantitative survey data, the interrater agreement metric needed to be calculated for two of the five variables in order to justify the aggregation of individual survey data into a team-level aggregate based on the average of four team member scores. As described in the research design section of this dissertation, the internal team environment and external coaching variables were represented by team-level aggregates that were based on the survey responses collected from each individual

member of the four member teams that took part in the research study. Since the aggregates (averages) are based on a composite of the individual members of a team, the interrater agreement metric needed to be calculated for the internal team environment and external coaching variables in order to justify the aggregation (i.e. averaging) of the individual data into a team-level aggregate (i.e. average).

Recall that the interrater agreement index is calculated by utilizing the following formula:

$$r_{wg} = 1 - (S_x^2 / \sigma_E^2) \qquad \text{(Eq. 4.1)}$$

In this formula, the S_x^2 term is the observed variance and the σ_E^2 term is known as the expected variance of the variable. Also recall that for each variable, the appropriate value of the σ_E^2 term is set based on the review of previous research designs and the expectations of the principal investigator. Based on previous research designs, it was determined that the σ_E^2 for the internal team environment would be set to 0.50, while the σ_E^2 for the external coaching variable was set to 0.30. The interrater agreement index was calculated at 32 points for the internal team environment and 32 points for the external coaching since each variable had a value for each team and there were eight teams in the study, each of which completed surveys at four time periods (i.e. one per team x eight teams x four time periods). Recall that for both variables, based on research into previous designs, the minimal acceptable level was defined to be 0.70. The calculated indices needed to be greater than 0.70 in order for aggregation of individual data to be justified.

For the internal team environment variable, the observed variances for the 32 points were calculated to be as shown in Table 3:

Table 3: Observed Variances for Internal Team Environment Variable

	Time Block			
Team #	1	2	3	4
1	0.020	0.049	0.043	0.073
2	0.057	0.020	0.040	0.022
3	0.037	0.097	0.027	0.014
4	0.107	0.046	0.056	0.024
5	0.019	0.014	0.047	0.015
6	0.117	0.065	0.073	0.010
7	0.051	0.015	0.097	0.110
8	0.107	0.103	0.078	0.016

Each of the interrater agreement indices were calculated based on the observed variances outlined in the previous table and the expected variance of 0.50. The resulting interrater agreement indices are shown in Table 4:

Table 4: Interrater Agreement Indices for Internal Team Environment Variable

	Time Block			
Team #	1	2	3	4
1	0.960	0.902	0.915	0.853
2	0.887	0.960	0.920	0.955
3	0.927	0.807	0.947	0.971
4	0.787	0.908	0.888	0.952
5	0.962	0.972	0.907	0.971
6	0.767	0.870	0.853	0.980
7	0.898	0.970	0.806	0.780
8	0.786	0.795	0.844	0.969

The table above indicates that the lowest interrater agreement index was 0.767, which is greater than the minimal acceptable level of 0.70. Therefore, it can be concluded that aggregation of individual team member data into a team-level value is justified for the internal team environment variable.

In terms of the external coaching variable, the observed variances for the 32 points were calculated to be as shown in Table 5:

Table 5: Observed Variances for External Coaching Variable

	Time Block			
Team #	1	2	3	4
1	0.028	0.000	0.028	0.037
2	0.074	0.075	0.072	0.028
3	0.063	0.011	0.047	0.053
4	0.068	0.025	0.045	0.064
5	0.031	0.052	0.022	0.063
6	0.018	0.024	0.010	0.022
7	0.027	0.021	0.039	0.000
8	0.054	0.074	0.023	0.025

Each of the interrater agreement indices were calculated based on the observed variances outlined in the previous table and the expected variance of 0.30. The resulting interrater agreement indices are shown in Table 6:

Table 6: Interrater Agreement Indices for External Coaching Variable

	Time Block			
Team #	1	2	3	4
1	0.907	1.000	0.907	0.877
2	0.753	0.750	0.760	0.907
3	0.790	0.962	0.843	0.823
4	0.773	0.917	0.850	0.787
5	0.897	0.827	0.927	0.790
6	0.940	0.920	0.966	0.927
7	0.910	0.930	0.870	1.000
8	0.820	0.753	0.923	0.917

The table above indicates that the lowest interrater agreement index is 0.750, which is greater than the minimal acceptable level of 0.70. Therefore, it can be concluded that aggregation of individual team member data into a team-level value is justified for the external coaching variable.

Having established justification for the creation of team-level aggregates based on the data collected at the individual team member level, we proceed now to the results of the main study.

4.3 Quantitative Analysis & Results – Main Study

Recall that the purpose of the quantitative analysis was to evaluate the five pre-defined hypotheses and identify what relationships (if any) existed between the five variables studied in the research. The quantitative analysis sought to utilize the quantitative data to prove (or disprove) the relationship defined by the five hypotheses as well as identify the specific phases of Six Sigma where these relationships may or may not exist. Inferential statistical methods served as the basis for evaluating the five hypotheses and as the tools that allowed me to make credible and accurate conclusions about the five hypotheses.

This section presents the analysis performed on the five hypotheses defined for the research project. The section is comprised of five sub-sections, in each of which one of the five hypotheses is analyzed and discussed. For each hypothesis, a graphical analysis was first performed for each team; the statistical analysis for each hypothesis began by performing a normality test on the data sets and subsequently selecting the proper inferential statistic to analyze them. Note that the type of inferential statistic utilized in the analysis of the hypotheses was dependent on whether or not the data was normal or non-normal, as outlined in the research methods section of the dissertation. After the proper inferential statistic was selected, the analysis of each hypothesis was executed in accordance with the analysis execution plan outlined in the research methods section of the dissertation.

For the shared leadership variable, recall that the values calculated from the formula discussed in the theories/model section of the dissertation were dependent on the number of team members that made up the team. Since all of the teams selected for the research study had four team members, the values for this variable were limited to [0.000, 0.167, 0.333, 0.500, 0.667, 0.833, and 1.000]. From this preset list of values, in order to accurately analyze the leadership networks for each team, a qualitative scale was defined for the shared leadership variable. Based on previous research efforts, the following qualitative scale was defined: a low value of shared leadership implied a value equal to [1.000, and 0.8333]; a moderate value of shared leadership signified a value equal to [0.667, 0.500, and 0.333]; and a high value of shared leadership implied a value equal to

[0.167, and 0.000]. This scale was utilized to perform the graphical analysis for each hypothesis.

4.3.1 Main Study – Hypothesis #1

4.3.1.1 Hypothesis Definition

Recall that hypothesis #1 states the following: To examine whether there is an increase in shared leadership from Time Point #1 (Define phase) to Time Point #4 (Improve phase) of the DMAIC structure.

4.3.1.2 Graphical Analysis

Reference Appendix F for the line plots developed for the shared leadership variable for each team. Recall that a lower value in the shared leadership variable (team centralization metric) signified more decentralized or shared leadership. Recall that graphical analysis was performed on the data related to this hypothesis for visualization purposes and to identify any potential conclusions and relationships. After the graphical analysis was complete for each team, the statistical analysis was performed; the statistical analysis was the mechanism utilized to draw concrete conclusions about the findings for this hypothesis.

The line plot developed for team #1 indicated that the team began the project with a shared leadership value of 0.50 (at time period #1), a value that decreased time period #2 to 0.33. At time period #3, it increased to 0.50, only to fall to 0.1667 at time period # 4. From a consecutive time period perspective, team #1 did not have a consistent decrease in its shared leadership value over the course of time. It did, however, achieve an overall improvement but when viewed from a before and after perspective (time period #1 versus time period #4), the team obtained a better degree of shared leadership by the end of the project since it went from 0.50 (time period #1) to 0.1667 (time period #4). This finding suggested that the team began the project with a more centralized leadership environment, but by the end of the project, the team was moving towards a more shared or decentralized leadership environment.

Team #2 began the project with a shared leadership value of 0.50 (at time period #1), but at time period #2 the team's value of shared leadership decreased to 0.33. But at time period #3, team #2 was found to have an increased shared leadership value, to a value of 0.667, but at time period #4, the team's value decreased to 0.1667. From a consecutive

time period perspective, team #2 did not have a consistent decrease in its shared leadership value (over the course of the successive time periods), but when viewed from a before and after perspective (time period #1 versus time period #4), the team obtained a better degree of shared leadership by the end of the project since it went from 0.50 (time period #1) to 0.1667 (time period #4). This finding suggested that the team began the project with a more centralized leadership environment, but by the end of the project, the team was moving towards a more shared or decentralized leadership environment.

The line plot developed for team #3 indicates that the team began the project with a value of 0.33, but decreased to a value of 0.1667 at time period #2. When the team progressed into time period #3, the shared leadership value was found to be 0.50 and the team remained at this level at the final time period as well. From a consecutive time period perspective, team #3 did not have a consistent decrease in its shared leadership value (over the course of the successive time periods); in addition, when viewed from a before and after perspective (time period #1 versus time period #4), team #3 was found to have a higher value of shared leadership at the end of the project (0.50 at time period #4) versus the beginning of the project (0.33 at time period #1), which indicated that the team began the project with an environment that displayed a good degree of shared leadership, but by the end of the project, the team was moving away from shared leadership and towards centralized leadership.

The line plot developed for team #4 indicated that the team began the project at a shared leadership value of 0.50 and the team remained at this value of leadership until time period #3 (the team had a value of 0.50 at time periods #1, #2, and #3). At time period #4, team #4 had a shared leadership value of 0.00, which signified the maximum degree of shared leadership that was possible in the team's environment. From a consecutive time period perspective, team #4 did not have a consistent decrease in its shared leadership value (over the course of the successive time periods), but when viewed from a before and after perspective (time period #1 versus time period #4), the team obtained a better degree of shared leadership by the end of the project since it went from 0.50 (time period #1) to 0.00 (time period #4). This finding suggested that the team began the project with a more centralized leadership environment and this value remained consistent for 3 consecutive time periods, but by the end of the project, the team was

moved to the highest degree of shared leadership that was possible in the team's environment.

The line plot developed for team #5 that the team began the project at a shared leadership value of 0.50 and the team remained at this value of leadership until time period #2 (the team had a value of 0.50 at time periods #1 and #2). At time period #3, team #5 had an increase in its shared leadership value to 0.667, but in the final time period, team #5 was found to have a shared leadership value of 0.1667. From a consecutive time period perspective, team #5 did not have a consistent decrease in its shared leadership value (over the course of the successive time periods), but when viewed from a before and after perspective (time period #1 versus time period #4), the team obtained a better degree of shared leadership by the end of the project since it went from 0.50 (time period #1) to 0.1667 (time period #4). This finding suggested that the team began the project with a more centralized leadership environment and this value remained consistent for two consecutive time periods, but by the end of the project, the team was moving towards a more shared or decentralized leadership environment.

The line plot constructed for team #6 identified that the team began the project at a shared leadership value of 0.50 and at time period #2, the team's shared leadership value increased to 0.667. At time period #3, the team's value of shared leadership was seen to decrease to 0.50 but in the final time period, the team's value of shared leadership once again increased to 0.667. From the plot, it can be seen that team #6 cycled between the leadership values of 0.50 and 0.667; at each successive time period, the team would consistently change between the values of 0.50 and 0.667. From a consecutive time period perspective, team #6 did not have a consistent decrease in its shared leadership value (over the course of the successive time periods); in addition, when viewed from a before and after perspective (time period #1 versus time period #4), team #6 was found to have a higher value of shared leadership at the end of the project (0.667 at time period #4) versus the beginning of the project (0.50 at time period #1), which indicated that the team began the project with an environment that displayed a good degree of shared leadership, but by the end of the project, the team was moving away from shared leadership and towards centralized leadership.

The line plot developed for team #7 indicated that the team began the project at a shared leadership value of 0.1667, but at time period #2, the team increased to a shared leadership value of 0.667 and the team remained at this value of leadership until time period #4 (the team had a value of 0.667 at time periods #2, #3 and #4). From a consecutive time period perspective, team #7 did not have a consistent decrease in its shared leadership value (over the course of the successive time periods), in addition, when viewed from a before and after perspective (time period #1 versus time period #4), team #7 was found to have a higher value of shared leadership at the end of the project (0.667 at time period #4) versus the beginning of the project (0.1667 at time period #1), which indicated that the team began the project with an environment that displayed a good degree of shared leadership, but by the end of the project, the team was moving away from shared leadership and towards centralized leadership.

The line plot constructed for team #8 identified that the team began the project with a shared leadership value of 1.00 (the least degree of shared leadership possible in the team environment), but at time period #2, the team decreased its shared leadership value to 0.50. But the team increased its shared leadership value to 0.833 at time period #3 and the team remained at this level for the final time period (the team had a value of 0.833 at time periods #3 and #4). From a consecutive time period perspective, team #8 did not have a consistent decrease in its shared leadership value (over the course of the successive time periods), but when viewed from a before and after perspective (time period #1 versus time period #4), the team obtained a better degree of shared leadership (even though the value at time period #4 is only slightly better than time period #1) by the end of the project since it went from 1.00 (time period #1) to 0.833 (time period #4). This finding suggested that the team began the project with a more centralized leadership environment and this value remained consistent for two consecutive time periods, but by the end of the project, the team was moving towards a more shared or decentralized leadership environment.

The line plots and shared leadership values developed for each team suggest that for the hypothesis that there is an increase in shared leadership from Time Point #1 (Define phase) to Time Point #4 (Improve phase) of the DMAIC structure may not be valid; this theory appeared to be valid for teams #1, #2, #4, #5, and #8 from the study while teams

#3, #6, and #7 had the opposite outcome for the shared leadership over the course of the DMAIC structure. But the subsequent statistical analysis was utilized to determine if there was statistical significance to support the theory outlined in hypothesis #1.

4.3.1.3 Statistical Analysis

Prior to performing analysis for this hypothesis, a normality test was performed in Minitab on the entire sample population data set collected for the shared leadership variable in order to determine if the sample population data (for this variable) were normal. Figure 3 below shows that the data set for the shared leadership variable is non-normal, a finding that is also verified by evaluating the p-value of the data set. In the case of normality tests, a data set is considered to be normal if the p-value is greater than or equal to 0.05 (defined alpha value for this research project). The p-value is < 0.005, which shows the conclusion that the data for shared leadership variable is non-normal.

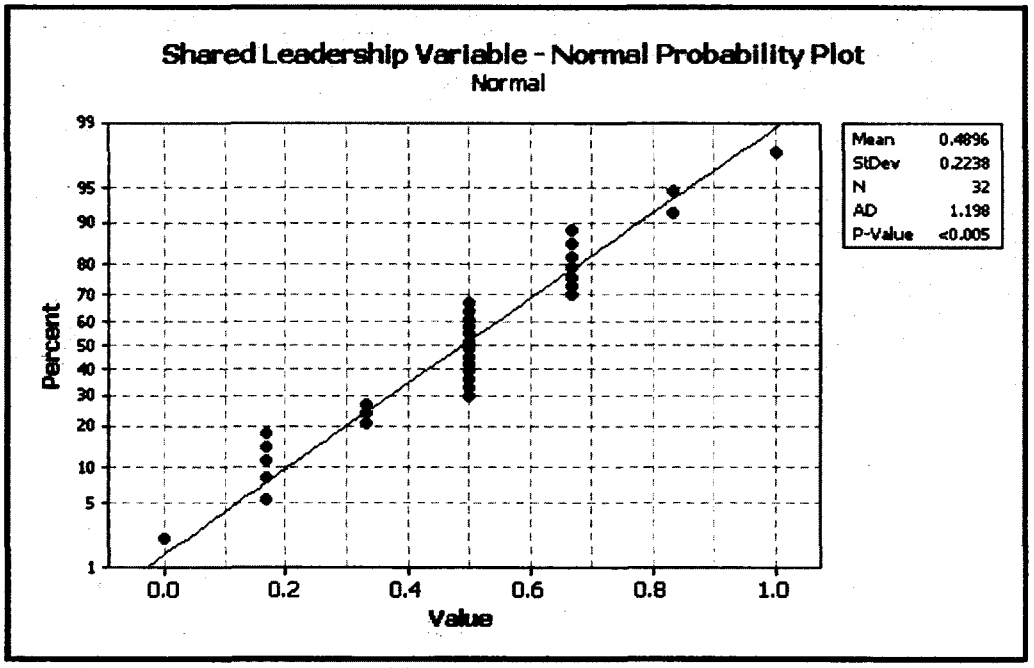

Figure 3: Normal Probability Plot for Shared Leadership Variable

Since these data were found to be non-normal, the non-parametric Wilcoxon Matched-Pairs Signed-Rank Test inferential statistic was selected as the tool to analyze the data set related to hypothesis #1. Based on how hypothesis #1 was defined, the

following comparison tests were performed on the time period data for the shared leadership variable:

- Comparison of Sequential Time Periods:
  - Time Period #1 vs. Time Period #2
  - Time Period #2 vs Time Period #3
  - Time Period #3 vs Time Period #4
- Comparison of Initial & Final Time Periods (Before And After Comparison):
  - Time Period #1 vs Time Period #4.

The Wilcoxon Matched-Pairs Signed-Rank Test is performed by evaluating the differences between data of paired samples (such as repeated measures or "before" or "after" measures) in order to determine if these differences are different than a median value. In order to execute this non-parametric test statistic for hypothesis #1, the differences between the shared leadership data from Time Period #1 vs. Time Period #2, Time Period #2 vs Time Period #3, Time Period #3 vs Time Period #4, and Time Period #1 vs Time Period #4 needed to be determined.

The Wilcoxon Matched-Pairs Signed-Rank Test typically utilizes a null hypothesis that states "The difference (d = x - y) between the members of each pair (x, y) has median value [X]." Therefore, for this study, the following null hypothesis (H_0) and alternative hypothesis (H_A) structure was utilized to test the four comparisons of Time Period #1 vs. Time Period #2, Time Period #2 vs Time Period #3, Time Period #3 vs Time Period #4, and Time Period #1 vs Time Period #4:

H_0 = Difference Between Shared Leadership $Value_i$ – Shared Leadership $Value_{i+1}$ Has Median Value = 0

H_A = Difference Between Shared Leadership $Value_i$ – Shared Leadership $Value_{i+1}$ Has Median Value > 0

It was decided to set the difference equation as Shared Leadership $Value_i$ – Shared Leadership $Value_{i+1}$ since the study hypothesizes that the value of the shared leadership metric should decrease from one (the worst value that a team can have) to zero (the best value that a team can have) as the team progresses through the DMAIC structure, indicating that the team has moved from centralized leadership (value of one) to a shared leadership environment (value of zero). This would imply that the theory is that one

should see a decrease of the centralization metric over time which signifies a more decentralized and shared leadership environment. The alternate hypothesis for each test was set to be > 0 due to the fact that the structure of hypothesis #1 implies that the shared leadership metric value for time period i should be more than the shared leadership metric value at time period i+1 and therefore the difference between time period i and time period i+1 should be > 0. A difference that is > 0 implies that the team is moving towards an ideal shared leadership environment (with a value of zero). In the other case, if the difference between time period i and time period i+1 is < 0, this implies that the team is moving away from an ideal shared leadership and instead moving towards a centralized leadership environment (with a value of one).

As indicated in the research methods section of the research study, each of these comparison tests were tested at the defined alpha value of 0.05 and the decision criteria for the acceptance or rejection of the null hypothesis (H_0) for each of these tests was to be based on the p-values obtained from the hypothesis tests. If the p-value of a test was found to be less than the alpha value of 0.05, then the null hypothesis would be rejected; if the p-value for a test was greater than the alpha value of 0.05, then the null hypothesis would be "failed to reject." A "failure to reject" the null hypothesis implied that there was not a statistically significant change in the value of leadership from time i to time i+1. But a rejection of the null hypothesis implied that there was a statistically significant change in the value of leadership from time i to time i+1 (i.e. that the teams had a statistically significant improvement in the value of leadership from time i to time i+1 such that they were moving away from a centralized leadership structure towards a more decentralized or shared leadership environment).

Based on the null hypothesis (H_0) and alternative hypothesis (H_A) structure defined above as well as the acceptance/rejection criteria for these tests, the Wilcoxon Matched-Pairs Signed-Rank Test was performed on the four comparison hypothesis tests through the use of Minitab. The results were as follows:

Comparison of Sequential Time Periods

Time Period #1 vs Time Period #2

H_0 = Difference between Shared Leadership $Value_1$ – Shared Leadership $Value_2$ Has Median Value = 0.

H_A = Difference between Shared Leadership $Value_1$ – Shared Leadership $Value_2$ Has Median Value > 0.

P-Value = 0.337.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.337 > 0.05).

Practical Conclusion: There is no statistical difference between the changes in the shared leadership values from Time Period #1 (Define Phase) to Time Period #2 (Measure Phase).

Time Period #2 vs Time Period #3

H_0 = Difference between Shared Leadership $Value_2$ – Shared Leadership $Value_3$ Has Median Value = 0.

H_A = Difference between Shared Leadership $Value_2$ – Shared Leadership $Value_3$ Has Median Value > 0.

P-Value = 0.970.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.970 > 0.05).

Practical Conclusion: There is no statistical difference between the changes in the shared leadership values from Time Period #2 (Measure Phase) to Time Period #3 (Analyze Phase).

Time Period #3 vs Time Period #4

H_0 = Difference between Shared Leadership $Value_3$ – Shared Leadership $Value_4$ Has Median Value = 0.

H_A = Difference between Shared Leadership $Value_3$ – Shared Leadership $Value_4$ Has Median Value > 0.

P-Value = 0.053.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.053 > 0.05).

Practical Conclusion: There is no statistical difference between the changes in the shared leadership values from Time Period #3 (Analyze Phase) to Time Period #4 (Improve Phase).

Comparison of Initial & Final Time Periods (Before And After Comparison)

Time Period #1 vs Time Period #4

H_0 = Difference between Shared Leadership $Value_1$ – Shared Leadership $Value_4$ Has Median Value = 0.

H_A = Difference between Shared Leadership $Value_1$ – Shared Leadership $Value_4$ Has Median Value > 0.

P-Value = 0.200.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.200 > 0.05).

Practical Conclusion: There is no statistical difference between the changes in the shared leadership values from Time Period #1 (Define Phase) to Time Period #4 (Improve Phase).

The results from these hypothesis tests, related to the comparison of sequential time periods, lead to the conclusion that there is insufficient evidence to validate the accuracy of hypothesis #1. The evidence from the hypothesis tests of the sequential time periods indicates that the shared leadership values do not increase from time period #1 (Define phase) through the time period #4 (Improve phase). The evidence supports the conclusion that the changes in the shared leadership values from Time Period #1 vs. Time Period #2, Time Period #2 vs Time Period #3, Time Period #3 vs Time Period #4 were not statistically significant.

The results from the hypothesis test related to the comparison of initial and final time periods (a before and after comparison), also lead to the conclusion that there is insufficient evidence to validate the accuracy of hypothesis #1. The evidence from the hypothesis test suggests that the shared leadership values do not increase from the initial time period #1 (Define phase) to the final time period #4 (Improve phase). The evidence from the hypothesis test supports the conclusion that the changes in the shared leadership values from Time Period #1 vs Time Period #4 were not statistically significant.

It should also be noted that as explained in Chapter Three, based on the setup of the statistical test chosen as well as the statistical power analysis performed for the sample size and analysis methods for the design, the results have a confidence level of 95% (in accordance with an alpha value of 0.05). Therefore, the results (the acceptance or rejection of the hypothesis) of the analysis of this hypothesis is sensitive to a confidence level of 95% (i.e. I can be 95% confident that the results produced the proper conclusion). These results will also have a power level 0.92, which signifies the probability of correctly rejecting the null hypothesis when it is false. The level of 0.92 implies that there is high confidence that the statistical results and interpretation were executed accurately.

Table 7 summarizes the findings of the comparisons tests performed for hypothesis #1:

Table 7: Summary Table for Hypothesis Testing on Hypothesis #1

Comparision	Null Hypothesis	Alternative Hypothesis	Statistical Test	P-Value	Statistical Conclusion	Practical Conclusion
Time Period #1 Vs Time Period #2	Difference Between Shared Leadership Value1 – Shared Leadership Value2 Has Median Value = 0.	Difference Between Shared Leadership Value1 – Shared Leadership Value2 Has Median Value > 0.	Wilcoxon Matched-Pairs Signed-Rank Test	0.3370	Fail to reject the null hypothesis (P-Value, 0.337 > 0.05).	There is no statistical difference between the changes in the shared leadership values from Time Period 1 (Define Phase) to Time Period 2 (Measure Phase).
Time Period #2 Vs Time Period #3	Difference Between Shared Leadership Value2 – Shared Leadership Value3 Has Median Value = 0.	Difference Between Shared Leadership Value2 – Shared Leadership Value3 Has Median Value > 0.	Wilcoxon Matched-Pairs Signed-Rank Test	0.9700	Fail to reject the null hypothesis (P-Value, 0.970 > 0.05).	There is no statistical difference between the changes in the shared leadership values from Time Period 2 (Measure Phase) to Time Period 3 (Analyze Phase).
Time Period #3 Vs Time Period #4	Difference Between Shared Leadership Value3 – Shared Leadership Value4 Has Median Value = 0.	Difference Between Shared Leadership Value3 – Shared Leadership Value4 Has Median Value > 0.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0530	Fail to reject the null hypothesis (P-Value, 0.053 > 0.05).	There is no statistical difference between the changes in the shared leadership values from Time Period 3 (Analyze Phase) to Time Period 4 (Improve Phase).
Time Period #1 Vs Time Period #4	Difference Between Shared Leadership Value1 – Shared Leadership Value4 Has Median Value = 0.	Difference Between Shared Leadership Value1 – Shared Leadership Value4 Has Median Value > 0.	Wilcoxon Matched-Pairs Signed-Rank Test	0.2000	Fail to reject the null hypothesis (P-Value, 0.200 > 0.05).	There is no statistical difference between the changes in the shared leadership values from Time Period 1 (Define Phase) to Time Period 4 (Improve Phase).

Note that in order to perform the analysis of hypotheses #2 through #5, the values of the shared leadership variables had to be normalized to the same level as the second variables. In order to normalize the shared leadership values, each value was multiplied by five in order to transform the shared leadership values onto the same scale (one to five) as the internal team environment, external coaching, project completion or customer satisfaction factors.

Also note that an alternative analysis method for hypotheses #2, #3, #4, and #5 is presented in Appendix G. In order to enhance the credibility and validity (triangulation of research for social science) of the results from the Wilcoxon Matched-Pairs Signed-Rank statistical test that was utilized to evaluate hypotheses #2, #3, #4, and #5, a Spearman correlation coefficient analysis was performed on hypotheses #2, #3, #4, and #5 and is presented in Appendix G.

4.3.2 Main Study – Hypothesis #2

4.3.2.1 Hypothesis Definition

Recall that hypothesis #2 states the following: To examine if there is a relationship between shared leadership and the internal team environmental condition at each phase of the DMAIC structure.

4.3.2.2 Graphical Analysis

Reference Appendix F for the line plots developed for the shared leadership variable and internal team environment variable for each team. Recall that graphical analysis was performed on the data related to this hypothesis for visualization purposes and to identify any potential conclusions and relationships. After the graphical analysis was complete for each team, the statistical analysis was performed; the statistical analysis was the mechanism utilized to draw concrete conclusions about the findings for this hypothesis.

In order to perform a graphical analysis on the two variables for each team at each time period, line plots were used to graph the data for each team and each variable. Recall that the two variables of interest for this hypothesis were defined on different and opposite scales (i.e. the shared leadership variable was defined on a zero to five scale, in which a value of zero was the highest degree/value of shared leadership and a value of five was the lowest degree/value of shared leadership; the internal team environment variable was defined on a one to five scale, in which a value of one indicated the lowest

value of internal team environment and a value of five was the highest value of internal team environment). Therefore in order to identify a relationship between the two variables at any time period, a gap (difference) needed to be identified between the two variables. Since the variables were defined on opposite scales, a large gap (difference) between the two variables at any time period would imply the potential of a significant relationship between the two variables; a small difference (gap) between the two variables at any time period would imply a trivial relationship (or no relationship at all) between the two variables.

At time period #1, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #7: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams was considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #1.

At time period #2, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #2: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #3: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #7: There appeared to be a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #8: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #2.

At time period #3, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #7: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #3.

At time period #4, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #2: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #5: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #7: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* to strong potential for a relationship between the two factors at time period #4.

The line plots developed for the two variables of interest revealed that throughout the Six Sigma DMAIC process, there was a *moderate to strong* potential for a relationship between the shared leadership and internal team environment variables at each of the time periods. The subsequent statistical analysis was utilized to determine if there was statistical significance to support the theory outlined in hypothesis #2.

4.3.2.3 Statistical Analysis

Prior to performing analysis for this hypothesis, a normality test was performed in Minitab on the entire sample population data sets collected for the internal team environmental condition and shared leadership variables in order to determine if the sample population data (for these variables) were normal. The normality test performed on the shared leadership variable's data set in section 4.2.1 showed that this data set was non-normal (see Figure 3). Recall that in the case of normality tests, a data set is considered to be normal if the p-value is greater than or equal to 0.05 (defined alpha value for this research project). A normality test was performed on the internal team environment data, see Figure 4, and the p-value is 0.038, which provides the conclusion that the data set for the internal team environment variable is non-normal.

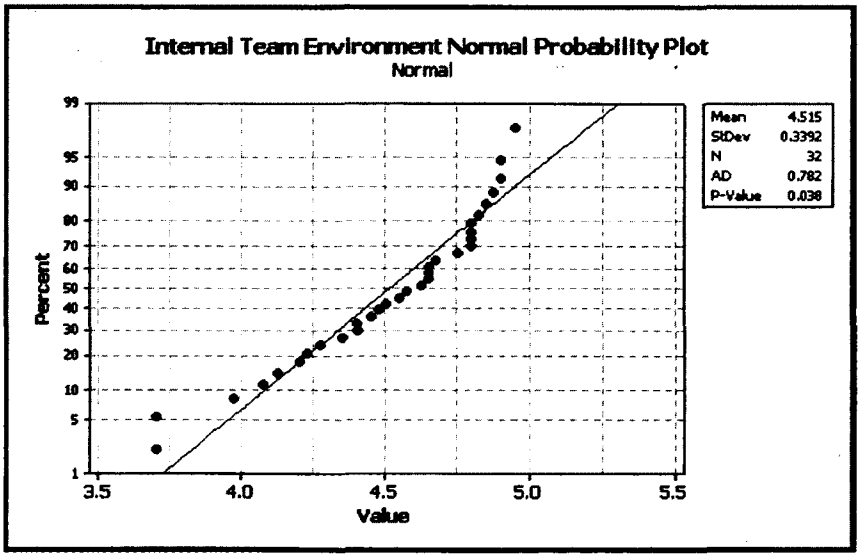

Figure 4: Normal Probability Plot for Internal Team Environment Variable

Since the data for both variables were found to be non-normal the Wilcoxon Matched-Pairs Signed-Rank Test was selected as the tool to analyze the data sets related to hypothesis #2. Based on how hypothesis #2 was defined, the following comparison tests were performed on the data for the shared leadership variable versus the internal team environment variable:

- Shared Leadership Variable Vs. Internal Team Environment At Time Period #1.
- Shared Leadership Variable Vs. Internal Team Environment At Time Period #2.
- Shared Leadership Variable Vs. Internal Team Environment At Time Period #3.
- Shared Leadership Variable Vs. Internal Team Environment At Time Period #4.

The Wilcoxon Matched-Pairs Signed-Rank Test is performed by evaluating the differences between data of paired samples (such as repeated measures or "before" or "after" measures) in order to determine if these differences are different than a median value. In order to utilize the Wilcoxon Matched-Pairs Signed-Rank for performing hypothesis #2, the difference between the shared leadership value (i.e. based on the normalized data) and the internal team environment variable was measured at each time period for each team. Therefore, at each time period, eight "difference" values were calculated (one value per team). It was determined that a difference between the factors being studied was appropriate for hypothesis #2 since this hypothesis was defined such that an association (or relationship) was assumed between the two factors being studied in hypothesis #2. The use of a "difference" between the two factors is a formal approach to testing for a relationship or association between two factors.

The Wilcoxon Matched-Pairs Signed-Rank Test typically utilizes a null hypothesis that states, "The difference ($d = x - y$) between the members of each pair (x, y) has median value [X]." The median test value (threshold value) utilized for this analysis was set to 0.50; this value was set based on performing research on how to accurately set a threshold (test) value. After performing research into setting an accurate threshold value, the threshold value was set to be 0.50 since this value was the difference between the median values of both variables. For the internal team environment variable, the values could take on any value between one and five (one being the lowest and five being the highest). The median value, based on how the internal team environment survey was structured, was three. This represented the minimal value required by a team in order for

that team to display some form of internal team environment (as defined based on the structure of the survey and the scale of the ratings on the survey). I therefore decided to use the median value of three to represent the internal team environment variable for the execution of the hypothesis testing.

In terms of the shared leadership variable, the normalized values of the variable could take on any of seven values between zero and five (zero representing the highest level of shared leadership and five representing the lowest, as per the centralization formula utilized for the project) (Refer to social network theory section in Chapter Two). These normalized values included [0, 0.8335, 1.665, 2.50, 3.335, 4.1665, and 5.00] (Refer to section 3.8.2 in Chapter Three). Based on how the shared leadership survey was structured, the median value was 2.50, represented the minimal value required by a team in order for that team to display some form of shared leadership (as defined based on the structure of the survey and the scale of the ratings on the survey). This median value of 2.50 was used to represent the shared leadership variable for the execution of the hypothesis testing. When the difference between the median values of both scales was calculated (i.e. 3 – 2.50), the difference value of 0.50 was identified. This then was the threshold value that was used for the evaluation of hypothesis #2. The value of 0.50 represented the minimum difference between the two factors that would signify the presence of a relationship or association between the two factors.

Therefore, for this study, the following null hypothesis (H_0) and alternative hypothesis (H_A) structure was developed to test the four comparisons of the two factors at Time Period #1, Time Period #2, Time Period #3, and Time Period #4:

H_0 = Difference between Internal Team Environment $Value_i$ – Shared Leadership $Value_i$ Has Median Value <= 0.50

H_A = Difference between Internal Team Environment $Value_i$ – Shared Leadership $Value_i$ Has Median Value > 0.50

I decided to set the difference equation as Internal Team Environment $Value_i$ – Shared Leadership $Value_i$ since I expected that the internal team environment values would typically be greater than the shared leadership value and the use of this difference equation enabled the differences in data to be positive, making it less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. Note that the setup of

the difference equation would not affect the conclusion made from the statistical analysis; the difference equation structure was chosen in order to make the data less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. The same conclusions about the relationship between the factors could be drawn regardless of the structure of the difference equation. For that reason, the less complex approach was selected.

Note also that the two factors were defined on opposite scales. The internal team environment variable was defined on a scale of one to five, where one was the least value and five was the greatest). The shared leadership variable (based on normalized data) was defined on a scale of zero to five, in which zero represented the best value and five the least, in accordance with the centralization metric formula utilized for the project.

Since these variables were defined on opposite scales, the detection of a relationship between the two factors was determined to be significant based on the difference between them. The hypotheses, then, needed to evaluate the difference between the two factors against the requirement that it be greater than the minimal threshold (test) value of 0.50. In order to account for this logic and structure, the null hypothesis was defined to state that the median difference between the internal team environment and shared leadership was less than or equal to the threshold value of 0.50. Similarly, the alternate hypothesis was defined to state that the median difference between the internal team environment and shared leadership was greater than the threshold value of 0.50. Based on the threshold value of 0.50 and the structure of the null and alternate hypotheses, it can be seen that a relationship between the internal team environment and shared leadership variables was said to exist if the median difference between the two variables was greater than the threshold value of 0.50. If the median difference was less than or equal to 0.50, then no association would exist between the two variables.

In accordance with the research methods section of the research study, each of these comparison tests were tested at the defined alpha value of 0.05 and the decision criteria for the acceptance or rejection of the null hypothesis (H_0) for each of these tests was to be based on the p-values obtained from the hypothesis tests. If the p-value of a test was found to be less than the alpha value of 0.05, then the null hypothesis would be rejected; if the p-value for a test was greater than the alpha value of 0.05, then the null hypothesis

would be "failed to reject." A "failure to reject" the null hypothesis implied that there was not a statistically significant difference between the internal team environment and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables. But a rejection of the null hypothesis implied that there was a statistically significant difference between the internal team environment and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables (i.e. that at time period i, a relationship or association exists between the internal team environment and shared leadership variables). Based on the null hypothesis (H_0) and alternative hypothesis (H_A) structure defined above as well as the acceptance/rejection criteria for these tests, the Wilcoxon Matched-Pairs Signed-Rank Test was performed on the four comparison hypothesis tests through the use of Minitab and the results were as follows:

Shared Leadership Variable vs. Internal Team Environment at Time Period #1

H_0 = Difference between Internal Team Environment $Value_1$ – Shared Leadership $Value_1$ Has Median Value <= 0.50.

H_A = Difference between Internal Team Environment $Value_1$ – Shared Leadership $Value_1$ Has Median Value > 0.50.

P-Value = 0.015.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.015 < 0.05).

Practical Conclusion: There was a statistically significant difference between the internal team environment and shared leadership variables at time period #1 (the Define phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the define phase.

Shared Leadership Variable vs. Internal Team Environment at Time Period #2

H_0 = Difference between Internal Team Environment $Value_2$ – Shared Leadership $Value_2$ Has Median Value <= 0.50.

H_A = Difference between Internal Team Environment $Value_2$ – Shared Leadership $Value_2$ Has Median Value > 0.50.

P-Value = 0.007.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.007 < 0.05).

Practical Conclusion: There was a statistically significant difference between the internal team environment and shared leadership variables at time period #2 (the Measure phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the measure phase.

Shared Leadership Variable vs. Internal Team Environment at Time Period #3

H_0 = Difference between Internal Team Environment $Value_3$ – Shared Leadership $Value_3$ Has Median Value <= 0.50.

H_A = Difference between Internal Team Environment $Value_3$ – Shared Leadership $Value_3$ Has Median Value > 0.50.

P-Value = 0.021.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.021 < 0.05).

Practical Conclusion: There was a statistically significant difference between the internal team environment and shared leadership variables at time period #3 (the Analyze phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the analyze phase.

Shared Leadership Variable vs. Internal Team Environment at Time Period #4

H_0 = Difference between Internal Team Environment $Value_4$ – Shared Leadership $Value_4$ Has Median Value <= 0.50.

H_A = Difference between Internal Team Environment $Value_4$ – Shared Leadership $Value_4$ Has Median Value > 0.50.

P-Value = 0.010.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.010 < 0.05).

Practical Conclusion: There was a statistically significant difference between the internal team environment and shared leadership variables at time period #4 (the Improve phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the improve phase.

The results from these hypothesis tests support the conclusion that a statistically significant relationship (association) exists between the internal team environment and

shared leadership variables at all four time periods. The p-values calculated for these hypothesis tests led to the conclusion that there is a statistically significant difference between the internal team environment and shared leadership variables throughout the Six Sigma DMAIC process and as a result, led to the conclusion that an association existed between the internal team environment and shared leadership variables throughout the execution of the Six Sigma projects. It should also be noted that as explained in Chapter Three, based on the setup of the statistical test chosen as well as the statistical power analysis performed for the sample size and analysis methods for the design, the results have a confidence level of 95% (in accordance with an alpha value of 0.05). Therefore, the results (the acceptance or rejection of the hypothesis) of the analysis of this hypothesis are sensitive to a confidence level of 95%. These results will also have a power level 0.92, which signifies the probability of correctly rejecting the null hypothesis when it is false. The level of 0.92 implies that there is high confidence that the statistical results and interpretation were executed accurately.

Table 8 summarizes the findings of the comparisons tests performed for hypothesis #2:

Table 8: Summary Table for Hypothesis Testing on Hypothesis #2

Comparision	Null Hypothesis	Alternative Hypothesis	Statistical Test	P-Value	Statistical Conclusion	Practical Conclusion
Time Period #1	Difference Between Internal Team Environment Value1 – Shared Leadership Value1 Has Median Value <= 0.50.	Difference Between Internal Team Environment Value1 – Shared Leadership Value1 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0150	Reject the null hypothesis (P-Value, 0.015 < 0.05).	There is a statistically significant difference between the internal team environment and shared leadership variables at time period #1 (the define phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the define phase.
Time Period #2	Difference Between Internal Team Environment Value2 – Shared Leadership Value2 Has Median Value <= 0.50.	Difference Between Internal Team Environment Value2 – Shared Leadership Value2 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0070	Reject the null hypothesis (P-Value, 0.007 < 0.05).	There is a statistically significant difference between the internal team environment and shared leadership variables at time period #2 (the measure phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the measure phase.
Time Period #3	Difference Between Internal Team Environment Value3 – Shared Leadership Value3 Has Median Value <= 0.50.	Difference Between Internal Team Environment Value3 – Shared Leadership Value3 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0210	Reject the null hypothesis (P-Value, 0.021 < 0.05).	There is a statistically significant difference between the internal team environment and shared leadership variables at time period #3 (the analyze phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the analyze phase.
Time Period #4	Difference Between Internal Team Environment Value4 – Shared Leadership Value4 Has Median Value <= 0.50.	Difference Between Internal Team Environment Value4 – Shared Leadership Value4 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0100	Reject the null hypothesis (P-Value, 0.010 < 0.05).	There is a statistically significant difference between the internal team environment and shared leadership variables at time period #4 (the improve phase), which led to the conclusion that an association (relationship) exists between the internal team environment and shared leadership variables in the improve phase.

4.3.3 Main Study – Hypothesis #3

4.3.3.1 Hypothesis Definition

Recall that hypothesis #3 states the following: To examine if there is a relationship between shared leadership and the external coaching environmental condition at each phase of the DMAIC structure.

4.3.3.2 Graphical Analysis

Reference Appendix F for the line plots developed for the shared leadership variable and external coaching variable for each team. Recall that graphical analysis was performed on the data related to this hypothesis for visualization purposes and to identify any potential conclusions and relationships. After the graphical analysis was complete for each team, the statistical analysis was performed; the statistical analysis was the mechanism utilized to draw concrete conclusions about the findings for this hypothesis.

In order to perform a graphical analysis on the two variables for each team at each time period, line plots were used to graph the data for each team and each variable. Recall that the two variables of interest for this hypothesis were defined on different and opposite scales. The shared leadership variable was defined on a zero to five scale, in which a value of zero was the highest degree/value of shared leadership and a value of five was the lowest degree/value of shared leadership; the external coaching variable was defined on a one to five scale, in which a value of one indicated the lowest value of external coaching and a value of five was the highest value of external coaching. Therefore, in order to identify a relationship between the two variables at any time period, a gap (difference) needed to be identified between the two variables. Since the variables were defined on opposite scales, a large gap (difference) between the two variables at any time period would imply the potential of a significant relationship between the two variables, while a small difference (gap) between the two variables at any time period would imply the potential of a trivial relationship (or no relationship at all) between the two variables.

At time period #1, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #7: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #8: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate to strong* potential for a relationship between the two factors at time period #1.

At time period #2, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate to strong* potential for a relationship between the two factors at time period #2.

At time period #3, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #6: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #7: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #3.

At time period #4, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #2: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #5: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #6: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate to strong* potential for a relationship between the two factors at time period #4.

The line plots developed for the two variables of interest revealed that throughout the Six Sigma DMAIC structure, there was a *moderate to strong* potential for a relationship between the shared leadership and external coaching variables at each of the time periods. But the subsequent statistical analysis was utilized to determine if there was statistical significance to support the theory outlined in hypothesis #3.

4.3.3.3 Statistical Analysis

Prior to performing analysis for this hypothesis, a normality test was performed in Minitab on the entire sample population data sets collected for the external coaching and shared leadership variables in order to determine if the sample population data (for these variables) were normal. The normality test perform on the shared leadership variable's data set in section 4.2.1 signified that this data set was non-normal. Figure 5 below shows that the data set for the external coaching variable is non-normal; this finding is also

verified by evaluating the p-value of the data set. In the case of normality tests, a data set is considered to be normal if the p-value is greater than or equal to 0.05 (defined alpha value for this research project). The p-value is 0.011, which reinforces the conclusion that the data set for the external coaching variable is non-normal.

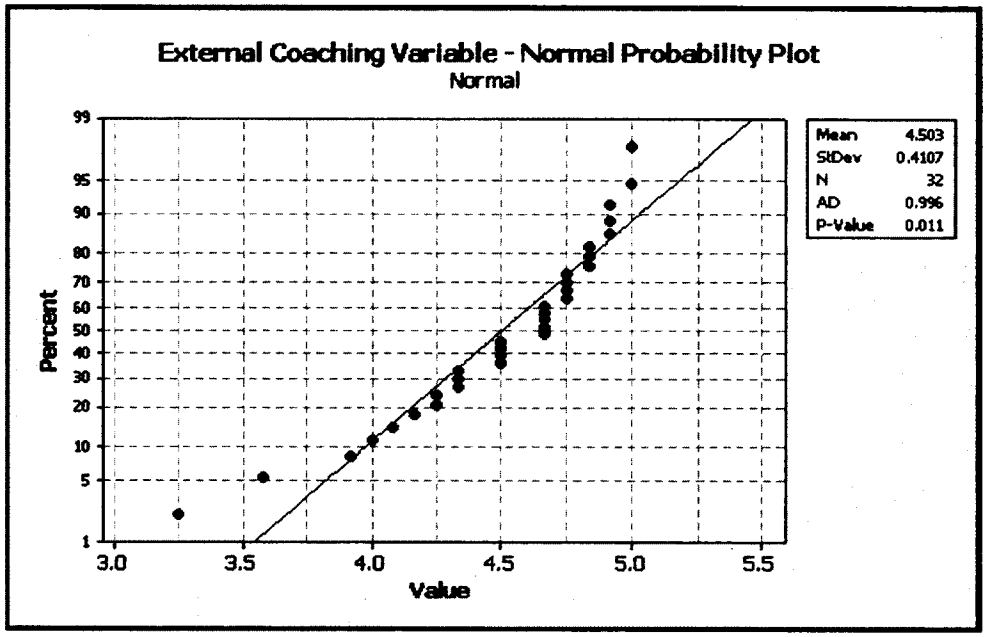

Figure 5: Normal Probability Plot for External Coaching Variable

Since the data for both variables were found to be non-normal, the Wilcoxon Matched-Pairs Signed-Rank Test was once again the tool used to analyze the data sets related to hypothesis #3. Based on how hypothesis #3 was defined, the following comparison tests were performed on the data for the shared leadership variable versus the external coaching variable:

- Shared Leadership Variable Vs. External Coaching At Time Period #1.
- Shared Leadership Variable Vs. External Coaching At Time Period #2.
- Shared Leadership Variable Vs. External Coaching At Time Period #3.
- Shared Leadership Variable Vs. External Coaching At Time Period #4.

I once again performed the Wilcoxon Matched-Pairs Signed-Rank Test by evaluating the differences between data of paired samples (such as repeated measures or "before" or "after" measures) in order to determine if these differences are different than a median value. In order to utilize the Wilcoxon Matched-Pairs Signed-Rank for performing

hypothesis #3, the difference needed to be taken between the shared leadership value (based on the normalized data) and the external coaching variable for each time period and for each team. Therefore, at each time period, eight "difference" values were calculated (one value per team). The use of this "difference" between the two factors was the formal approach to testing for a relationship or association between two factors.

The Wilcoxon Matched-Pairs Signed-Rank Test typically utilizes a null hypothesis that states "The difference (d = x - y) between the members of each pair (x, y) has median value [X]." After performing research on how to accurately set a threshold (test) value, the median test value used for this analysis was set to 0.50, the difference between the median values of both variables. The external coaching variable took on values between one and five (one being the lowest and five being the highest). Based on the structure of the external coaching survey, the median value was three. This represented the minimal value required by a team in order to display some form of external coaching (as defined based on the structure of the survey and the scale of the ratings on the survey), and therefore represented the external coaching variable for the execution of the hypothesis testing.

The normalized values of the shared leadership variable took on one of seven values between zero and five (zero being the best value of shared leadership and five being the least value of shared leadership, in accordance with the centralization formula utilized for the project) (Refer to social network theory section in Chapter Two). These normalized values included [0, 0.8335, 1.665, 2.50, 3.335, 4.1665, and 5.00] (Refer to section 3.8.2 in Chapter Three). Based on how the shared leadership survey was structured, the median value was 2.50. The median value of 2.50 represented the minimal value required by a team in order for that team to display some form of shared leadership (as defined based on the structure of the survey and the scale of the ratings on the survey). This median value of 2.50 represented the shared leadership variable for the execution of the hypothesis testing. When the difference between the median values of both scales was calculated (i.e. 3 – 2.50), the difference value of 0.50 was identified; this was the threshold value that was utilized for the evaluation of hypothesis #3. The value of 0.50 represented the minimum difference between the two factors that would signify the presence of a relationship or association between the two factors.

For this study, the following null hypothesis (H_0) and alternative hypothesis (H_A) structure was used to test the four comparisons of the two factors at Time Period #1, Time Period #2, Time Period #3, and Time Period #4:

H_0 = Difference Between External Coaching Value$_i$ – Shared Leadership Value$_i$ Has Median Value <= 0.50

H_A = Difference Between External Coaching Value$_i$ – Shared Leadership Value$_i$ Has Median Value > 0.50

I decided to set the difference equation as External Coaching Value$_i$ – Shared Leadership Value$_i$ since I expected that the external coaching values would typically be greater than the shared leadership value and the use of this difference equation enabled the differences in data to be positive, making it less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. Note that the setup of the difference equation would not affect the conclusion made from the statistical analysis; the difference equation structure was chosen in order to make the data less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. The same conclusions about the relationship between the factors could be drawn regardless of the structure of the difference equation. For that reason, the less complex approach was selected.

Note also that the two factors were defined on opposite scales. The internal team environment variable was defined on a scale of one to five, where one was the least value and five was the greatest). The shared leadership variable (based on normalized data) was defined on a scale of zero to five, in which zero represented the best value and five the least, in accordance with the centralization metric formula utilized for the project.

Since these variables were defined on opposite scales, the detection of a relationship between the two factors was determined to be significant based on the difference between them. The hypotheses, then, needed to evaluate the difference between the two factors against the requirement that it be greater than the minimal threshold (test) value of 0.50. In order to account for this logic and structure, the null hypothesis was defined to state that the median difference between the internal team environment and shared leadership was less than or equal to the threshold value of 0.50. Similarly, the alternate hypothesis was defined to state that the median difference between the internal team environment and shared leadership was greater than the threshold value of 0.50. Based on the

threshold value of 0.50 and the structure of the null and alternate hypotheses, it can be seen that a relationship between the internal team environment and shared leadership variables was said to exist if the median difference between the two variables was greater than the threshold value of 0.50. If the median difference was less than or equal to 0.50, then no association would exist between the two variables.

In accordance with the research methods section of the research study, each of these comparison tests were tested at the defined alpha value of 0.05 and the decision criteria for the acceptance or rejection of the null hypothesis (H_0) for each of these tests was based on the p-values obtained from the hypothesis tests. If the p-value of a test was found to be less than the alpha value of 0.05, then the null hypothesis would be rejected; if the p-value for a test was greater than the alpha value of 0.05, then the null hypothesis would be "failed to reject." A "failure to reject" the null hypothesis implied that there was not a statistically significant difference between the external coaching and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables. A rejection of the null hypothesis implied that there was a statistically significant difference between the external coaching and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables. Based on the null hypothesis (H_0) and alternative hypothesis (H_A) structure defined above as well as the acceptance/rejection criteria for these tests, the Wilcoxon Matched-Pairs Signed-Rank Test was performed on the four comparison hypothesis tests through the use of Minitab and the results were as follows:

Shared Leadership Variable vs. External Coaching at Time Period #1

H_0 = Difference between External Coaching $Value_1$ – Shared Leadership $Value_1$ Has Median Value <= 0.50.

H_A = Difference between External Coaching $Value_1$ – Shared Leadership $Value_1$ Has Median Value > 0.50.

P-Value = 0.062.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.062 > 0.05).

Practical Conclusion: There was not a statistically significant difference between the external coaching and shared leadership variables at time period #1 (the Define phase) that would symbolize an association (relationship) between the two variables.

In turn, this conclusion implied that no association (relationship) exists between the external coaching and shared leadership variables in the define phase.

Shared Leadership Variable vs. External Coaching at Time Period #2

H_0 = Difference between External Coaching $Value_2$ – Shared Leadership $Value_2$ Has Median Value <= 0.50.

H_A = Difference between External Coaching $Value_2$ – Shared Leadership $Value_2$ Has Median Value > 0.50.

P-Value = 0.007.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.007 < 0.05).

Practical Conclusion: There was a statistically significant difference between the external coaching and shared leadership variables at time period #2 (the Measure phase), which led to the conclusion that an association (relationship) exists between the external coaching and shared leadership variables in the measure phase.

Shared Leadership Variable vs. External Coaching at Time Period #3

H_0 = Difference between External Coaching $Value_3$ – Shared Leadership $Value_3$ Has Median Value <= 0.50.

H_A = Difference between External Coaching $Value_3$ – Shared Leadership $Value_3$ Has Median Value > 0.50.

P-Value = 0.011.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.011 < 0.05).

Practical Conclusion: There was a statistically significant difference between the external coaching and shared leadership variables at time period #3 (the Analyze phase), which led to the conclusion that an association (relationship) exists between the external coaching and shared leadership variables in the Analyze phase.

Shared Leadership Variable vs. External Coaching at Time Period #4

H_0 = Difference between External Coaching $Value_4$ – Shared Leadership $Value_4$ Has Median Value <= 0.50.

H_A = Difference between External Coaching $Value_4$ – Shared Leadership $Value_4$ Has Median Value > 0.50.

P-Value = 0.010.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.010 < 0.05).

Practical Conclusion: There was a statistically significant difference between the external coaching and shared leadership variables at time period #4 (the Improve phase), which led to the conclusion that an association (relationship) exists between the external coaching and shared leadership variables in the improve phase.

The results from these hypothesis tests led to the conclusion that there was not a statistically significant difference between the external coaching and shared leadership variables at time period #1 (the Define phase) but that there was a statistically significant difference between the external coaching and shared leadership variables at time periods #2, #3, and #4. In turn, this supports the conclusion that no association existed between the external coaching and shared leadership variables in the Define phase, but an association did exist between the external coaching and shared leadership variables at the Measure, Analyze, and Improve phases of the Six Sigma DMAIC process.

It should also be noted that as explained in Chapter Three, based on the setup of the statistical test chosen as well as the statistical power analysis performed for the sample size and analysis methods for the design, the results have a confidence level of 95% (in accordance with an alpha value of 0.05). Therefore, the results (the acceptance or rejection of the hypothesis) of the analysis of this hypothesis is sensitive to a confidence level of 95% (i.e. I can be 95% confident that the results produced the proper conclusion). These results will also have a power level 0.92, which signifies the probability of correctly rejecting the null hypothesis when it is false. The level of 0.92 implies that there is high confidence that the statistical results and interpretation were executed accurately.

Table 9 summarizes the findings of the comparisons tests performed for hypothesis #3:

Table 9: Summary Table for Hypothesis Testing on Hypothesis #3

Comparision	Null Hypothesis	Alternative Hypothesis	Statistical Test	P-Value	Statistical Conclusion	Practical Conclusion
Time Period #1	Difference Between External Coaching Value1 – Shared Leadership Value1 Has Median Value <= 0.50.	Difference Between External Coaching Value1 – Shared Leadership Value1 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0620	Fail to reject the null hypothesis (P-Value, 0.062 > 0.05).	There was not a statistically significant difference between the external coaching and shared leadership variables at time period #1 (the define phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the external coaching and shared leadership variables in the define phase.
Time Period #2	Difference Between External Coaching Value2 – Shared Leadership Value2 Has Median Value <= 0.50.	Difference Between External Coaching Value2 – Shared Leadership Value2 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0070	Reject the null hypothesis (P-Value, 0.007 < 0.05).	There was a statistically significant difference between the external coaching and shared leadership variables at time period #2 (the measure phase), which led to the conclusion that an association (relationship) exists between the external coaching and shared leadership variables in the measure phase.
Time Period #3	Difference Between External Coaching Value3 – Shared Leadership Value3 Has Median Value <= 0.50.	Difference Between External Coaching Value3 – Shared Leadership Value3 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0110	Reject the null hypothesis (P-Value, 0.011 < 0.05).	There was a statistically significant difference between the external coaching and shared leadership variables at time period #3 (the analyze phase), which led to the conclusion that an association (relationship) exists between the external coaching and shared leadership variables in the analyze phase.
Time Period #4	Difference Between External Coaching Value4 – Shared Leadership Value4 Has Median Value <= 0.50.	Difference Between External Coaching Value4 – Shared Leadership Value4 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0100	Reject the null hypothesis (P-Value, 0.010 < 0.05).	There was a statistically significant difference between the external coaching and shared leadership variables at time period #4 (the improve phase), which led to the conclusion that an association (relationship) exists between the external coaching and shared leadership variables in the improve phase.

4.3.4 Main Study – Hypothesis #4

4.3.4.1 Hypothesis Definition

Recall that hypothesis #4 states the following: To examine if there is a relationship between shared leadership and the project completion performance metric at each phase of the DMAIC structure.

4.3.4.2 Graphical Analysis

Reference Appendix F for the line plots developed for the shared leadership variable and project completion variable for each team. Recall that graphical analysis was performed on the data related to this hypothesis for visualization purposes and to identify any potential conclusions and relationships. After the graphical analysis was complete for each team, the statistical analysis was performed; the statistical analysis was the mechanism utilized to draw concrete conclusions about the findings for this hypothesis.

In order to perform a graphical analysis on the two variables for each team at each time period, line plots were utilized to graph the data for each team and each variable. Recall that the two variables of interest for this hypothesis were defined on different and opposite scales. The shared leadership variable was defined on a zero to five scale, in which a value of zero indicated the highest degree/value of shared leadership and a value of five indicated the lowest degree/value of shared leadership. The project completion variable was defined on a one to five scale, in which a value of one indicated the lowest value of project completion and a value of five the highest. Therefore, in order to identify a relationship between the two variables at any time period, a gap (difference) needed to be identified between the two variables. Since the variables were defined on opposite scales, a large gap (difference) between the two variables at any time period implied the a significant relationship between the two variables, while a small difference (gap) between the two variables at any time period implied a trivial relationship (or no relationship at all) between the two variables.

At time period #1, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #1.

At time period #2, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #2: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #3: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #4: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #2.

At time period #3, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #2: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #3.

At time period #4, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #2: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #5: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #6: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate to strong* potential for a relationship between the two factors at time period #4.

The line plots developed for the two variables of interest revealed that throughout the Six Sigma DMAIC process, there was a *moderate to strong* potential for a relationship between the shared leadership and project completion variables at each of the time periods. The subsequent statistical analysis was used to determine if there was statistical significance to support the theory outlined in hypothesis #4.

4.3.4.3 Statistical Analysis

Prior to performing analysis for this hypothesis, a normality test was performed in Minitab on the entire sample population data sets collected for the project completion and shared leadership variables in order to determine if the sample population data (for these variables) were normal. The normality test perform on the shared leadership variable's data set in section 4.2.1 indicated that this data set was non-normal. Figure 6 below shows that the data set for the project completion variable is non-normal, a finding that is

also verified by evaluating the p-value of the data set. In the case of normality tests, a data set is considered to be normal if the p-value is greater than or equal to 0.05 (defined alpha value for this research project). The p-value is < 0.005, which reinforces the conclusion that the data set for the external coaching variable is non-normal.

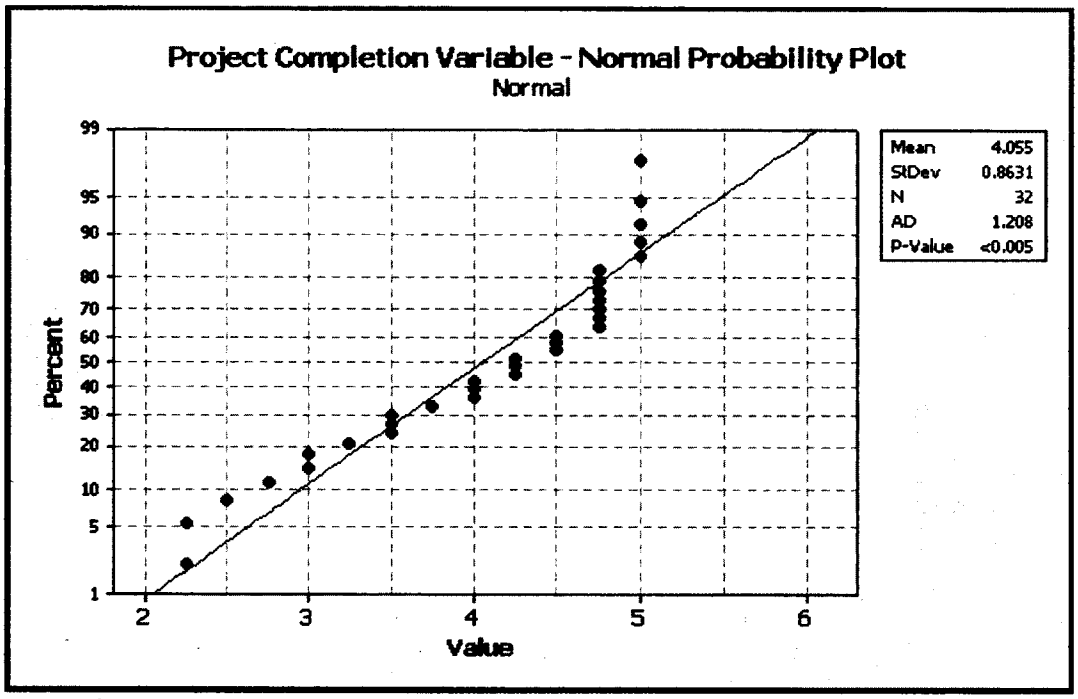

Figure 6: Normal Probability Plot for Project Completion Variable

Since the data for both variables were found to be non-normal, I once again used the Wilcoxon Matched-Pairs Signed-Rank Test as the tool to analyze the data sets related to hypothesis #4. Based on how hypothesis #4 was defined, the following comparison tests were performed on the data for the shared leadership variable versus the project completion variable:

- Shared Leadership Variable Vs. Project Completion At Time Period #1.
- Shared Leadership Variable Vs. Project Completion At Time Period #2.
- Shared Leadership Variable Vs. Project Completion At Time Period #3.
- Shared Leadership Variable Vs. Project Completion At Time Period #4.

I once again performed the Wilcoxon Matched-Pairs Signed-Rank Test by evaluating the differences between data of paired samples (such as repeated measures or "before" or "after" measures) in order to determine if these differences are different than a median

value. In order to utilize the Wilcoxon Matched-Pairs Signed-Rank for performing hypothesis #4, the difference needed to be taken between the shared leadership value (based on the normalized data) and the project completion variable for each time period and for each team. Therefore, at each time period, eight "difference" values were calculated (one value per team). The use of this "difference" between the two factors was the formal approach to testing for a relationship or association between two factors.

The Wilcoxon Matched-Pairs Signed-Rank Test typically utilizes a null hypothesis that states "The difference (d = x - y) between the members of each pair (x, y) has median value [X]." After performing research on how to accurately set a threshold (test) value, the median test value used for this analysis was set to 0.50, the difference between the median values of both variables. The project completion variable took on values between one and five (one being the lowest and five being the highest). Based on the structure of the project completion survey, the median value was three. This represented the minimal value required by a team in order to display some form of project completion (as defined based on the structure of the survey and the scale of the ratings on the survey), and therefore represented the project completion variable for the execution of the hypothesis testing.

The normalized values of the shared leadership variable took on one of seven values between zero and five (zero being the best value of shared leadership and five being the least value of shared leadership, in accordance with the centralization formula utilized for the project) (Refer to social network theory section in Chapter Two). These normalized values included [0, 0.8335, 1.665, 2.50, 3.335, 4.1665, and 5.00] (Refer to section 3.8.2 in Chapter Three). Based on how the shared leadership survey was structured, the median value was 2.50. The median value of 2.50 represented the minimal value required by a team in order for that team to display some form of shared leadership (as defined based on the structure of the survey and the scale of the ratings on the survey). This median value of 2.50 represented the shared leadership variable for the execution of the hypothesis testing. When the difference between the median values of both scales was calculated (i.e. 3 – 2.50), the difference value of 0.50 was identified; this was the threshold value that was utilized for the evaluation of hypothesis #4. The value of 0.50

represented the minimum difference between the two factors that would signify the presence of a relationship or association between the two factors.

Therefore, for this study, the following null hypothesis (H_0) and alternative hypothesis (H_A) structure was utilized to test the four comparisons of the two factors at Time Period #1, Time Period #2, Time Period #3, and Time Period #4:

H_0 = Difference Between Project Completion Value$_i$ – Shared Leadership Value$_i$ Has Median Value <= 0.50

H_A = Difference Between Project Completion Value$_i$ – Shared Leadership Value$_i$ Has Median Value > 0.50

I decided to set the difference equation as Project Completion Value$_i$ – Shared Leadership Value$_i$ since I expected that the project completion values would typically be greater than the shared leadership value and the use of this difference equation enabled the differences in data to be positive, making it less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. Note that the setup of the difference equation would not affect the conclusion made from the statistical analysis; the difference equation structure was chosen in order to make the data less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. The same conclusions about the relationship between the factors could be drawn regardless of the structure of the difference equation. For that reason, the less complex approach was selected.

Note also that the two factors were defined on opposite scales. The project completion variable was defined on a scale of one to five, where one was the least value and five was the greatest). The shared leadership variable (based on normalized data) was defined on a scale of zero to five, in which zero represented the best value and five the least, in accordance with the centralization metric formula utilized for the project.

Since these variables were defined on opposite scales, the detection of a relationship between the two factors was determined to be significant based on the difference between them. The hypotheses, then, needed to evaluate the difference between the two factors against the requirement that it be greater than the minimal threshold (test) value of 0.50. In order to account for this logic and structure, the null hypothesis was defined to state that the median difference between the project completion variable and shared leadership was less than or equal to the threshold value of 0.50. Similarly, the alternate hypothesis

was defined to state that the median difference between the project completion variable and shared leadership was greater than the threshold value of 0.50. Based on the threshold value of 0.50 and the structure of the null and alternate hypotheses, it can be seen that a relationship between the project completion variable and shared leadership variables was said to exist if the median difference between the two variables was greater than the threshold value of 0.50. If the median difference was less than or equal to 0.50, then no association would exist between the two variables.

In accordance with the research methods section of the research study, each of these comparisons were tested at the defined alpha value of 0.05 and the decision criteria for the acceptance or rejection of the null hypothesis (H_0) for each of these tests was based on the p-values obtained from the hypothesis tests. If the p-value of a test was found to be less than the alpha value of 0.05, then the null hypothesis would be rejected; if the p-value for a test was greater than the alpha value of 0.05, then the null hypothesis would be "failed to reject." A "failure to reject" the null hypothesis implied that there was not a statistically significant difference between the project completion and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables. A rejection of the null hypothesis implied that there was a statistically significant difference between the project completion and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables (i.e. that at time period i, a relationship or association exists between the project completion and shared leadership variables). Based on the null hypothesis (H_0) and alternative hypothesis (H_A) structure defined above as well as the acceptance/rejection criteria for these tests, the Wilcoxon Matched-Pairs Signed-Rank Test was performed on the four comparison hypothesis tests through the use of Minitab and the results were as follows:

Shared Leadership Variable vs. Project Completion at Time Period #1

H_0 = Difference between Project Completion $Value_1$ – Shared Leadership $Value_1$ Has Median Value <= 0.50.

H_A = Difference between Project Completion $Value_1$ – Shared Leadership $Value_1$ Has Median Value > 0.50.

P-Value = 0.092.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.092 > 0.05).

Practical Conclusion: There was not a statistically significant difference between the project completion and shared leadership variables at time period #1 (the Define phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) existed between the project completion and shared leadership variables at the Define phase.

Shared Leadership Variable vs. Project Completion at Time Period #2

H_0 = Difference between Project Completion $Value_2$ – Shared Leadership $Value_2$ Has Median Value <= 0.50.

H_A = Difference between Project Completion $Value_2$ – Shared Leadership $Value_2$ Has Median Value > 0.50.

P-Value = 0.015.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.015 < 0.05).

Practical Conclusion: There was a statistically significant difference between the project completion and shared leadership variables at time period #2 (the Measure phase), which led to the conclusion that an association (relationship) exists between the project completion and shared leadership variables at the Measure phase.

Shared Leadership Variable vs. Project Completion at Time Period #3

H_0 = Difference between Project Completion $Value_3$ – Shared Leadership $Value_3$ Has Median Value <= 0.50.

H_A = Difference between Project Completion $Value_3$ – Shared Leadership $Value_3$ Has Median Value > 0.50.

P-Value = 0.400.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.400 > 0.05).

Practical Conclusion: There was not a statistically significant difference between the project completion and shared leadership variables at time period #3 (the Analyze phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the project completion and shared leadership variables at the Analyze phase.

Shared Leadership Variable vs. Project Completion at Time Period #4

H_0 = Difference between Project Completion $Value_4$ – Shared Leadership $Value_4$ Has Median Value <= 0.50.

H_A = Difference between Project Completion $Value_4$ – Shared Leadership $Value_4$ Has Median Value > 0.50.

P-Value = 0.007.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.007 < 0.05).

Practical Conclusion: There was a statistically significant difference between the project completion and shared leadership variables at time period #4 (the Improve phase), which led to the conclusion that an association (relationship) exists between the project completion and shared leadership variables at the Improve phase.

The results from these hypothesis tests led to the conclusion that there was not a statistically significant difference between the project completion and shared leadership variables at time period #1 (the Define phase) and time period #3 (the Analyze phase) but that there was a statistically significant difference between the project completion and shared leadership variables at time periods #2 and #4. In turn, this supports the conclusion that no association existed between the project completion and shared leadership variables in the Define and Analyze phases, but an association did exist between the project completion and shared leadership variables at the Measure and Improve phases of the Six Sigma DMAIC process.

The p-values calculated for these hypothesis tests led to the conclusion that there was a statistically significant relationship (association) between the project completion and shared leadership variables at the measure and improve phases of the Six Sigma projects, but at the Define and Analyze phases of the Six Sigma projects, there was not a statistically significant association between the project completion and shared leadership variables. It should also be noted that as explained in Chapter Three, based on the setup of the statistical test chosen as well as the statistical power analysis performed for the sample size and analysis methods for the design, the results have a confidence level of 95% (in accordance with an alpha value of 0.05). Therefore, the results (the acceptance or rejection of the hypothesis) of the analysis of this hypothesis are sensitive to 95%. These results will also have a power level 0.92, which signifies the probability of correctly

rejecting the null hypothesis when it is false. The level of 0.92 implies that there is high confidence that the statistical results and interpretation were executed accurately. Table 10 summarizes the findings for hypothesis #4:

Table 10: Summary Table for Hypothesis Testing on Hypothesis #4

Comparision	Null Hypothesis	Alternative Hypothesis	Statistical Test	P-Value	Statistical Conclusion	Practical Conclusion
Time Period #1	Difference Between Project Completion Value1 – Shared Leadership Value1 Has Median Value <= 0.50.	Difference Between Project Completion Value1 – Shared Leadership Value1 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0920	Fail to reject the null hypothesis (P-Value, 0.092 > 0.05).	There was not a statistically significant difference between the project completion and shared leadership variables at time period #1 (the define phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the project completion and shared leadership variables in the define phase.
Time Period #2	Difference Between Project Completion Value2 – Shared Leadership Value2 Has Median Value <= 0.50.	Difference Between Project Completion Value2 – Shared Leadership Value2 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0150	Reject the null hypothesis (P-Value, 0.015 < 0.05).	There was a statistically significant difference between the project completion and shared leadership variables at time period #2 (the measure phase), which led to the conclusion that an association (relationship) exists between the project completion and shared leadership variables in the measure phase.
Time Period #3	Difference Between Project Completion Value3 – Shared Leadership Value3 Has Median Value <= 0.50.	Difference Between Project Completion Value3 – Shared Leadership Value3 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.4000	Fail to reject the null hypothesis (P-Value, 0.400 > 0.05).	There was not a statistically significant difference between the project completion and shared leadership variables at time period #3 (the analyze phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the project completion and shared leadership variables in the analyze phase.
Time Period #4	Difference Between Project Completion Value4 – Shared Leadership Value4 Has Median Value <= 0.50.	Difference Between Project Completion Value4 – Shared Leadership Value4 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0070	Reject the null hypothesis (P-Value, 0.007 < 0.05).	There was a statistically significant difference between the project completion and shared leadership variables at time period #4 (the improve phase), which led to the conclusion that an association (relationship) exists between the project completion and shared leadership variables in the improve phase.

4.3.5 Main Study – Hypothesis #5

4.3.5.1 Hypothesis Definition

Recall that hypothesis #5 states the following: To examine if there is a relationship between shared leadership and the customer satisfaction performance metric at each phase of the DMAIC structure.

4.3.5.2 Graphical Analysis

Reference Appendix F for the line plots developed for the shared leadership variable and customer satisfaction variable for each team. Recall that graphical analysis was performed on the data related to this hypothesis for visualization purposes and to identify any potential conclusions and relationships. After the graphical analysis was complete for each team, the statistical analysis was performed; the statistical analysis was the mechanism utilized to draw concrete conclusions about the findings for this hypothesis.

In order to perform a graphical analysis on the two variables for each team at each time period, line plots were utilized to graph the data for each team and each variable. Recall that the two variables of interest for this hypothesis were defined on different and opposite scales. The shared leadership variable was defined on a zero to five scale, where zero indicated the highest degree/value of shared leadership and a value of five indicated the lowest degree/value of shared leadership. The customer satisfaction variable was defined on a one to five scale, where a value of one indicated the lowest value of customer satisfaction and a value of five was the highest value of customer satisfaction. Therefore, in order to identify a relationship between the two variables at any time period, a gap (difference) needed to be identified between the two variables. Since the variables were defined on opposite scales, a large gap (difference) between the two variables at any time period implied the potential of a significant relationship between the two variables, while a small difference (gap) between the two variables at any time period would imply the potential of a trivial relationship (or no relationship at all) between the two variables.

At time period #1, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #1.

At time period #2, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #2: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate* potential for a relationship between the two factors at time period #2.

At time period #3, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #2: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #5: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #7: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *trivial to moderate* potential for a relationship between the two factors at time period #3.

At time period #4, the line plots developed between the two variables for each of the teams revealed the following takeaways:

- For team #1: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #2: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #3: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #4: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #5: There was a *large* difference (gap) between the two variables, which indicated a strong potential for a relationship between the two variables.
- For team #6: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.
- For team #7: There was a *moderate* difference (gap) between the two variables, which indicated a potential relationship between the two variables.
- For team #8: There was a *small* difference (gap) between the two variables, which indicated the potential for a trivial or no relationship between the two variables.

Overall, when the data from the eight teams were considered as one set, the line plots supported the belief that there was a *moderate to strong* potential for a relationship between the two factors at time period #4.

The line plots developed for the two variables of interest revealed that throughout the Six Sigma DMAIC process, there was a *moderate* potential for a relationship between the shared leadership and customer satisfaction variables at each of the time periods. But the subsequent statistical analysis was utilized to determine if there was statistical significance to support the theory outlined in hypothesis #5.

4.3.5.3 Statistical Analysis

Prior to performing analysis for this hypothesis, a normality test was performed in Minitab on the entire sample population data sets collected for the customer satisfaction and shared leadership variables in order to determine if the sample population data (for these variables) were normal. The normality test performed on the shared leadership variable's data set in section 4.2.1 indicated that this data set was non-normal. Figure 7 below shows that the data set for the customer satisfaction variable is normal, a finding

verified by evaluating the p-value of the data set. In the case of normality tests, a data set is considered to be normal if the p-value is greater than or equal to 0.05 (the defined alpha value for this research project). The p-value is 0.097, which reinforces the conclusion that the data set for the customer satisfaction variable is normal.

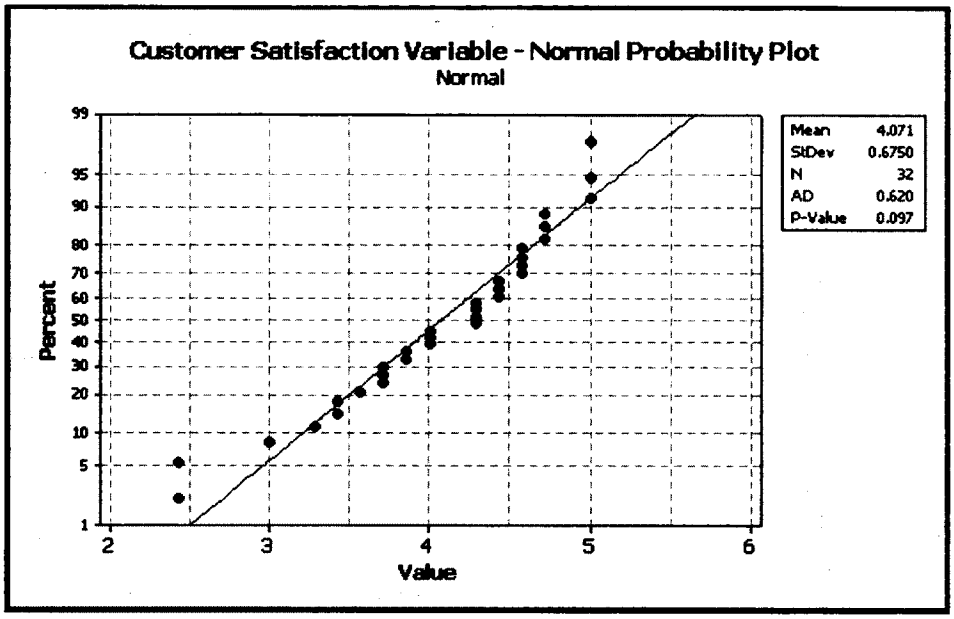

Figure 7: Normal Probability Plot for Customer Satisfaction Variable

Since the data for the shared leadership variable were non-normal, but the customer satisfaction data set was normal, I once again used the Wilcoxon Matched-Pairs Signed-Rank Test as the tool to analyze the data sets related to hypothesis #5. Based on how hypothesis #5 was defined, the following comparison tests will be performed on the data for the shared leadership variable versus the customer satisfaction variable:

- Shared Leadership Variable Vs. Customer Satisfaction At Time Period #1.
- Shared Leadership Variable Vs. Customer Satisfaction At Time Period #2.
- Shared Leadership Variable Vs. Customer Satisfaction At Time Period #3.
- Shared Leadership Variable Vs. Customer Satisfaction At Time Period #4.

I performed the Wilcoxon Matched-Pairs Signed-Rank Test by evaluating the differences between data of paired samples (such as repeated measures or "before" or "after" measures) in order to determine if these differences are different than a median value. In order to utilize the Wilcoxon Matched-Pairs Signed-Rank for performing

hypothesis #5, the difference needed to be taken between the shared leadership value (based on the normalized data) and the customer satisfaction variable for each time period and for each team. Therefore, at each time period, eight "difference" values were calculated (one value per team). The use of this "difference" between the two factors was the formal approach to testing for a relationship or association between two factors.

The Wilcoxon Matched-Pairs Signed-Rank Test typically utilizes a null hypothesis that states "The difference (d = x - y) between the members of each pair (x, y) has median value [X]." After performing research on how to accurately set a threshold (test) value, the median test value used for this analysis was set to 0.50, the difference between the median values of both variables. The customer service variable took on values between one and five (one being the lowest and five being the highest). Based on the structure of the customer service survey, the median value was three. This represented the minimal value required by a team in order to display some level of customer service (as defined based on the structure of the survey and the scale of the ratings on the survey), and therefore represented the customer service variable for the execution of the hypothesis testing.

The normalized values of the shared leadership variable took on one of seven values between zero and five (zero being the best value of shared leadership and five being the least value of shared leadership, in accordance with the centralization formula utilized for the project) (Refer to social network theory section in Chapter Two). These normalized values included [0, 0.8335, 1.665, 2.50, 3.335, 4.1665, and 5.00] (Refer to section 3.8.2 in Chapter Three). Based on how the shared leadership survey was structured, the median value was 2.50. The median value of 2.50 represented the minimal value required by a team in order for that team to display some form of shared leadership (as defined based on the structure of the survey and the scale of the ratings on the survey). This median value of 2.50 represented the shared leadership variable for the execution of the hypothesis testing. When the difference between the median values of both scales was calculated (i.e. 3 – 2.50), the difference value of 0.50 was identified; this was the threshold value that was utilized for the evaluation of hypothesis #4. The value of 0.50 represented the minimum difference between the two factors that would signify the presence of a relationship or association between the two factors.

Therefore, for this study, the following null hypothesis (H_0) and alternative hypothesis (H_A) structure was utilized to test the four comparisons of the two factors at Time Period #1, Time Period #2, Time Period #3, and Time Period #4:

H_0 = Difference Between Customer Satisfaction Value$_i$ – Shared Leadership Value$_i$ Has Median Value <= 0.50

H_A = Difference Between Customer Satisfaction Value$_i$ – Shared Leadership Value$_i$ Has Median Value > 0.50

I decided to set the difference equation as Customer Satisfaction Value$_i$ – Shared Leadership Value$_i$ since I expected that the customer service values would typically be greater than the shared leadership value and the use of this difference equation enabled the differences in data to be positive, making it less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. Note that the setup of the difference equation would not affect the conclusion made from the statistical analysis; the difference equation structure was chosen in order to make the data less complex to use when performing the Wilcoxon Matched-Pairs Signed-Rank Test. The same conclusions about the relationship between the factors could be drawn regardless of the structure of the difference equation. For that reason, the less complex approach was selected.

Note also that the two factors were defined on opposite scales. The customer service variable was defined on a scale of one to five, where one was the least value and five was the greatest). The shared leadership variable (based on normalized data) was defined on a scale of zero to five, in which zero represented the best value and five the least, in accordance with the centralization metric formula utilized for the project.

Since these variables were defined on opposite scales, the detection of a relationship between the two factors was determined to be significant based on the difference between them. The hypotheses, then, needed to evaluate the difference between the two factors against the requirement that it be greater than the minimal threshold (test) value of 0.50. In order to account for this logic and structure, the null hypothesis was defined to state that the median difference between the project completion variable and shared leadership was less than or equal to the threshold value of 0.50. Similarly, the alternate hypothesis was defined to state that the median difference between the project completion variable and shared leadership was greater than the threshold value of 0.50. Based on the

threshold value of 0.50 and the structure of the null and alternate hypotheses, it can be seen that a relationship between the project completion variable and shared leadership variables was said to exist if the median difference between the two variables was greater than the threshold value of 0.50. If the median difference was less than or equal to 0.50, then no association would exist between the two variables.

In accordance with the research methods section of the research study, each of these comparison tests were tested at the defined alpha value of 0.05 and the decision criteria for the acceptance or rejection of the null hypothesis (H_0) for each of these tests was to be based on the p-values obtained from the hypothesis tests. If the p-value of a test was found to be less than the alpha value of 0.05, then the null hypothesis would be rejected; if the p-value for a test was greater than the alpha value of 0.05, then the null hypothesis would be "failed to reject." A "failure to reject" the null hypothesis implied that there was not a statistically significant difference between the customer satisfaction and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables. But a rejection of the null hypothesis implied that there was a statistically significant difference between the customer satisfaction and shared leadership variables at time period i that would symbolize an association (relationship) between the two variables (i.e. that at time period i, a relationship or association exists between the customer satisfaction and shared leadership variables). Based on the null hypothesis (H_0) and alternative hypothesis (H_A) structure defined above as well as the acceptance/rejection criteria for these tests, the Wilcoxon Matched-Pairs Signed-Rank Test was performed on the four comparison hypothesis tests through the use of Minitab and the results were as follows:

Shared Leadership Variable vs. Customer Satisfaction at Time Period #1

H_0 = Difference between Customer Satisfaction $Value_1$ – Shared Leadership $Value_1$ Has Median Value <= 0.50.

H_A = Difference between Customer Satisfaction $Value_1$ – Shared Leadership $Value_1$ Has Median Value > 0.50.

P-Value = 0.092.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.092 > 0.05).

Practical Conclusion: There was not a statistically significant difference between the customer satisfaction and shared leadership variables at time period #1 (the Define phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the customer satisfaction and shared leadership variables at the Define phase.

Shared Leadership Variable vs. Customer Satisfaction at Time Period #2

H_0 = Difference between Customer Satisfaction $Value_2$ – Shared Leadership $Value_2$ Has Median Value <= 0.50.

H_A = Difference between Customer Satisfaction $Value_2$ – Shared Leadership $Value_2$ Has Median Value > 0.50.

P-Value = 0.010.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.010 < 0.05).

Practical Conclusion: There was a statistically significant difference between the customer satisfaction and shared leadership variables at time period #2 (the Measure phase), which led to the conclusion that an association (relationship) exists between the customer satisfaction and shared leadership variables at the Measure phase.

Shared Leadership Variable vs. Customer Satisfaction at Time Period #3

H_0 = Difference between Customer Satisfaction $Value_3$ – Shared Leadership $Value_3$ Has Median Value <= 0.50.

H_A = Difference between Customer Satisfaction $Value_3$ – Shared Leadership $Value_3$ Has Median Value > 0.50.

P-Value = 0.075.

Statistical Conclusion: Fail to reject the null hypothesis (P-Value, 0.075 > 0.05).

Practical Conclusion: There was not a statistically significant difference between the customer satisfaction and shared leadership variables at time period #3 (the Analyze phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the customer satisfaction and shared leadership variables at the Analyze phase.

Shared Leadership Variable vs. Customer Satisfaction at Time Period #4

H_0 = Difference between Customer Satisfaction $Value_4$ – Shared Leadership $Value_4$ Has Median Value <= 0.50.

H_A = Difference between Customer Satisfaction $Value_4$ – Shared Leadership $Value_4$ Has Median Value > 0.50.

P-Value = 0.015.

Statistical Conclusion: Reject the null hypothesis (P-Value, 0.015 < 0.05).

Practical Conclusion: There was a statistically significant difference between the customer satisfaction and shared leadership variables at time period #4 (the Improve phase), which led to the conclusion that an association (relationship) exists between the customer satisfaction and shared leadership variables at the Improve phase.

The results from these hypothesis tests led to the conclusion that there was not a statistically significant difference between the customer satisfaction and shared leadership variables at time periods #1 (the Define phase) and #3 (the Analyze phase) but that there *was* a statistically significant difference between the customer satisfaction and shared leadership variables at time periods #2 and #4. In turn, this supports the conclusion that no association existed between the customer satisfaction and shared leadership variables in the Define phase and the Analyze phases, but an association did exist between the customer satisfaction and shared leadership variables at the Measure and Improve phases of the Six Sigma DMAIC process.

It should also be noted that as explained in Chapter Three, based on the setup of the statistical test chosen as well as the statistical power analysis performed for the sample size and analysis methods for the design, the results have a confidence level of 95% (in accordance with an alpha value of 0.05). Therefore, the results (the acceptance or rejection of the hypothesis) of the analysis of this hypothesis is sensitive to a confidence level of 95% (i.e. I can be 95% confident that the results produced the proper conclusion). These results will also have a power level 0.92, which signifies the probability of correctly rejecting the null hypothesis when it is false. The level of 0.92 implies that there is high confidence that the statistical results and interpretation were executed accurately.

Table 11 summarizes the findings of the comparisons tests performed for hypothesis #5.

Table 11: Summary Table for Hypothesis Testing on Hypothesis #5

Comparision	Null Hypothesis	Alternative Hypothesis	Statistical Test	P-Value	Statistical Conclusion	Practical Conclusion
Time Period #1	Difference Between Customer Satisfaction Value1 – Shared Leadership Value1 Has Median Value <= 0.50.	Difference Between Customer Satisfaction Value1 – Shared Leadership Value1 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0920	Fail to reject the null hypothesis (P-Value, 0.092 > 0.05).	There was not a statistically significant difference between the customer satisfaction and shared leadership variables at time period #1 (the define phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the customer satisfaction and shared leadership variables in the define phase.
Time Period #2	Difference Between Customer Satisfaction Value2 – Shared Leadership Value2 Has Median Value <= 0.50.	Difference Between Customer Satisfaction Value2 – Shared Leadership Value2 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0100	Reject the null hypothesis (P-Value, 0.010 < 0.05).	There was a statistically significant difference between the customer satisfaction and shared leadership variables at time period #2 (the measure phase), which led to the conclusion that an association (relationship) exists between the customer satisfaction and shared leadership variables in the measure phase.
Time Period #3	Difference Between Customer Satisfaction Value3 – Shared Leadership Value3 Has Median Value <= 0.50.	Difference Between Customer Satisfaction Value3 – Shared Leadership Value3 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0750	Fail to reject the null hypothesis (P-Value, 0.075 > 0.05).	There was not a statistically significant difference between the customer satisfaction and shared leadership variables at time period #3 (the analyze phase) that would symbolize an association (relationship) between the two variables. In turn, this conclusion implied that no association (relationship) exists between the customer satisfaction and shared leadership variables in the analyze phase.
Time Period #4	Difference Between Customer Satisfaction Value4 – Shared Leadership Value4 Has Median Value <= 0.50.	Difference Between Customer Satisfaction Value4 – Shared Leadership Value4 Has Median Value > 0.50.	Wilcoxon Matched-Pairs Signed-Rank Test	0.0150	Reject the null hypothesis (P-Value, 0.015 < 0.05).	There was a statistically significant difference between the customer satisfaction and shared leadership variables at time period #4 (the improve phase), which led to the conclusion that an association (relationship) exists between the customer satisfaction and shared leadership variables in the improve phase.

The analysis above highlights the findings and conclusions identified from the quantitative analysis of the five pre-defined hypotheses, in which each hypothesis performed specific comparisons among time periods in order to obtain findings and conclusions related to each hypothesis. The findings and high-level conclusions from the five hypotheses are summarized in Table 12 below, but these findings and conclusions were utilized to develop the subsequent discussion section.

Table 12: Summary Table for All Hypothesis Testing

Hypothesis #	Definition	Variables Tested	Acceptance of Hypothesis	Conclusion
1	To examine whether there is an increase in shared leadership from Time Point #1 (Define phase) to Time Point #4 (Improve phase) of the DMAIC structure.	Shared Leadership	Rejection of the Hypothesis. Test failed at all time periods.	There is no consistent increase in a team's degree of shared leadership as they progress from the Define phase to the Improve phase.
2	To examine if there is a relationship between shared leadership and the internal team environmental condition at each phase of the DMAIC structure.	Shared Leadership & Internal Team Environment	Acceptance of the Hypothesis. Test passed at all time periods.	There is relationship between shared leadership and the internal team environmental condition as a team progresses through each phase of the DMAIC structure.
3	To examine if there is a relationship between shared leadership and the external coaching environmental condition at each phase of the DMAIC structure.	Shared Leadership & External Coaching	Rejection of the Hypothesis. Test passed three of four time periods.	There is no consistent relationship between shared leadership and the external coaching environmental condition at each phase as a team progresses through each phase of the DMAIC structure. Relationship is only present at the Measure, Analyze, and Improve phases.
4	To examine if there is a relationship between shared leadership and the project completion performance metric at each phase of the DMAIC structure.	Shared Leadership & Project Completion	Rejection of the Hypothesis. Test passed two of four time periods.	There is no consistent relationship between shared leadership and the project completion performance metric at each phase of the DMAIC structure. Relationship is only present at the Measure and Improve phases.
5	To examine if there is a relationship between shared leadership and the customer satisfaction performance metric at each phase of the DMAIC structure.	Shared Leadership & Customer Satisfaction	Rejection of the Hypothesis. Test passed two of four time periods.	There is no consistent relationship between shared leadership and the customer satisfaction performance metric at each phase of the DMAIC structure. Relationship is only present at the Measure and Improve phases.

4.4 Qualitative Analysis (Qualitative Questions) – Main Study

Recall that the purpose of the analysis of the data from the qualitative questions was to identify concerns, issues, trends, patterns, and justifications that could help support (and explain) the conclusions drawn from the quantitative analysis of the five hypotheses. I used the methodology outlined in the research design to perform the qualitative analysis of the qualitative questions for both the internal and external coach surveys. The analysis presented in this section is organized by each factor. Within each factor, each question is analyzed independently. For each factor, the analysis was performed by independently analyzing the data for qualitative question that was related to the factor and at each time period. For each question, the data were analyzed by evaluating the data specific to the time period level (i.e. each time period independently) as well as the question as a whole from the entire length of the DMAIC process (i.e. the data from all four time periods analyzed as a cumulative data set). This analysis structure was executed for each factor.

4.4.1 Internal Team Environment (4 Qualitative Questions)

The qualitative segment for the internal team environment variable was assessed through the use of four qualitative questions from the internal member survey.

Recall that the first question was structured in the following manner:

1. What do you think of your current team environment?

Response:

Option #1: The Team environment needs much improvement.

Option #2: The team works well together but needs improvement.

Option #3: Team is cohesive and works very well together.

Option #4: Other Please Specify: _____

Figure 8 below presents a chart and graph (visual representation) that summarizes the data to question #1 from both the individual time periods as well as the study as a whole.

	Question 1				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	0.00%	0.00%	0.00%	0.00%	0.00%
Option 2	37.50%	12.50%	25.00%	12.50%	21.88%
Option 3	62.50%	87.50%	75.00%	87.50%	78.13%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

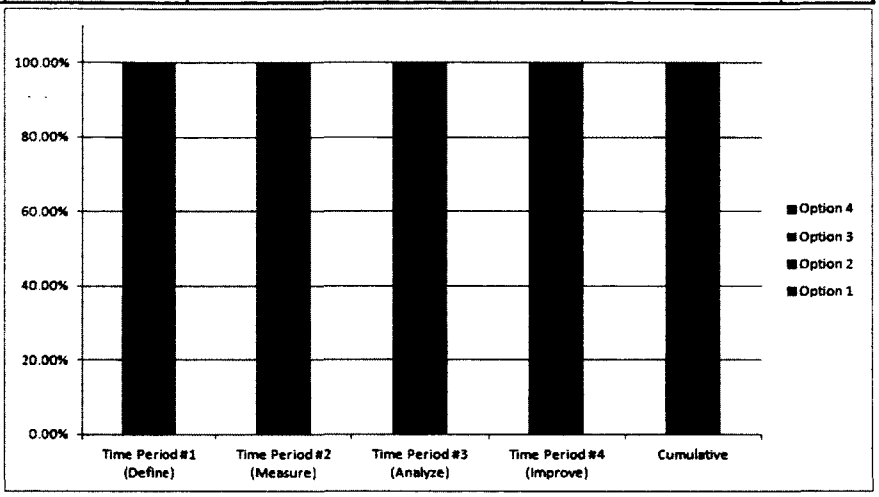

Figure 8: Internal Team Environment - Qualitative Question #1 Results

From these analyses, it was concluded that majority of the teams believed that their teams worked cohesively and well together throughout the project (option #3) while a few of the teams also believed that their teams worked well together but needed improvement of some sort during the execution of the project (option #2). Note that no team member(s) selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Recall that the second question was structured in the following manner:

2. What is the most significant factor in your current team environment?

Response:

Option #1: The level of shared vision among the team members.

Option #2: The level of social support that the team members display.

Option #3: The level of voice that each member is given.

Option #4: Other. Please Specify: _____

Figure 9 below presents a chart and graph (visual representation) that summarizes the data to question #2 from both the individual time periods as well as the study as a whole.

	Question 2				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	62.50%	37.50%	37.50%	37.50%	43.75%
Option 2	0.00%	25.00%	25.00%	37.50%	21.88%
Option 3	37.50%	37.50%	25.00%	25.00%	31.25%
Option 4	0.00%	0.00%	12.50%	0.00%	3.13%

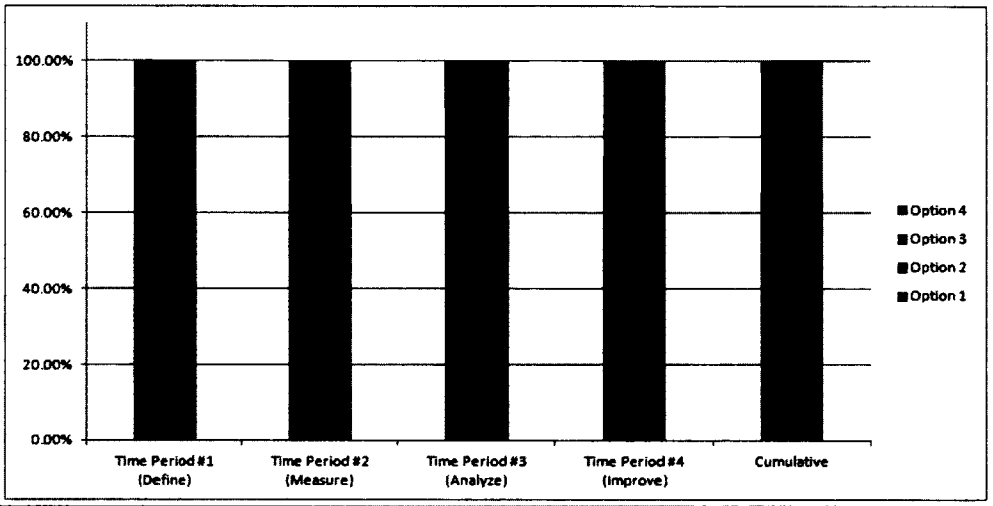

Figure 9: Internal Team Environment - Qualitative Question #2 Results

The analyses led to the practical conclusion that the teams had mixed feelings about which dimension of internal team environment was the most significant factor for their team's environment throughout the project. The findings support the belief that the teams valued the three dimensions (social support, shared vision, and voice) equally throughout the project. Note that in regards to option #4, even though it was rarely selected by the team (and members); the free text option found that time commitment and communication was the main themes identified by team members. The comments included: "Time commitment due to job responsibilities," and "Consistent communication among team members."

The third question was arranged in the following manner:

3. What do you think needs to change or improve in terms of your current team environment?

Response:

Option #1: The level of shared vision among the team members.

Option #2: The level of social support that the team members display.

Option #3: The level of voice that each member is given.

Option #4: Other, Please Specify: _____

Figure 10 below presents a chart and graph (visual representation) that summarizes the data to question #3 from both the individual time periods as well as the study as a whole.

	Question 3				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	62.50%	12.50%	25.00%	0.00%	25.00%
Option 2	12.50%	37.50%	50.00%	62.50%	40.63%
Option 3	25.00%	50.00%	25.00%	37.50%	34.38%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

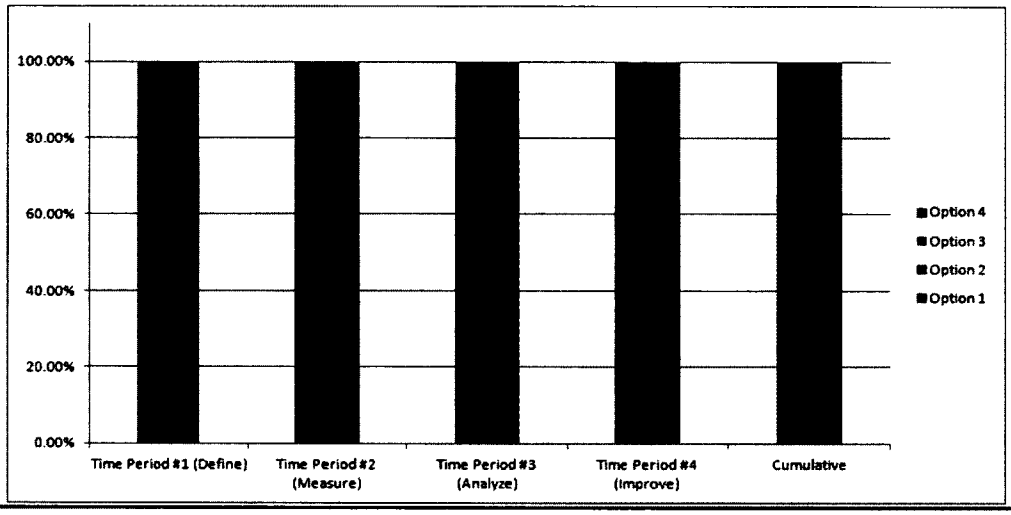

Figure 10: Internal Team Environment - Qualitative Question #3 Results

The results of these analyses also supported the belief that the teams valued the three dimensions (social support, shared vision, and voice) equally throughout the project. The analyses led to the practical conclusion that the teams believed that it was equally important to maintain and continually improve the three dimensions of internal team environment. Note that no team member(s) selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

The fourth question was arranged in the following manner:

4. In what area has your team's internal team environment had the most significant impact on the team's ability to complete this phase of the project (up to this point)?

Response:

Option #1: Making decisions and completing tasks in a timely manner.

Option #2: Establishing a clear and consistent team direction.

Option #3: Establishing an environment where each member has an equal voice and has unwavering team support.

Option #4: Other, Please Specify: _____

Figure 11 below presents a chart and graph (visual representation) that summarizes the data to question #4 from both the individual time periods as well as the study as a whole.

	Question 4				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	25.00%	37.50%	37.50%	37.50%	34.38%
Option 2	62.50%	50.00%	37.50%	12.50%	40.63%
Option 3	12.50%	12.50%	12.50%	50.00%	21.88%
Option 4	0.00%	0.00%	12.50%	0.00%	3.13%

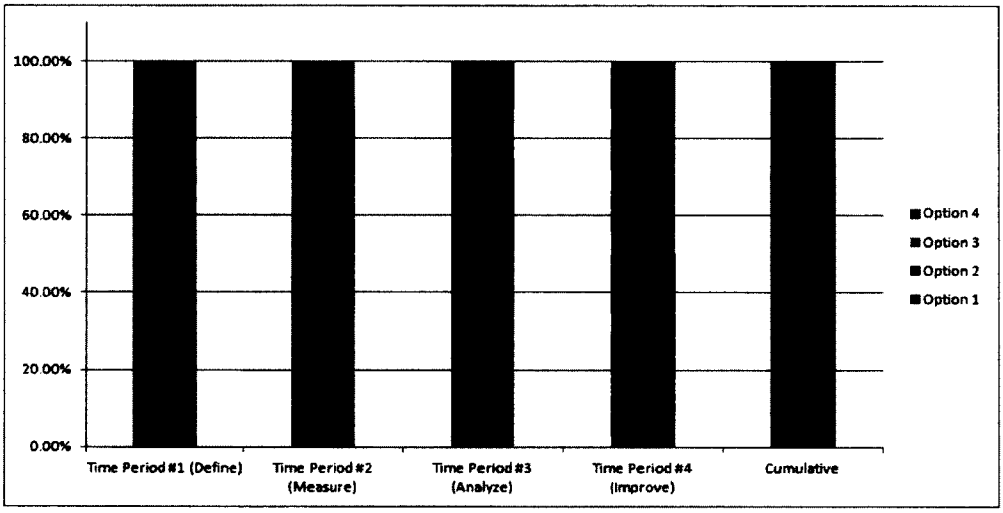

Figure 11: Internal Team Environment - Qualitative Question #4 Results

These analyses led me to conclude that the teams believed that internal team environment makes a significant but almost equal impact on a team's ability to make decisions and complete tasks in a timely manner, establish a clear direction, and establish an environment where each member has team support and an equal voice. While the significance of the impact from the internal team environment variable might vary from phase to phase, the teams felt that the internal team environment variable had a significant impact on all three areas (options #1, #2, and #3). Note that in regards to option #4, even though it was rarely selected by the team (and members); the free text option found that member participation was the main theme identified by team members.

The comments included: "Participation by all members" and "Level of contribution & participation from every team member."

Table 13 summarizes the findings from the analysis of the qualitative questions related to the internal team environment variable.

Table 13: Internal Team Environment - Summary of Qualitative Questions

Factor	Question	Significant Findings
Internal Team Environment	Q1. What do you think of your current team environment?	Majority of the teams believed that their teams worked cohesively and well together throughout the project (option #3) while a few of the teams also believed that their teams worked well together but needed improvement of some sort during the execution of the project (option #2).
Internal Team Environment	Q2: What is the most significant factor in your current team environment?	The teams had mixed feelings about which dimension of internal team environment was the most significant factor for their team's environment throughout the project. The findings support the belief that the teams valued the three dimensions (social support, shared vision, and voice) equally throughout the project.
Internal Team Environment	Q3: What do you think needs to change or improve in terms of your current team environment?	Teams valued the three dimensions (social support, shared vision, and voice) equally throughout the project. The analyses led to the practical conclusion that the teams believed that it was equally important to maintain and continually improve the three dimensions of internal team environment.
Internal Team Environment	Q4: In what area has your team's internal team environment had the most significant impact on the team's ability to complete this phase of the project (up to this point)?	Teams believed that internal team environment makes a significant but almost equal impact on a team's ability to make decisions and complete tasks in a timely manner, establish a clear direction, and establish an environment where each member has team support and an equal voice. While the significance of the impact from the internal team environment variable might vary from phase to phase, the teams felt that the internal team environment variable had a significant impact on all three areas (options #1, #2, and #3).

4.4.2 External Coaching (4 Qualitative Questions)

The qualitative segment for the external coaching variable was assessed through the use of four qualitative questions from the internal member survey.

Recall that the first question was structured in the following manner:

1. What do you think of the level of support and guidance from your External Coach?

Response:

Option #1: External coach does not display any level of support or guidance.

Option #2: External coach provides some guidance and support, but improvement is needed.

Option #3: External coach provides a consistent level of guidance and support.

Option #4: Other, Please Specify: _____

Figure 12 below presents a chart and graph (visual representation) that summarizes the data to question #1 from both the individual time periods as well as the study as a whole.

	Question 1				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	0.00%	0.00%	0.00%	0.00%	0.00%
Option 2	25.00%	0.00%	0.00%	0.00%	6.25%
Option 3	75.00%	100.00%	100.00%	100.00%	93.75%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

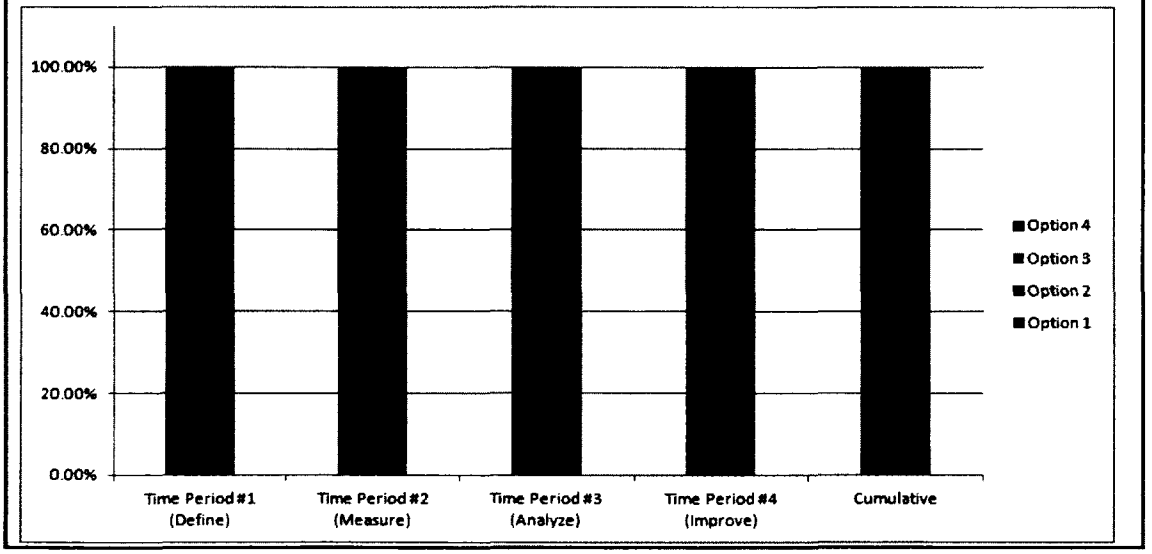

Figure 12: External Coaching - Qualitative Question #1 Results

These analyses led to the practical conclusion that majority of the teams believed that their external coaches provided a consistent level of guidance and support throughout the execution of the project (option #3), while a few teams believed that their external coaches provided good guidance and support throughout the execution of the project, but that some improvement was needed (option #2). Note that no team member(s) selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Recall that the second question was structured in the following manner:

2. What are the positive aspects of your External Coach?

Response:

Option #1: Level of support, guidance, and presence.

Option #2: Willingness to provide mentorship and help at any point in the project.

Option #3: Consistency of communication.

Option #4: Other, Please Specify: _____

Figure 13 below presents a chart and graph (visual representation) that summarizes the data to question #2 from both the individual time periods as well as the study as a whole.

	Question 2				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	25.00%	12.50%	12.50%	12.50%	15.63%
Option 2	50.00%	50.00%	87.50%	62.50%	62.50%
Option 3	12.50%	37.50%	0.00%	25.00%	18.75%
Option 4	12.50%	0.00%	0.00%	0.00%	3.13%

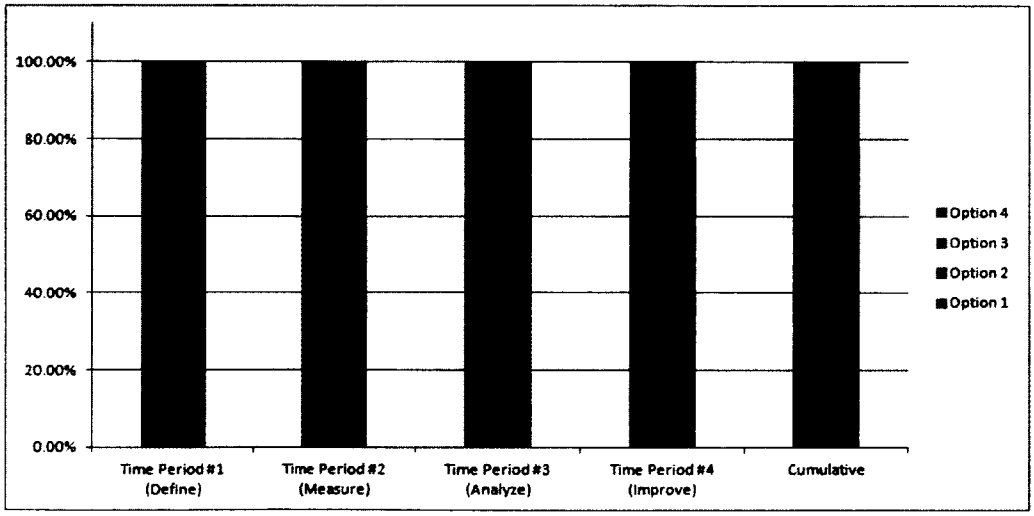

Figure 13: External Coaching - Qualitative Question #2 Results

The findings from these analyses led to the conclusion that the teams believed that some of the strongest traits of the external coach was that the external coach was willing to provide mentorship and help to the teams at any point in the project (option #2). The analyses also led to the conclusion that the teams placed a strong value on the external coach's ability to provide consistent communication and high levels of presence and guidance throughout the execution of a project. Note that in regards to option #4, even though it was rarely selected by the team (and members); the free text option found that that level of autonomy given from the external coach was the main theme identified by team members. The comments included: "Let the team do most of the work and just provide guidance and support" and "The external coach gives sufficient guidance and support to be self sustaining."

Recall that the third question was structured in the following manner:

3. What do you think needs to change or improve in terms of the guidance/support given by your External Coach?

Response:

Option #1: Level of support, guidance, and presence.

Option #2: Willingness to provide mentorship and help at any point in the project.

Option #3: Consistency of communication.

Option #4: Other, Please Specify: _____

Figure 14 below presents a chart and graph (visual representation) that summarizes the data to question #3 from both the individual time periods as well as the study as a whole.

	Question 3				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	37.50%	37.50%	12.50%	12.50%	25.00%
Option 2	25.00%	25.00%	62.50%	37.50%	37.50%
Option 3	37.50%	37.50%	25.00%	50.00%	37.50%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

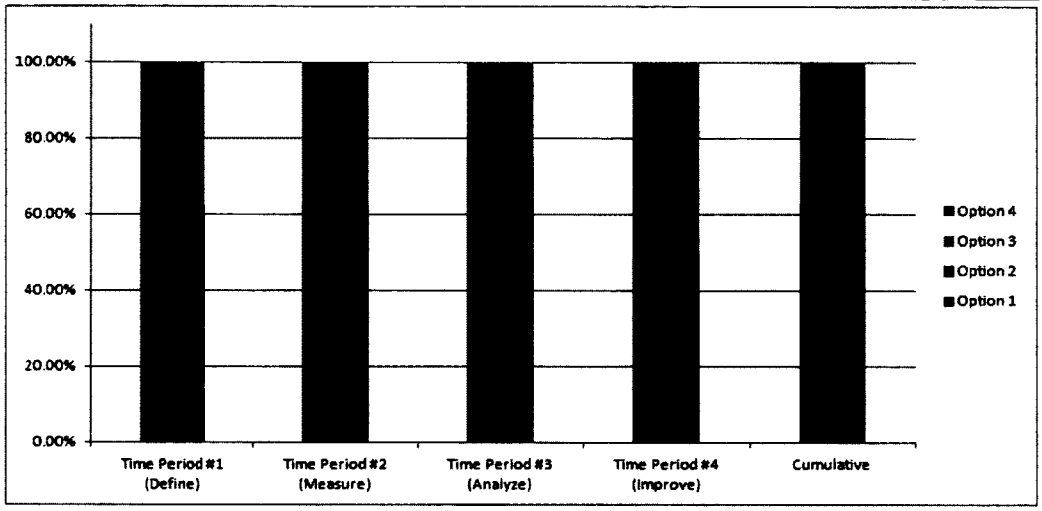

Figure 14: External Coaching - Qualitative Question #3 Results

These analyses provide a basis to conclude that the teams placed strong but relatively equal importance on an external coach's ability to provide support, consistent communication, and willingness to provide mentorship throughout a project. While all of these items were found to be strongly present in all of the external coaches, the teams believed that these three items needed to be equally improved and maintained throughout a project; there was not one item that stood out as a poor performer and not one item that stood out as a best performer. Note that no team member(s) selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Recall that the fourth question was structured in the following manner:

4. In what area has the coach's external coaching had the most significant impact on the team's ability to complete this phase of the project (up to this point)?

Response:

Option #1: Ensuring that the team stays focused.

Option #2: Removal of obstacles and barriers that are in the team's way.

Option #3: Providing clear direction on deliverables and providing advice to the team as needed.

Option #4: Other, Please Specify: _____

Figure 15 below presents a chart and graph (visual representation) that summarizes the data to question #4 from both the individual time periods as well as the study as a whole.

	Question 4				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	50.00%	37.50%	12.50%	12.50%	28.13%
Option 2	12.50%	0.00%	0.00%	12.50%	6.25%
Option 3	37.50%	62.50%	87.50%	75.00%	65.63%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

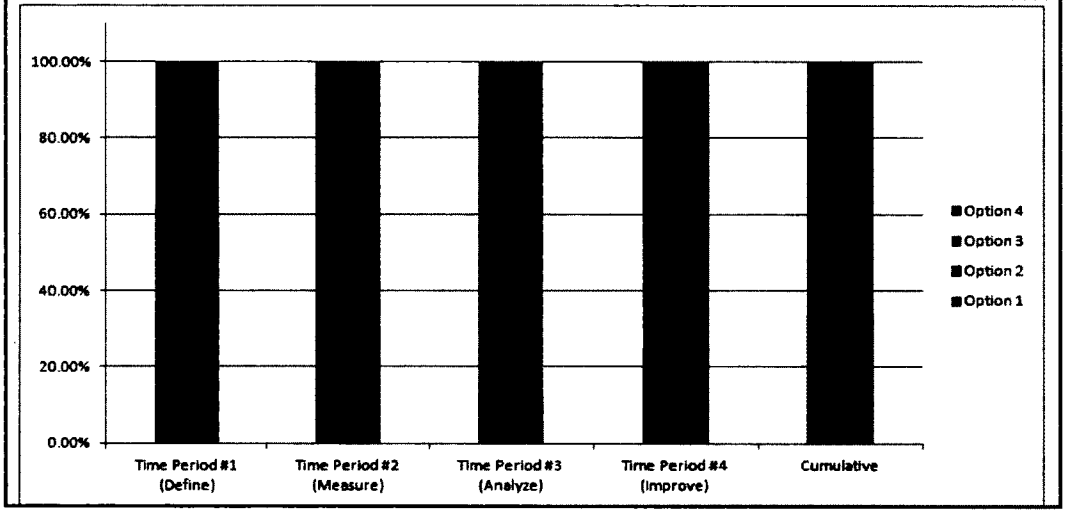

Figure 15: External Coaching - Qualitative Question #4 Results

These findings led to the conclusion that the teams believed that the support and guidance provided by the external coaches have made a significant impact on the team's focus (option #1) and the direction for the team in terms of deliverables and steps to follow. This meant that the team's believed that an external coach can make the most impact by ensuring that the team is remaining focused on the project as well as ensuring that the team has a clear direction in terms of deliverables and the steps that need to be taken to complete a phase of the project. Note that no team member(s) selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Table 14 summarizes the findings from the analysis of the qualitative questions related to the external coaching variable.

Table 14: External Coaching - Summary of Qualitative Questions

Factor	Question	Significant Findings
External Coaching	Q1: What do you think of the level of support and guidance from your External Coach?	Majority of the teams believed that their external coaches provided a consistent level of guidance and support throughout the execution of the project (option #3), while a few teams believed that their external coaches provided good guidance and support throughout the execution of the project, but that some improvement was needed (option #2).
External Coaching	Q2: What are the positive aspects of your External Coach?	Teams believed that some of the strongest traits of the external coach was that the external coach was willing to provide mentorship and help to the teams at any point in the project (option #2). The analyses also led to the conclusion that the teams placed a strong value on the external coach's ability to provide consistent communication and high levels of presence and guidance throughout the execution of a project.
External Coaching	Q3: What do you think needs to change or improve in terms of the guidance/support given by your External Coach?	Teams placed strong but relatively equal importance on an external coach's ability to provide support, consistent communication, and willingness to provide mentorship throughout a project. While all of these items were found to be strongly present in all of the external coaches, the teams believed that these three items needed to be equally improved and maintained throughout a project; there was not one item that stood out as a poor performer and not one item that stood out as a best performer.
External Coaching	Q4: In what area has the coach's external coaching had the most significant impact on the team's ability to complete this phase of the project (up to this point)?	Teams believed that the support and guidance provided by the external coaches have made a significant impact on the team's focus (option #1) and the direction for the team in terms of deliverables and steps to follow. This meant that the team's believed that an external coach can make the most impact by ensuring that the team is remaining focused on the project as well as ensuring that the team has a clear direction in terms of deliverables and the steps that need to be taken to complete a phase of the project.

4.4.3 Shared Leadership (4 Qualitative Questions)

The qualitative segment for the shared leadership variable was assessed through the use of four qualitative questions from the internal member survey.

Recall that the first question was structured in the following manner:

1. What do you think of the level of leadership displayed by:

Response:

Option #1: Need to show leadership in the team setting.

Option #2: Shows leadership but needs much improvement.

Option #3: Provides consistent leadership; he/she only needs to maintain this level.

Option #4: Other, Please Specify: _____

Figure 16 below presents a chart and graph (visual representation) that summarizes the data to question #1 from both the individual time periods as well as the study as a whole.

	Question 1				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	0.00%	0.00%	0.00%	0.00%	0.00%
Option 2	25.00%	0.00%	12.50%	0.00%	9.38%
Option 3	75.00%	100.00%	87.50%	100.00%	90.63%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

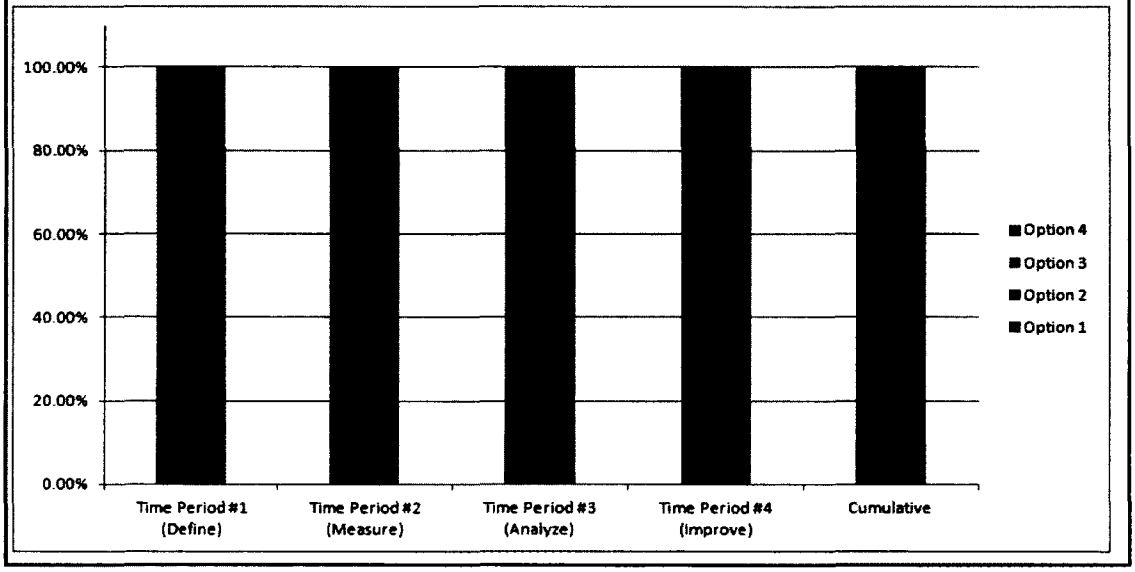

Figure 16: Shared Leadership - Qualitative Question #1 Results

These analyses lead to the conclusion that majority of the teams believed that the individual team members provided consistent shared leadership throughout the project (option #3) and that the teams did not need to change any condition of the team's

environment; they needed only to maintain the teams' levels of shared leadership. It was also concluded that some teams believed that that team had a good degree of shared leadership in the environment during the execution of the project, but that the degree of shared leadership needed to be improved in some manner. Note that no team member(s) selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Recall that the second question was structured in the following manner:

2. What do you think needs to change or improve with the leadership of:

Response:

Option #1: Delegate more tasks and responsibilities to the team members.

Option #2: Be more open-minded to hearing the thoughts and opinions of all members.

Option #3: Be more assertive and follow the procedures of the project (i.e. timelines and deadlines).

Option #4: Other, Please Specify: _____

Figure 17 below presents a chart and graph (visual representation) that summarizes the data to question #2 from both the individual time periods as well as the study as a whole.

	Question 2				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	12.50%	25.00%	12.50%	12.50%	15.63%
Option 2	37.50%	12.50%	62.50%	50.00%	40.63%
Option 3	50.00%	62.50%	25.00%	25.00%	40.63%
Option 4	0.00%	0.00%	0.00%	12.50%	3.13%

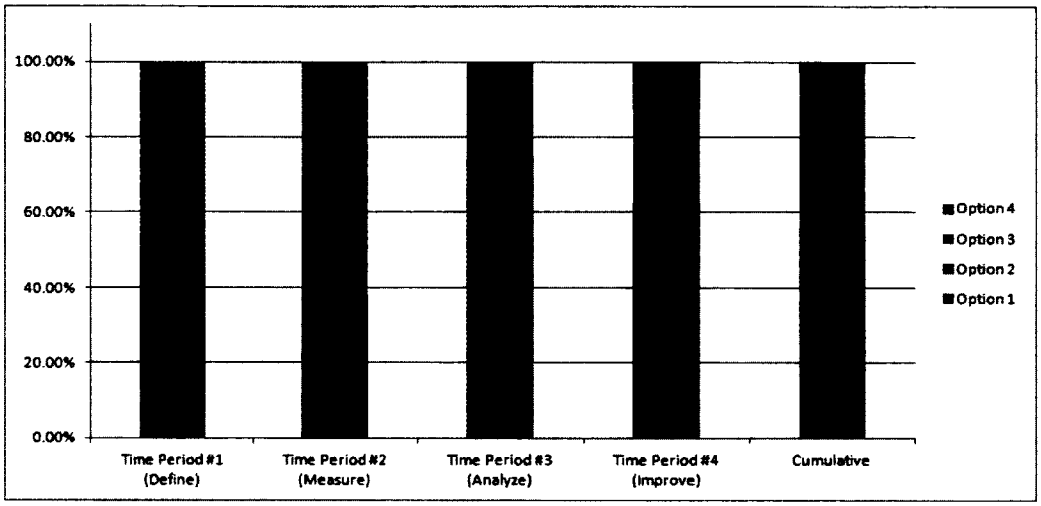

Figure 17: Shared Leadership - Qualitative Question #2 Results

The analyses provided basis to conclude that the teams believed that the degree of shared leadership could significantly improve if the members of the teams were both more open-minded to hearing the thoughts and opinions of all team members and being more assertive and willing to follow the timelines and deadlines set for the project phases. The teams believed that improving these two aspects of the team would help to significantly improve the levels of shared leadership in the team environments. Note that in regards to option #4, even though it was rarely selected by the team (and members); the free text option found that that degree of responsibility and prioritization of job/project responsibilities were the main themes identified by team members. The comments included: "Members need to take on more responsibility" and "Team members should learn to prioritize their project work with their regular job responsibilities."

Recall that the third question was structured in the following manner:

3. What recommendations do you have for improvement or change for:

Response:

Option #1: Delegate more to the team members.

Option #2: Set deadlines and enforce policies/deadlines for the team.

Option #3: Be more confident and assertive with your role in the team.

Option #4: Other, Please Specify: _____

Figure 18 below presents a chart and graph (visual representation) that summarizes the data to question #3 from both the individual time periods as well as the study as a whole.

	Question 3				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	0.00%	12.50%	0.00%	0.00%	3.13%
Option 2	62.50%	37.50%	0.00%	37.50%	34.38%
Option 3	37.50%	37.50%	100.00%	50.00%	56.25%
Option 4	0.00%	12.50%	0.00%	12.50%	6.25%

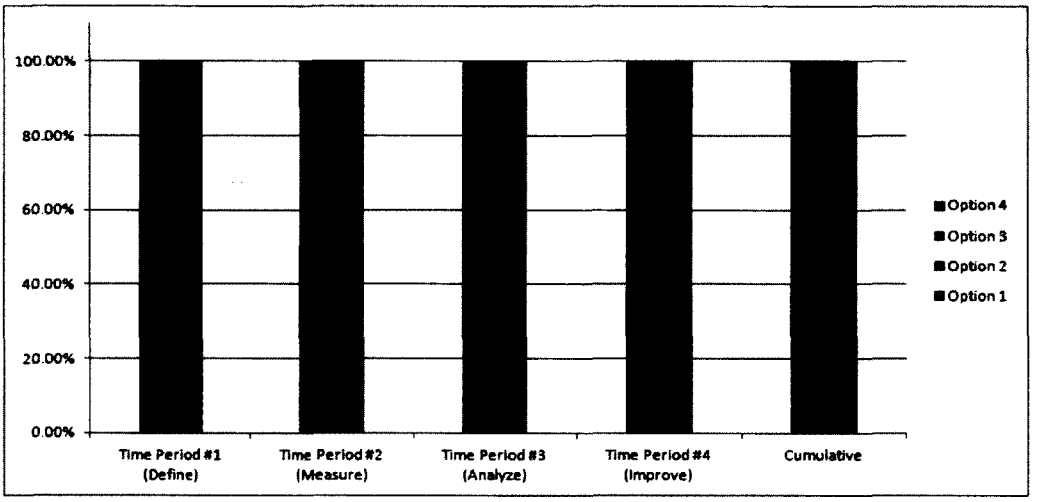

Figure 18: Shared Leadership - Qualitative Question #3 Results

These analyses led to the conclusion that the teams believed that in order to improve a team's overall performance (including leadership), the teams must improve their abilities to set deadlines as well as enforce policies for the team; the findings also led to the conclusion that the teams believed that members needed to be more confident and assertive with their roles in the team environments, which in turn would improve a team's overall performance, including leadership. Note that in regards to option #4, the free text option found that that degree of responsibility and prioritization of job/project responsibilities were the main themes identified by team members. The comments included: "Be willing and open to taking on more responsibility" and "Learn to manage your time properly in order balance your project and job responsibilities."

Recall that the fourth question was structured in the following manner:

4. In what area has the level of internal team leadership had the most significant impact on the team's ability to complete this phase of the project as well as meet the expectations/requirements of the project (up to this point)?

Response:

Option #1: Ability to create an environment where all members share responsibilities of the leadership role.

Option #2: Ability to resolve conflicts and issues in a timely and effective manner.

Option #3: Ability to provide clear direction on deliverables and providing an outlet for all members to openly speak their minds.

Option #4: Other, Please Specify: _____

Figure 19 below presents a chart and graph (visual representation) that summarizes the data to question #4 from both the individual time periods as well as the study as a whole.

	Question 4				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	25.00%	25.00%	0.00%	0.00%	12.50%
Option 2	12.50%	12.50%	0.00%	25.00%	12.50%
Option 3	62.50%	62.50%	100.00%	75.00%	75.00%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

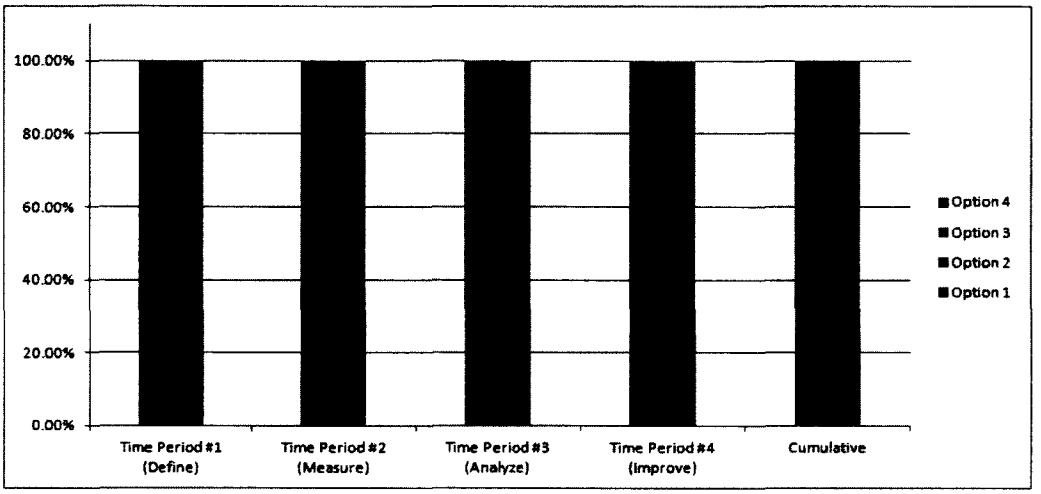

Figure 19: Shared Leadership - Qualitative Question #4 Results

These analyses led me to conclude that majority of the teams believed that the team's ability have a strong degree of shared leadership enabled them to make a significant impact on establishing a clear direction for the team and to provide a mechanism for all members to openly express their minds (option #3). The analyses also found that some teams believed that the strength of shared leadership made equal impacts (but less than the previous item) in the areas of creating an environment where all members share the leadership responsibilities as well as creating an environment where a team can resolved conflicts in a timely and effective manner. Note that no team member(s) selected option

#4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Table 15 summarizes the findings from the analysis of the qualitative questions related to the shared leadership variable.

Table 15: Shared Leadership - Summary of Qualitative Questions

Factor	Question	Significant Findings
Shared Leadership	Q1: What do you think of the level of leadership displayed by?	Teams believed that the individual team members provided consistent shared leadership throughout the project (option #3) and that the teams did not need to change any condition of the team's environment; they needed only to maintain the teams' levels of shared leadership. It was also concluded that some teams believed that that team had a good degree of shared leadership in the environment during the execution of the project, but that the degree of shared leadership needed to be improved in some manner.
Shared Leadership	Q2: What do you think needs to change or improve with the leadership of?	Teams believed that the degree of shared leadership could significantly improve if the members of the teams were both more open-minded to hearing the thoughts and opinions of all team members and being more assertive and willing to follow the timelines and deadlines set for the project phases. The teams believed that improving these two aspects of the team would help to significantly improve the levels of shared leadership in the team environments.
Shared Leadership	Q3: What recommendations do you have for improvement or change for?	Teams believed that in order to improve a team's overall performance (including leadership), the teams must improve their abilities to set deadlines as well as enforce policies for the team; the findings also led to the conclusion that the teams believed that members needed to be more confident and assertive with their roles in the team environments, which in turn would improve a team's overall performance, including leadership.
Shared Leadership	Q4: In what area has the level of internal team leadership had the most significant impact on the team's ability to complete this phase of the project as well as meet the expectations/requirements of the project (up to this point)?	Teams believed that the team's ability have a strong degree of shared leadership enabled them to make a significant impact on establishing a clear direction for the team and to provide a mechanism for all members to openly express their minds (option #3). The analyses also found that some teams believed that the strength of shared leadership made equal impacts (but less than the previous item) in the areas of creating an environment where all members share the leadership responsibilities as well as creating an environment where a team can resolved conflicts in a timely and effective manner.

4.4.4 Project Completion (3 Qualitative Questions)

The qualitative segment for the project completion variable was assessed through the use of three qualitative questions from the external coach survey.

Recall that the first question was structured in the following manner:

1. In what area has your level of support or guidance had the most significant impact on the team's ability to complete the project on time (up to this point)?

Response:

Option #1: Establishing a clear direction and staying on task.

Option #2: Establishing a collaborative team environment.

Option #3: Removing barriers or resolving conflict that the team is faced with.

Option #4: Other, Please Specify: _____

Figure 20 below presents a chart and graph (visual representation) that summarizes the data to question #1 from both the individual time periods as well as the study as a whole.

	Question 1				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	87.50%	62.50%	0.00%	75.00%	56.25%
Option 2	12.50%	37.50%	25.00%	12.50%	21.88%
Option 3	0.00%	0.00%	25.00%	12.50%	9.38%
Option 4	0.00%	0.00%	50.00%	0.00%	12.50%

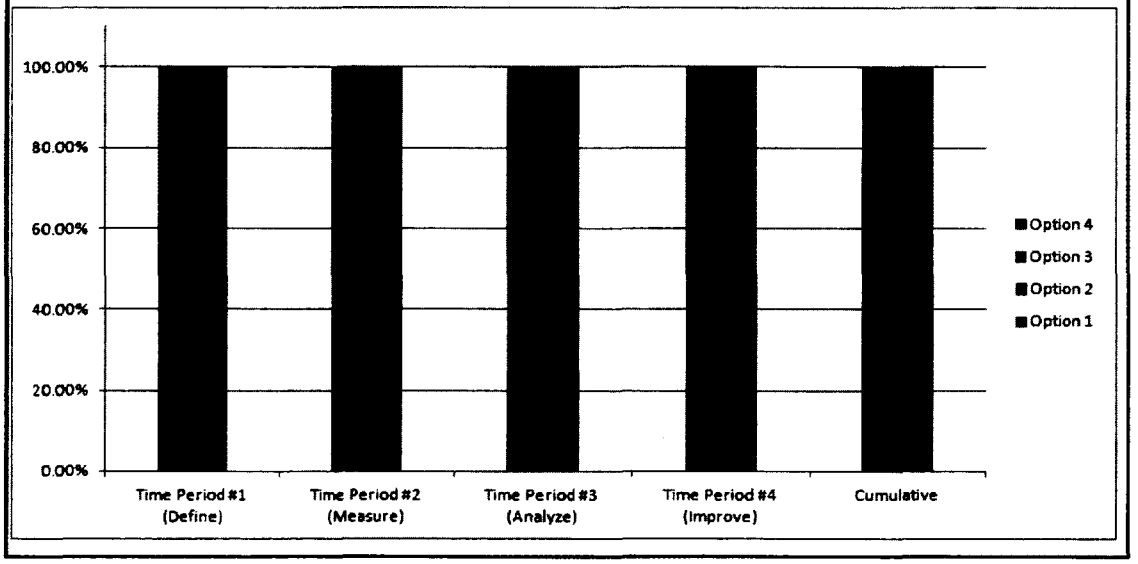

Figure 20: Project Completion - Qualitative Question #1 Results

These analyses led to the conclusion that external coaches believed throughout the projects, their guidance and support helped teams to complete the projects on time by making the most significant impact in the areas of establishing a clear direction and maintaining the team's focus as well as establishing a collaborative team environment. The external coaches believed that the guidance and support they provided in these areas made the most impact on helping the teams to complete their projects on time. Note that in regards to option #4, it was selected 12.50% of the time (overall across all phases) by the external coaches and the free text option found that maintaining the focus on the problem and not solutions was the main theme identified by external coaches. The comments included "Reinforce that they shouldn't come with solutions" and "Spent a lot time ensuring that the teams did not jump to solutions but focused on the problem at hand."

Recall that the second question was structured in the following manner:

2. In what area has your level of support or guidance had the most significant impact on the team's ability to complete the project deliverables (up to this point)?

Response:

Option #1: Identification of project requirements and project tasks.

Option #2: Staying focused on the objective of the phase and the project as a whole.

Option #3: How to apply concepts and tools to the team's project (process).

Option #4: Other, Please Specify: _____

Figure 21 below presents a chart and graph (visual representation) that summarizes the data to question #2 from both the individual time periods as well as the study as a whole.

	Question 2				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	12.50%	25.00%	25.00%	0.00%	15.63%
Option 2	62.50%	25.00%	50.00%	62.50%	50.00%
Option 3	25.00%	50.00%	25.00%	37.50%	34.38%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

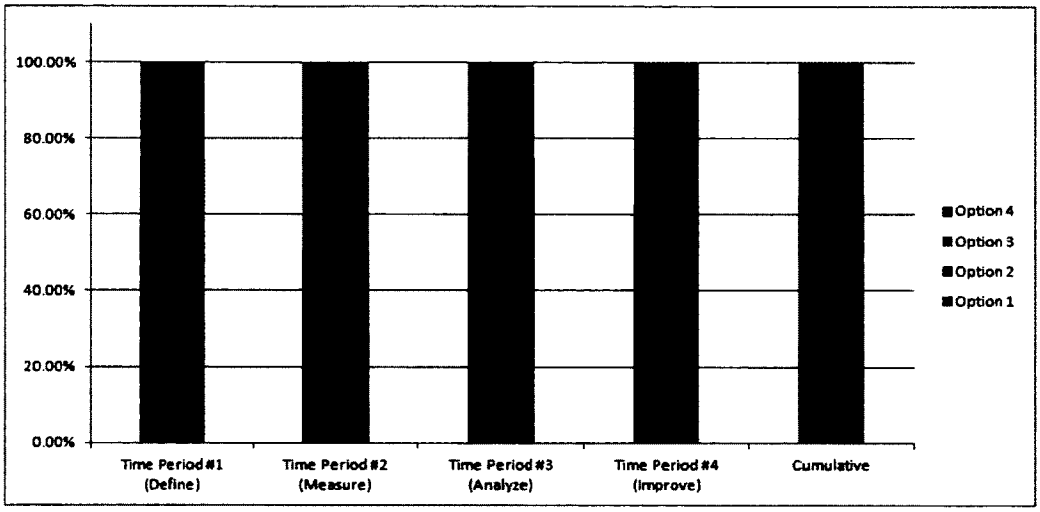

Figure 21: Project Completion - Qualitative Question #2 Results

The findings from these analyses led to the conclusion that external coaches believed throughout the projects, that their guidance and support helped teams to complete project deliverables by making the most significant impact in the areas of staying focused on the objective of the phase (and the project as a whole) as well as applying the concepts and tools to the teams' projects (processes). The external coaches believed that the guidance and support they provided in these areas made the most impact on helping the teams to complete their project deliverables. Note that no external coaches selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Recall that the third question was structured in the following manner:

3. What recommendations do you have for improvement or change for the team's ability to complete project requirements and deliverables (up to this point)?

Response:

Option #1: Ability to stay on task and stay focused on the objective of the phase.

Option #2: Working collaboratively as a team and delegating tasks to each member.

Option #3: Setting deadlines and schedules for each project tasks and ensuring that the team sticks (works) to the specific deadlines and schedules.

Option #4: Other, Please Specify: _____

Figure 22 below presents a chart and graph (visual representation) that summarizes the data to question #3 from both the individual time periods as well as the study as a whole.

	Question 3				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	25.00%	12.50%	0.00%	37.50%	18.75%
Option 2	25.00%	37.50%	50.00%	25.00%	34.38%
Option 3	37.50%	50.00%	50.00%	25.00%	40.63%
Option 4	12.50%	0.00%	0.00%	12.50%	6.25%

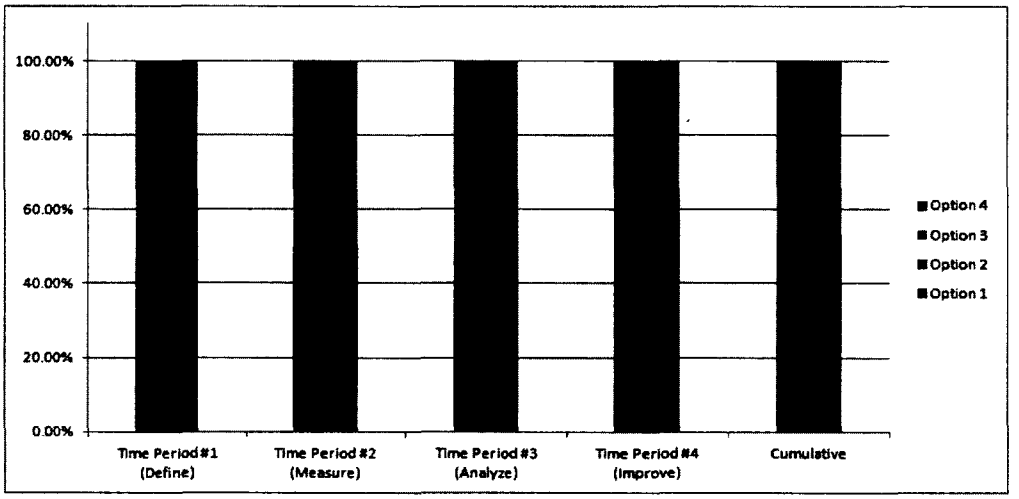

Figure 22: Project Completion - Qualitative Question #3 Results

These analyses led to the conclusion that the external coaches believed that a team can improve its project completion metric if they stay on task and focus on the objective of the phase (and project as a whole) and work collaboratively as a team and delegate the proper tasks to each team member. The external coaches believed that focusing on these two areas would help a team to not only improve its leadership but also improve its ability to complete project deliverables with good quality and on time. Note that in regards to option #4, the free text option found that focusing on the problem and not solutions was the main theme identified by external coaches. The comments included: "Do a better job at focusing on the problems and not solutions until the Improve phase" and "Identify a method to focus on only the problems until Improve."

Table 16 summarizes the findings from the analysis of the qualitative questions related to the project completion variable.

Table 16: Project Completion - Summary of Qualitative Questions

Factor	Question	Significant Findings
Project Completion	Q1: In what area has your level of support or guidance had the most significant impact on the team's ability to complete the project on time (up to this point)?	External coaches believed throughout the projects, their guidance and support helped teams to complete the projects on time by making the most significant impact in the areas of establishing a clear direction and maintaining the team's focus as well as establishing a collaborative team environment. The external coaches believed that the guidance and support they provided in these areas made the most impact on helping the teams to complete their projects on time.
Project Completion	Q2: In what area has your level of support or guidance had the most significant impact on the team's ability to complete the project deliverables (up to this point)?	External coaches believed throughout the projects, that their guidance and support helped teams to complete project deliverables by making the most significant impact in the areas of staying focused on the objective of the phase (and the project as a whole) as well as applying the concepts and tools to the teams' projects (processes). The external coaches believed that the guidance and support they provided in these areas made the most impact on helping the teams to complete their project deliverables.
Project Completion	Q3: What recommendations do you have for improvement or change for the team's ability to complete project requirements and deliverables (up to this point)?	External coaches believed that a team can improve its project completion metric if they stay on task and focus on the objective of the phase (and project as a whole) and work collaboratively as a team and delegate the proper tasks to each team member. The external coaches believed that focusing on these two areas would help a team to not only improve its leadership but also improve its ability to complete project deliverables with good quality and on time.

4.4.5 Customer Satisfaction (3 Qualitative Questions)

The qualitative segment for the customer satisfaction variable was assessed through the use of three qualitative questions from the external coach survey.

Recall that the first question was structured in the following manner:

1. In what area has your level of support or guidance had the most significant impact on the team's ability to satisfy the customer (up to this point)?

Response:

Option #1: Identification of customer requirements and identification of customer's expectations of the project.

Option #2: Obtaining the support and buy-in from the customer and stakeholders.

Option #3: Establishing a clear direction and focus that aligns with the expectations and requirements of the customers.

Option #4: Other, Please Specify: _____

Figure 23 below presents a chart and graph (visual representation) that summarizes the data to question #1 from both the individual time periods as well as the study as a whole.

	Question 1				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	50.00%	12.50%	12.50%	37.50%	28.13%
Option 2	0.00%	12.50%	75.00%	12.50%	25.00%
Option 3	50.00%	75.00%	0.00%	50.00%	43.75%
Option 4	0.00%	0.00%	12.50%	0.00%	3.13%

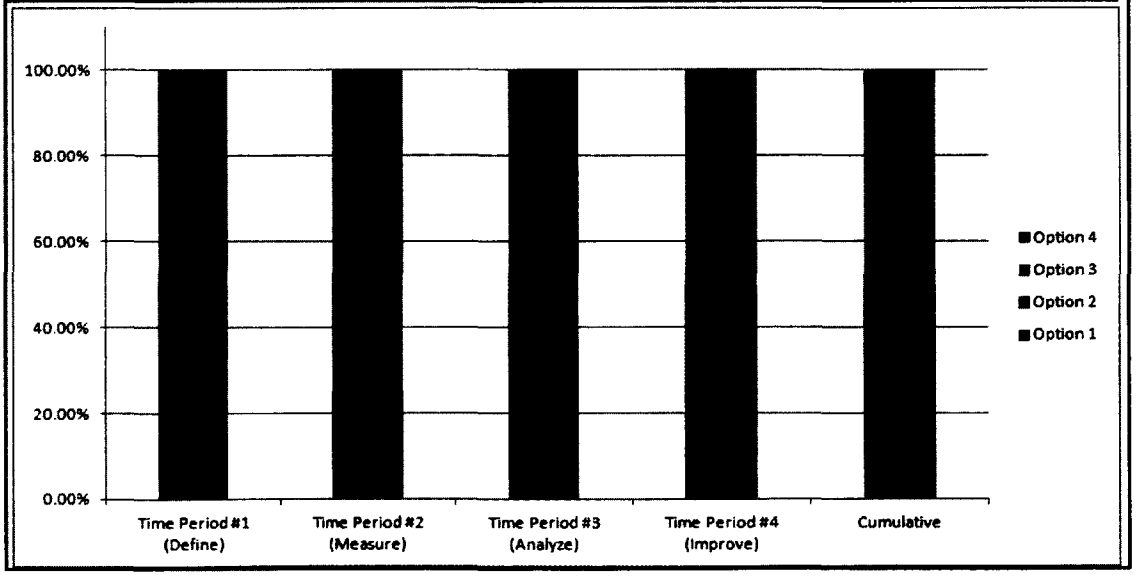

Figure 23: Customer Satisfaction - Qualitative Question #1 Results

The analyses provided the basis for concluding that the external coaches believed their guidance and support in three areas throughout the projects had the most significant impact on their team's ability to satisfy the requirements of their customer. The external coaches believed that their support in the areas of: identifying the customer requirements and expectations, obtaining support and buy-in from the customer and stakeholders, and establishing a clear direction that aligns with the requirements and expectations of the customer, all had significant impacts on enabling the teams to satisfy the requirements of their customers throughout the projects. Note that in regards to option #4, even though it was rarely selected by the external coaches; the free text option found that the active participation level of the Greenbelts was the main theme identified by external coaches. The comments included: "Getting all the Greenbelts actively involved."

Recall that the second question was structured in the following manner:

2. In what area has your level of support or guidance had the most significant impact on the team's level of quality for solutions and deliverables to the customer (up to this point)?

Response:

Option #1: Alignment of team's deliverables and solutions with the expectations and requirements of the customers.

Option #2: Obtaining the support and buy-in from the customer and stakeholders.

Option #3: Removing barriers or resolving conflict that the team is faced with

Option #4: Other, Please Specify: _____

Figure 24 below presents a chart and graph (visual representation) that summarizes the data to question #2 from both the individual time periods as well as the study as a whole.

	Question 2				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	62.50%	62.50%	75.00%	50.00%	62.50%
Option 2	25.00%	12.50%	25.00%	37.50%	25.00%
Option 3	12.50%	25.00%	0.00%	12.50%	12.50%
Option 4	0.00%	0.00%	0.00%	0.00%	0.00%

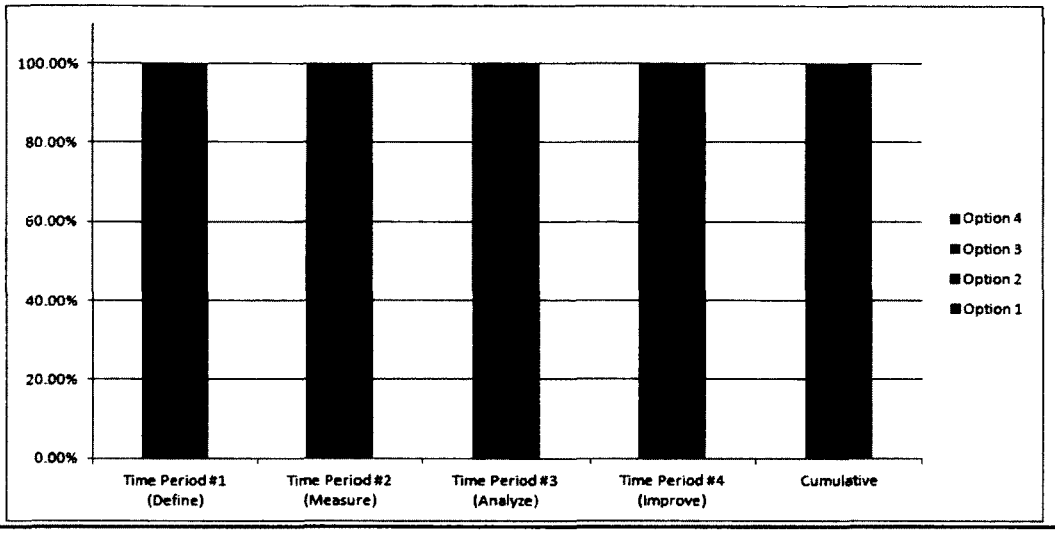

Figure 24: Customer Satisfaction - Qualitative Question #2 Results

These findings led to the conclusion that the external coaches believed that throughout the projects, their guidance and support provided the most impact (for their teams' level of quality for solutions and deliverables to the customer) by ensuring that the deliverables and solutions were aligned with the expectations and requirements of the customers. Providing the team with the guidance needed to obtain the buy-in and support from the stakeholders and customers was a distant second. Note that no external coaches selected option #4 (the free text or "write in" option) and therefore, there is no data or qualitative comments to discuss for this question.

Recall that the third question was structured in the following manner:

3. What recommendations do you have for improvement or change for the team's ability to meet the expectations of the customer and satisfy the customer's needs (up to this point)?

Response:

Option #1: Ability to stay on task and stay focused on the objective of the phase.

Option #2: Obtain and maintain the support and buy-in from the customer and stakeholders.

Option #3: Align the team's focus and direction (i.e. the tasks and steps the team takes) with the expectations and requirements of the customers.

Option #4: Other, Please Specify: _____

Figure 25 below presents a chart and graph (visual representation) that summarizes the data to question #3 from both the individual time periods as well as the study as a whole.

	Question 3				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	12.50%	25.00%	25.00%	12.50%	18.75%
Option 2	50.00%	37.50%	50.00%	62.50%	50.00%
Option 3	37.50%	37.50%	12.50%	12.50%	25.00%
Option 4	0.00%	0.00%	12.50%	12.50%	6.25%

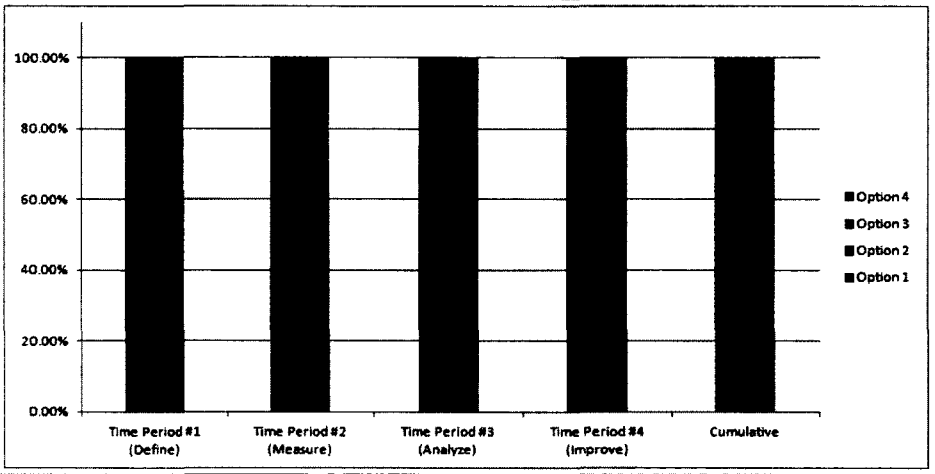

Figure 25: Customer Satisfaction - Qualitative Question #3 Results

These analyses led to the conclusion that the external coaches believed that their teams could improve their ability to meet the expectations of the customer and satisfy the customer's needs throughout the projects if they improved their ability to obtain and maintain the support and buy-in from their stakeholders and customers and aligned the team's focus and direction (i.e. the tasks and steps the team takes) with the expectations and requirements of the customers. The external coaches believed that if the teams could improve these two aspects of their performance, they could improve their leadership as well as their ability to meet the expectations of the customer and satisfy the customer's needs throughout the projects. Note that in regards to option #4, the free text option found that the "continuous need for actively participating Greenbelts" was the main theme

identified by external coaches. The comments included: "Find a tool to have all Greenbelts actively involved throughout the project."

Table 17 summarizes the findings from the analysis of the qualitative questions related to the customer satisfaction variable.

Table 17: Customer Satisfaction - Summary of Qualitative Questions

Factor	Question	Significant Findings
Customer Satisfaction	Q1: In what area has your level of support or guidance had the most significant impact on the team's ability to satisfy the customer (up to this point)?	External coaches believed their guidance and support in three areas throughout the projects had the most significant impact on their team's ability to satisfy the requirements of their customer. The external coaches believed that their support in the areas of: identifying the customer requirements and expectations, obtaining support and buy-in from the customer and stakeholders, and establishing a clear direction that aligns with the requirements and expectations of the customer, all had significant impacts on enabling the teams to satisfy the requirements of their customers throughout the projects.
Customer Satisfaction	Q2: In what area has your level of support or guidance had the most significant impact on the team's level of quality for solutions and deliverables to the customer (up to this point)?	External coaches believed that throughout the projects, their guidance and support provided the most impact (for their teams' level of quality for solutions and deliverables to the customer) by ensuring that the deliverables and solutions were aligned with the expectations and requirements of the customers. Providing the team with the guidance needed to obtain the buy-in and support from the stakeholders and customers was a distant second.
Customer Satisfaction	Q3: What recommendations do you have for improvement or change for the team's ability to meet the expectations of the customer and satisfy the customer's needs (up to this point)?	External coaches believed that their teams could improve their ability to meet the expectations of the customer and satisfy the customer's needs throughout the projects if they improved their ability to obtain and maintain the support and buy-in from their stakeholders and customers and aligned the team's focus and direction (i.e. the tasks and steps the team takes) with the expectations and requirements of the customers. The external coaches believed that if the teams could improve these two aspects of their performance, they could improve their leadership as well as their ability to meet the expectations of the customer and satisfy the customer's needs throughout the projects.

4.4.6 General Questions (2 Qualitative Questions)

The qualitative segment also asked two general qualitative questions of the external coach, which were located on the external coach survey.

Recall that the first question was structured in the following manner:

1. What do you think needs to change or improve with the team environment (internally)?

Response:

Option #1: The ability to set priorities and keep all members actively participating in the project.

Option #2: The ability to stay on task and adhere to schedules and deadlines.

Option #3: The ability to consistently communicate with the team and delegate project tasks and responsibilities to each team members.

Option #4: Other, Please Specify: _____

Figure 26 below presents a chart and graph (visual representation) that summarizes the data to question #1 from both the individual time periods as well as the study as a whole.

	Question 1				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	25.00%	37.50%	37.50%	62.50%	40.63%
Option 2	37.50%	25.00%	37.50%	12.50%	28.13%
Option 3	12.50%	37.50%	25.00%	12.50%	21.88%
Option 4	25.00%	0.00%	0.00%	12.50%	9.38%

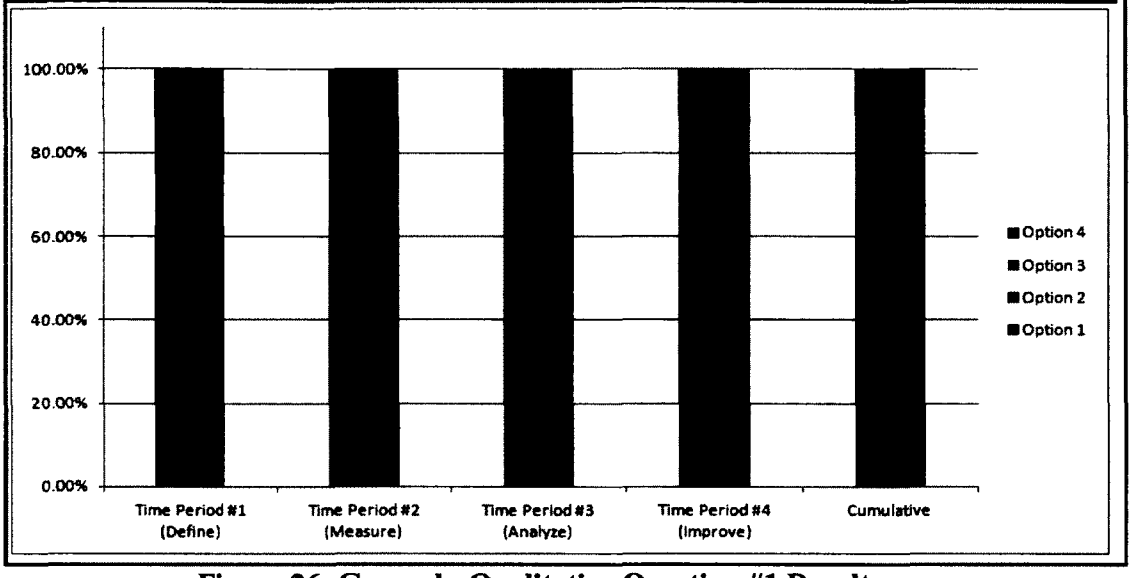

Figure 26: General - Qualitative Question #1 Results

The findings provided the basis for concluding that the external coaches were mixed in what areas they believed the teams need to improve in terms of the internal team environment factor. The analyses suggest that the external coaches believed that in order to improve a team's internal team environment, almost equal importance should be placed on these areas: (1) how to set priorities and keep all members actively involved in the project; (2) how to focus on a task and adhere to schedules and deadlines; and (3) how to consistently communicate with the team and delegate project tasks responsibilities to each member. While they placed equal importance on all of these items, the analysis suggests that these areas need to be improved and maintained throughout the execution of a project. Note that in regards to option #4, the free text option found that "focusing on the problem and not solutions" was the main theme identified by external coaches. The comments included: "Ability to stay focused on problem not solution until the proper time."

Recall that the second question was structured in the following manner:

2. What recommendations do you have for improvement or change for the team Environment (internally)?

Response:

Option #1: Need to set priorities as well as balance workloads and project responsibilities.

Option #2: Need to establish methods to stay on task as well as set schedules and deadlines and adhere to schedules and deadlines.

Option #3: Need to establish a clear communication plan for the team and outline how tasks and responsibilities will be delegated to the team members.

Option #4: Other, Please Specify: _____

Figure 27 below presents a chart and graph (visual representation) that summarizes the data to question #2 from both the individual time periods as well as the study as a whole.

	Question 2				
Option	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	Cumulative
Option 1	37.50%	25.00%	25.00%	25.00%	28.13%
Option 2	25.00%	62.50%	25.00%	37.50%	37.50%
Option 3	25.00%	12.50%	50.00%	25.00%	28.13%
Option 4	12.50%	0.00%	0.00%	12.50%	6.25%

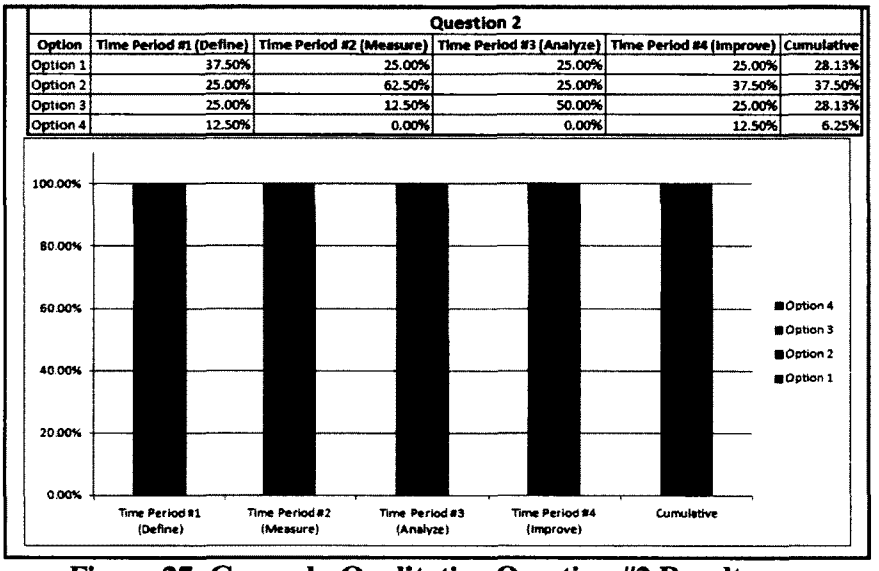

Figure 27: General - Qualitative Question #2 Results

The analyses led to the conclusion that the external coaches almost equally supported three improvement strategies that could help a team to improve its internal team environment, including: (1) setting priorities and balancing workloads and project responsibilities; (2) establishing methods to stay on task and how to set and adhere to schedules; and (3) how to establish a clear communication plan for the team and how to outline delegation of tasks and responsibilities for the team members. The external coaches believed that the use of these three improvement strategies helped a team to

improve its shared leadership as well as maximize its internal team environment. Note that in regards to option #4, the free text option found that "finding a method to focus on the problem until the Improve phase" was the main theme identified by external coaches. The comments included: "Blackbelts should identify a method to ensure that the teams do not jump to solutions too early" and "The team needs to remain focused on the problems until the Improve phase."

Table 18 summarizes the findings from the analysis of the qualitative questions related to the general questions.

Table 18: General Questions - Summary of Qualitative Questions

Factor	Question	Significant Findings
General Question	Q1: What do you think needs to change or improve with the team environment (internally)?	External coaches were mixed in what areas they believed the teams need to improve in terms of the internal team environment factor. The analyses suggest that the external coaches believed that in order to improve a team's internal team environment, almost equal importance should be placed on these areas: (1) how to set priorities and keep all members actively involved in the project; (2) how to focus on a task and adhere to schedules and deadlines; and (3) how to consistently communicate with the team and delegate project tasks responsibilities to each member. While they placed equal importance on all of these items, the analysis suggests that these areas need to be improved and maintained throughout the execution of a project.
General Question	Q2: What recommendations do you have for improvement or change for the team Environment (internally)?	External coaches almost equally supported three improvement strategies that could help a team to improve its internal team environment, including: (1) setting priorities and balancing workloads and project responsibilities; (2) establishing methods to stay on task and how to set and adhere to schedules; and (3) how to establish a clear communication plan for the team and how to outline delegation of tasks and responsibilities for the team members. The external coaches believed that the use of these three improvement strategies helped a team to improve its shared leadership as well as maximize its internal team environment.

The analysis above highlights the findings and conclusions identified from the qualitative analysis of the qualitative (mixed response) questions, which was performed at both the time period level as well as whole project level for each question and for each factor. These findings and conclusions were utilized to develop the subsequent discussion section. Even though the free text (option #4) was not utilized to a great extent by the respondents, table 19 below summarizes the main themes and patterns as well recorded comments from the free text option of the qualitative questions.

Table 19: Summary of Free-Text Comments and Themes from Qualitative Analysis

Factor	Question	Comments	Theme
Internal Team Environment	Q2: What is the most significant factor in your current team environment?	"Time commitment due to job responsibilities." "Consistent communication among team members."	Time commitment & Communication.
Internal Team Environment	Q4: In what area has your team's internal team environment had the most significant impact on the team's ability to complete this phase of the project (up to this point)?	"Participation by all members." "Level of contribution & participation from every team member."	Member participation.
External Coaching	Q2: What are the positive aspects of your External Coach?	"Let the team do most of the work and just provide guidance and support." "The external coach gives sufficient guidance and support to be self sustaining."	Level of autonomy given from the external coach.
Shared Leadership	Q2: What do you think needs to change or improve with the leadership of?	"Members need to take on more responsibility." "Team members should learn to prioritize their project work with their regular job responsibilities."	Degree of responsibility & Prioritization of job/project responsibilities.
Shared Leadership	Q3: What recommendations do you have for improvement or change for?	"Be willing and open to taking on more responsibility." "Learn to manage your time properly in order balance your project and job responsibilities."	Degree of responsibility & Prioritization of job/project responsibilities.
Project Completion	Q1: In what area has your level of support or guidance had the most significant impact on the team's ability to complete the project on time (up to this point)?	"Reinforce that they shouldn't come with solutions." "Spent a lot time ensuring that the teams did not jump to solutions but focused on the problem at hand."	Maintaining the focus on the problem and not solutions.
Project Completion	Q3: What recommendations do you have for improvement or change for the team's ability to complete project requirements and deliverables (up to this point)?	"Do a better job at focusing on the problems and not solutions until the Improve phase." "Identify a method to focus on only the problems until Improve."	Focusing on the problem and not solutions.
Customer Satisfaction	Q1: In what area has your level of support or guidance had the most significant impact on the team's ability to satisfy the customer (up to this point)?	"Getting all the Greenbelts actively involved."	Active participation level of the Greenbelts.
Customer Satisfaction	Q3: What recommendations do you have for improvement or change for the team's ability to meet the expectations of the customer and satisfy the customer's needs (up to this point)?	"Find a tool to have all Greenbelts actively involved throughout the project."	Continuous need for actively participating Greenbelts.
General Question	Q1: What do you think needs to change or improve with the team environment (internally)?	"Ability to stay focused on problem not solution until the proper time."	Focusing on the problem and not solutions.
General Question	Q2: What recommendations do you have for improvement or change for the team Environment (internally)?	"Blackbelts should identify a method to ensure that the teams do not jump to solutions too early." "The team needs to remain focused on the problems until the Improve phase."	Finding a method to focus on the problem until the Improve phase.

4.5 Qualitative Analysis (Leadership Networks) – Main Study

Recall that the purpose of the analysis of the leadership networks was to enable me to study the leadership interactions that each member had with each of their team members and the changes of these interactions from time period to time period. The ability to see how interactions change within a team as the team progresses from time period to time period is a unique feature of social network theory (i.e. leadership networks); this is not a feature that is readily available with other leadership analysis methods. An additional purpose of analyzing the leadership networks is that it also enabled me to understand how the concerns, issues, trends, patterns, and justifications identified from the analysis of the qualitative data impacted (and helped to explain) the conclusions drawn from the quantitative analysis of the five hypotheses.

The qualitative analysis of the leadership networks developed for each team at each time period was executed using the methodology outlined in the research design. Note that use of social network theory enabled me to study the leadership interactions that each member had with each of their team members and the use of social network theory enabled me to study the changes of these interactions from time period to time period. The ability to see how interactions change within a team as the team progresses from time period to time period is a unique feature of social network theory; this is not a feature that is readily available with other leadership analysis methods. An additional unique feature of social network theory is that enabled me to measure and study leadership development in a team environment but from two angles, those being at the individual and team levels. The centralization metric, part of social network theory, is composed of individual centrality values (for each value) as well as a team-level metric; this unique feature enabled me to measure the individual leadership value for each team member as well as the team-level metric. From this point, by utilizing the individual and team leadership values, I was able to study how leadership changed at the individual and team level as the team(s) progressed through the DMAIC process. This provided me with a robust view into how leadership truly changed in a Six Sigma environment at both the individual and team level perspectives. This robust and dual approach to studying leadership develop is not a feature that is readily available with other leadership analysis methods.

Also note that in shared leadership environments, the lower the variance, the greater the degree of shared leadership in the team. Recall that the values calculated from the formula discussed in the theories/model section of the dissertation were dependent on the number of team members that made up the team. Since all of the teams selected for the research study had four team members, the values for this variable were limited to [0.000, 0.167, 0.333, 0.500, 0.667, 0.833, and 1.000]. From this preset list of values, in order to accurately analyze the leadership networks for each team, a qualitative scale was defined for the shared leadership variable. Based on previous research efforts, the following qualitative scale was defined: a low value of shared leadership implied a value equal to [1.000, and 0.8333]; a moderate value of shared leadership signified a value equal to [0.667, 0.500, and 0.333]; and a high value of shared leadership implied a value equal to [0.167, and 0.000]. This scale was utilized to analyze the leadership networks developed for each of the subject teams.

The analysis presented in this section is organized by each of the eight teams that took part in the research project. For each team, an analysis was performed on each of the four associated leadership networks (one per time period) as well as on the changes that occurred between the four leadership networks from the start of the project (i.e. the define phase) to the conclusion of the project (i.e. the improve phase). This analysis structure was executed for each team and is presented below. As discussed in the research design section of this dissertation recall that in a network, arrows represent leadership relations and an arrow pointing from one member (A) to another (B) means that member B is perceived as a source of leadership by member A. Two-headed arrows means that two individuals perceive one another as a source of leadership.

4.5.1 Team #1 (Four Leadership Networks)

From the interpretation of Figure 28, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #3. They displayed the same degree of leadership, meaning that the team members perceived a high degree of leadership coming from members #1 and #3.

- Member #4 was perceived to display the lowest degree of leadership in the team environment. From an interaction standpoint, team member #1 did not perceive that team member #4 displayed a high degree of leadership.
- From an interaction standpoint, team member #3 did not perceive that team members #2 or #4 displayed a high degree of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #4 was the only team member that was perceived to display a low level of leadership at this time period.

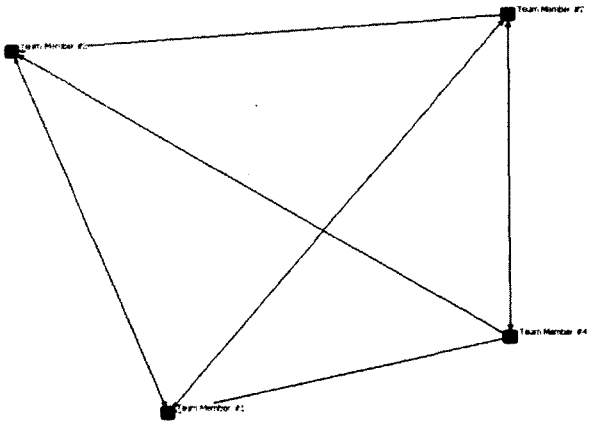

Figure 28: Team #1, Time Period #1 (Define Phase)

From the interpretation of Figure 29, at time period #2 (the Measure phase), the following findings were identified:

- The degree of shared leadership continued to be centralized around team members #1 and #3. They each displayed the same degree of leadership.
- It was found that team members #2 and #4 were believed to display the same level of leadership but at a lower level than members #1 and #3.
- From an interaction standpoint, team member #3 did not perceive team members #2 or #4 to display a high degree of leadership.
- All other interactions among members were perceived to have a high degree of leadership.

• Overall, from this network, it was determined that team member #4 was the only team member that was perceived to display a low level of leadership at this time period, even though team member #4 had the same degree of centralization as team member #2.

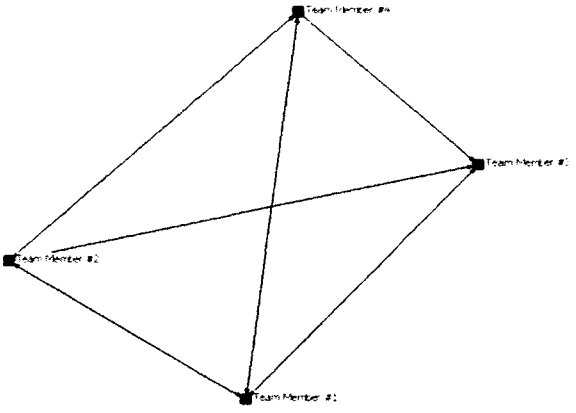

Figure 29: Team #1, Time Period #2 (Measure Phase)

From the interpretation of Figure 30, at time period #3 (the Analyze phase), the following findings were identified:

• The degree of shared leadership was again centralized around team members #1 and #3.

• On the other side of the continuum, at this time period, member #4 was perceived to display the lowest degree of leadership in the team environment.

• From an interaction standpoint, team member #1 did not perceive that team member #4 displayed a high degree of leadership. In addition, from the interaction level, team member #3 did not perceive that team members #2 or #4 displayed a high degree of leadership.

• All other interactions among members were perceived to have a high degree of leadership.

• Overall, from this network, it was determined that team member #4 was the only team member that was perceived to display a low level of leadership at this time period.

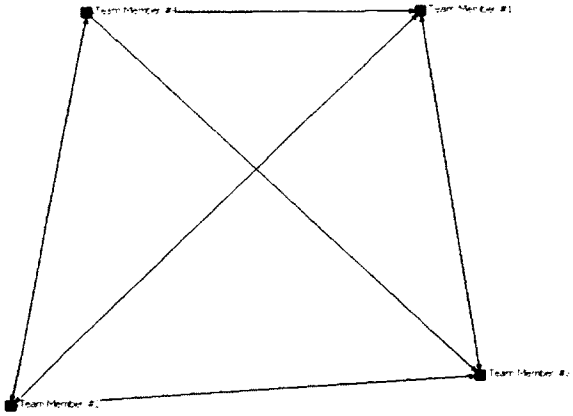

Figure 30: Team #1, Time Period #3 (Analyze Phase)

From the interpretation of Figure 31, in the final time period (the Improve phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1, #2, and #3.
- Team member #4 was once again perceived to display the lowest degree of leadership in the team environment.
- From an interaction standpoint, team member #3 did not perceive that team member #4 displayed a high degree of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #4 was the only team member that was perceived to display a low level of leadership at this time period.

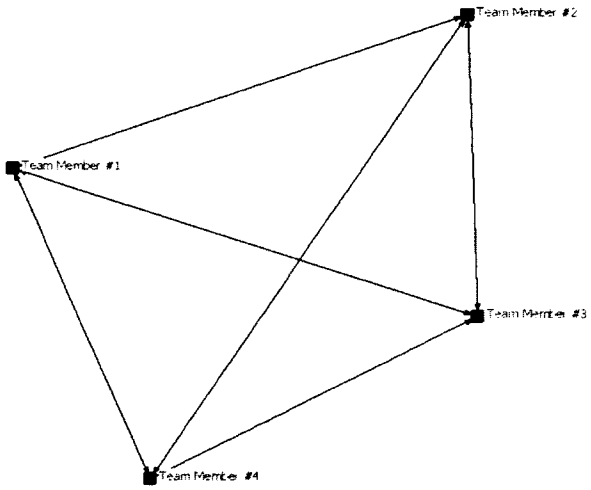

Figure 31: Team #1, Time Period #4 (Improve Phase)

Comparing the four networks, the following findings were identified:

- Members #1 and #3 were consistently believed to display the highest degree of leadership throughout the project. At each time period, they both achieved and maintained the highest degree of leadership.
- At time periods #1, #2, and #3, team member #2 provided leadership levels that were in-between the highest and lowest degrees displayed throughout the team's environment, but by the end of the project (the final time period), team member #2 achieved the highest degree of leadership, along with team members #1 and #3.
- At time periods #1 and #3, team member #4 displayed little to no leadership, but at time periods #2 and #4, member #4 displayed levels of leadership that were in-between the highest and lowest degrees displayed throughout the team's environment. This meant that from the start of the project to the end of the project, member #4 switched back and forth between displaying little to no leadership levels to displaying middling values of leadership.
- By the end of the project, leadership was decentralized between team members #1, #2, and #3, but member #4 consistently was perceived to display a low degree of shared leadership.
- By the end of the project, the leadership role was most evenly shared between members #1, #2, and #3.

- Team member #4 was consistently perceived to display the lowest degree of leadership throughout the project.

General notes regarding team #1:

- Team member #1 was the team's Blackbelt.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was a Greenbelt on the team.

4.5.2 Team #2 (Four Leadership Networks)

From the interpretation of Figure 32, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #2.
- Member #3 was perceived to display the lowest degree of leadership in the team environment.
- From an interaction standpoint, team member #2 did not perceive that team members #3 or #4 displayed a high degree of leadership. Team member #4 did not perceive that team member #3 displayed a high degree of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #3 was the only team member that was perceived to display a low level of leadership at this time period.

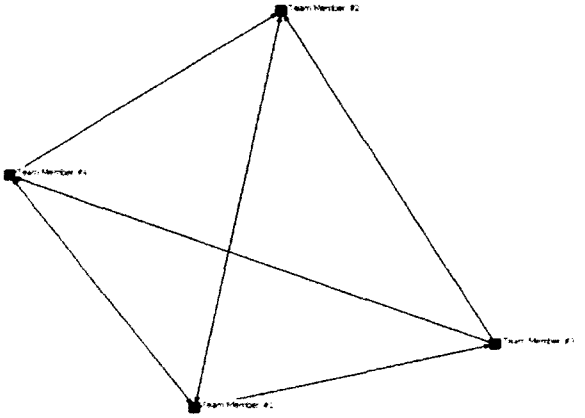

Figure 32: Team #2, Time Period #1 (Define Phase)

From the interpretation of Figure 33, at time period #2 (the Measure phase), the following findings were identified:

- The degree of shared leadership was again centralized around team members #1 and #2 who both displayed the same degree of leadership.
- Members #3 and #4 were perceived to display the lowest degree of leadership in the team environment, even though both were only slightly lower than the degree displayed by members #1 and #2.
- From an interaction standpoint, team member #2 did not perceive that team member #3 displayed a high degree of leadership and team member #3 did not believe that team member #4 displayed a high degree of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team members #3 and #4 were perceived to display low levels of leadership at this time period, even though their levels were only slightly lower than the degree displayed by members #1 and #2.

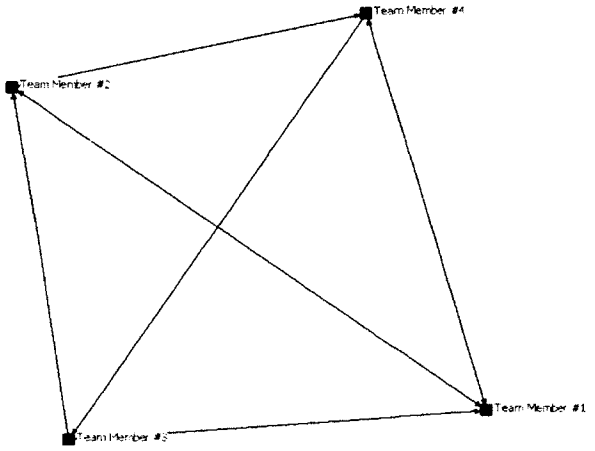

Figure 33: Team #2, Time Period #2 (Measure Phase)

From the interpretation of Figure 34, at time period #3 (the Analyze phase), the following findings were identified:

- The degree of shared leadership was centralized mostly around team member #1, while team member #3 was perceived to display the lowest degree of leadership.

- Team members #2 and #4 were found to display the same, middling level of leadership at this period.
- From an interaction standpoint, team member #2 did not believe that members #3 or #4 displayed a high degree of leadership at this time period. Team member #4 did not perceive that members #2 or #3 displayed a high degree of leadership at this phase in the project.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #3 was perceived to display low levels of leadership at this time period.

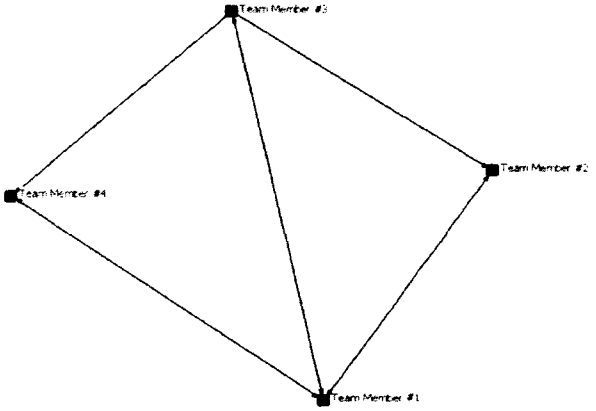

Figure 34: Team #2, Time Period #3 (Analyze Phase)

From the interpretation of Figure 35, at the final period (the Improve phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1, #2, and #4.
- On the other side of the spectrum, team member #3 was perceived to display the lowest degree of leadership, even though this value is only slightly lower than the highest degree of leadership displayed from members #1, #2, and #4.
- From the interaction level, team member #2 did not perceive that member #3 displayed a high degree of leadership at this time period.

- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #3 was perceived to display low levels of leadership at this time period.

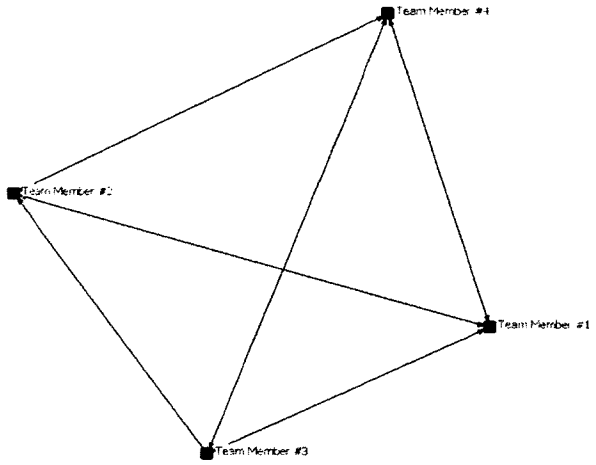

Figure 35: Team #2, Time Period #4 (Improve Phase)

When comparing the four networks as a whole throughout the project, the following findings were identified:

- Member #1 was consistently believed to display the highest degree of leadership throughout the project. At each time period, this member achieved and maintained the highest degree of leadership.
- At time periods #1, #2, and #4, team member #2 displayed the highest degree of leadership, but at time period #3, member #2 displayed leadership levels that were in-between the highest and lowest degrees displayed throughout the team's environment. Team member #2 maintained the highest level of leadership for many of the time periods, but in one time period, member #2 decreased to a middle value of leadership, but was able to rebound to the highest level of leadership by the end of the project.
- At time periods #1 and #3, team member #3 displayed little to no leadership, but at time periods #2 and #4, member #3 displayed levels of leadership that were in-between the highest and lowest degrees displayed throughout the team's

environment. This meant that from the start of the project to the end of the project, member #3 switched back and forth between displaying little to no leadership levels to displaying middling values of leadership.

- At time periods #1, #2, and #3, team member #4 provided leadership levels that were in-between the highest and lowest degrees displayed throughout the team's environment, but by the end of the project (the final time period), team member #4 achieved the highest degree of leadership.
- By the end of the project, leadership was shared between team members #1, #2, and #4, but member #3 consistently was perceived to display a low degree of shared leadership, even though by the end of the project, team member #3 had a value that was only slightly lower than the degree displayed by members #1, #2, and #4.

General notes regarding team #2:

- Team member #1 was the team's Blackbelt.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was a Greenbelt on the team.

4.5.3 Team #3 (Four Leadership Networks)

From the interpretation of Figure 36, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1, #3, and #4.
- Team member #2 was found to display the lowest degree of leadership at this time period.
- From an interaction standpoint, team members #3 and #4 did not perceive that member #2 displayed a high degree of leadership at this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

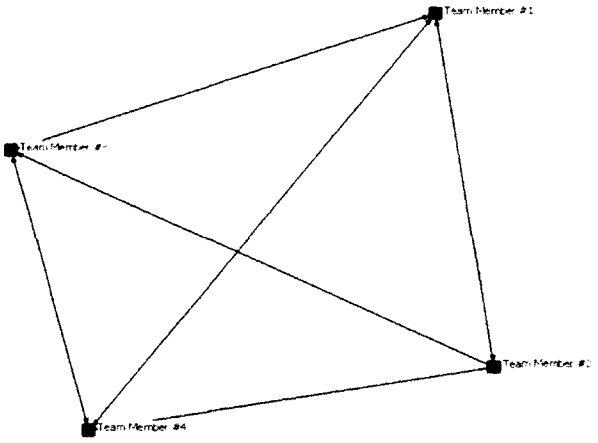

Figure 36: Team #3, Time Period #1 (Define Phase)

From the interpretation of Figure 37, at time period #2 (the Measure phase), the following findings were identified:

- The degree of shared leadership was again centralized around team members #1, #3, and #4.
- Team member #2 was found to display the lowest degree of leadership at this time period.
- With respect to interaction, team member #3 did not believe that team member #2 displayed a high degree of leadership at this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

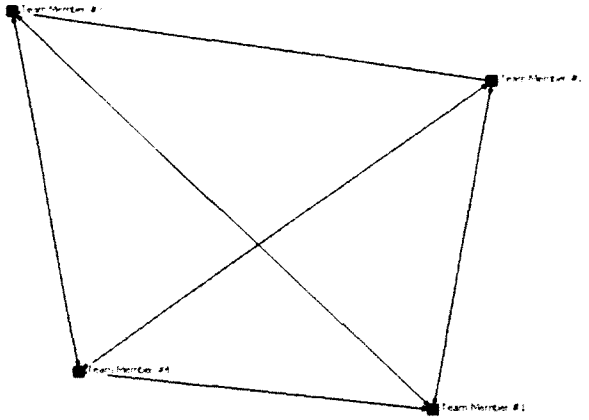

Figure 37: Team #3, Time Period #2 (Measure Phase)

From the interpretation of Figure 38, at time period #3 (the Analyze phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1, #3, and #4.
- Team member #2 was found to display the lowest degree of leadership at this time period.
- From an interaction standpoint, team members #1, #3, and #4 did not believe that team member #2 displayed a high degree of leadership at this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

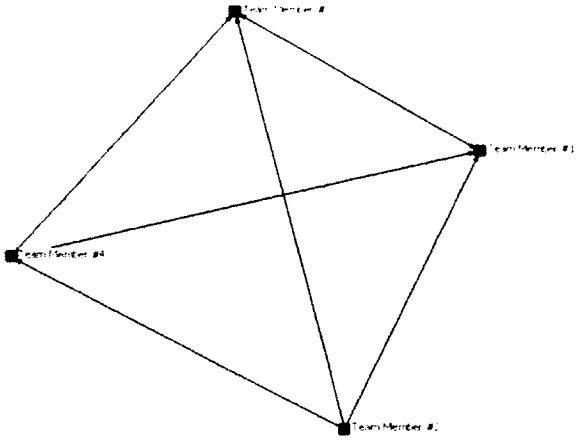

Figure 38: Team #3, Time Period #3 (Analyze Phase)

From the interpretation of Figure 39, at the final period (the Improve phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #3 (they displayed the same degree of leadership).
- Team member #2 was found to display the lowest degree of leadership at this time period.
- Team member #3 did not believe that members #2 or #4 displayed a high degree of leadership in this period.
- Team member #4 did not perceive that member #2 displayed a high level of leadership in this period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

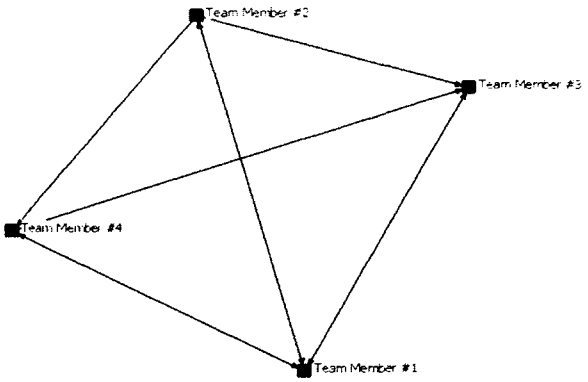

Figure 39: Team #3, Time Period #4 (Improve Phase)

When comparing the four networks as a whole throughout the project, the following findings were identified:

- Throughout the time periods, leadership was consistently centralized around members #1 and #3. At each time period, these members achieved and maintained the highest degree of leadership.
- At time periods #1, #3, and #4, team member #2 displayed little to no leadership, but at time period #2, member #2 was able to achieve a level of leadership that was in-between the highest and lowest degrees displayed throughout the team's environment. For three of the four time periods, member #2 displayed little to no leadership and they could only achieve a moderate value of leadership in one time period.
- At time periods #1, #2, and #3, team member #4 was able to achieve and maintain the highest degree of leadership in the environment, but in the final time period, member #4 decreased in terms of their degree of leadership. For the first three time periods, member #4 was able to achieve and maintain the highest degree of leadership, but in the final period, member #4 was only able to achieve a moderate value of leadership.
- Throughout the project, member #2 was consistently perceived to display the lowest levels of leadership at each time period in the project.
- Throughout the project, leadership was centralized between team members #1 and #3, but member #2 consistently was perceived to display a low degree of shared leadership.

- Team member #4 consistently provided a level of leadership that was either a value that was in the middle of the spectrum or at the highest end of the spectrum (i.e. displayed same level as team member #1 and #3).

General notes regarding team #3:

- Team member #1 was the team's Blackbelt.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was a Greenbelt on the team.

4.5.4 Team #4 (Four Leadership Networks)

From the interpretation of Figure 40, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #3 and #4.
- Team member #1 was found to display the lowest degree of leadership at this time period.
- From an interaction standpoint, team member #2 did not perceive that member #1 displayed a high level of leadership. Team member #3 shared this assessment.
- Team member #4 did not perceive that member #2 displayed a high level of leadership at this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #1 was perceived to display low levels of leadership at this time period.

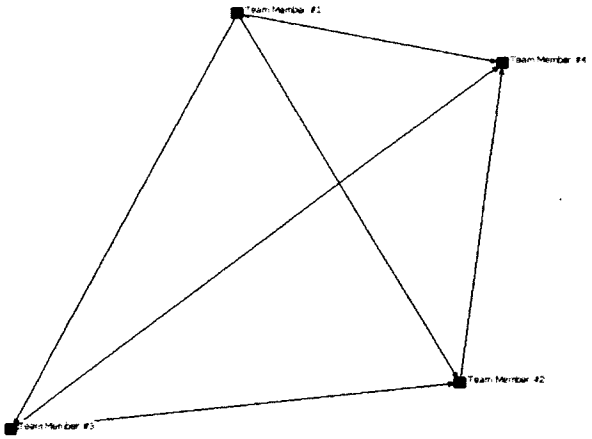

Figure 40: Team #4, Time Period #1 (Define Phase)

From the interpretation of Figure 41, at time period #2 (the Measure phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #3 and #4.
- Team member #1 was found to display the lowest degree of leadership at this time period.
- Team member #2 did not perceive that member #1 displayed a high level of leadership.
- Team member #3 did not perceive that members #1 or #2 displayed a high level of leadership at this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #1 was perceived to display low levels of leadership at this time period.

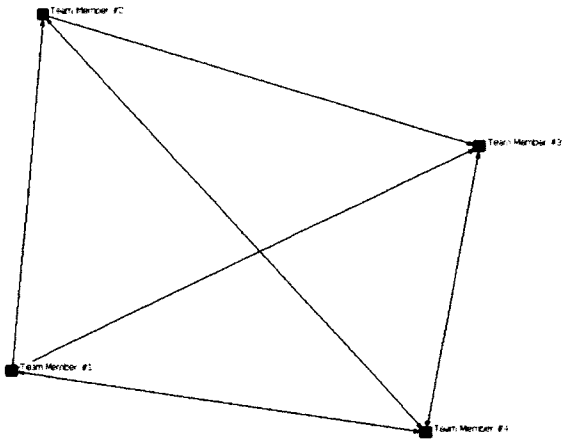

Figure 41: Team #4, Time Period #2 (Measure Phase)

From the interpretation of Figure 42, at time period #3 (the Analyze phase), the following findings were identified:

- The degree of shared leadership was centralized around team member #3.
- Team members #1, #2, and #4 were found to display the lowest degree of leadership at this time period.
- From the interaction perspective, team member #3 did not perceive that members #1, #2, nor #4 displayed any high level of leadership during this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team members #1, #2, and #4 were perceived to display low levels of leadership at this time period.

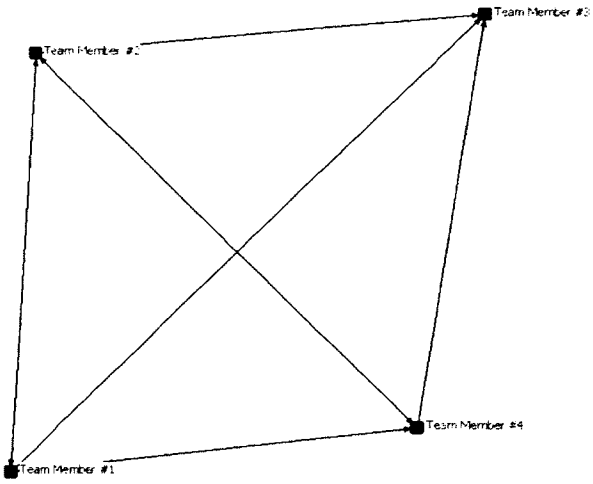

Figure 42: Team #4, Time Period #3 (Analyze Phase)

From the interpretation of Figure 43, at the final time period (the Improve phase), the following findings were identified:

- The leadership was equally distributed and shared among the four team members; all members were perceived to display the same high level of leadership at this time period.
- No member was perceived to have a low level of leadership at this time period.
- From the interaction level, all other interactions among members were perceived to have a high degree of leadership.
- No member perceived any other member of having displayed a low level of leadership at this time period.

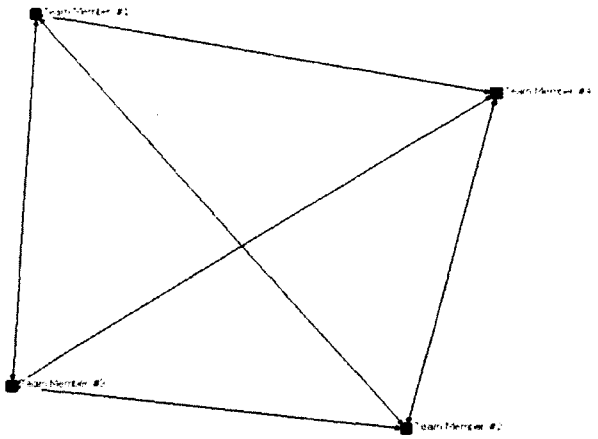

Figure 43: Team #4, Time Period #4 (Improve Phase)

When comparing the four networks as a whole throughout the project, the following findings were identified:

- Throughout the project, the leadership role was consistently centralized around team member #3. Member #3 achieved and maintained the highest degree of leadership at each phase of the project.
- For the first two phases of the project, team member #1 was consistently perceived to display the lowest levels of leadership; but in the third and final phase of the project, team member #1 was found to display high levels of leadership.
- Throughout the first three phases of the project, team member #2 was found to display a consistent level of leadership that was a value that was in the middle of the spectrum; by the final phase of the project, team member #2 achieved the highest degree of leadership in the environment.
- Throughout the first two phases of the project, team member #4 was perceived to display the highest level of leadership in the environment. In time period #3, member #4 was found to display a level of leadership that was a value that was in the middle of the spectrum, but in the final phase of the project, team member #4 was able to return to the highest degree of leadership in the environment.
- The project began with centralizing leadership around specific team members, but by the final phase of the project, the degree of leadership was equally distributed and shared among the four team members; all members were perceived to display the same high level of leadership at this time period.

General notes regarding team #4:

- Team member #1 was a Greenbelt on the team.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was the team's Blackbelt.

4.5.5 Team #5 (Four Leadership Networks)

From the interpretation of Figure 44, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team member #1.
- Members #2, #3, and #4 were found to display the lowest degree of leadership at this time period.
- From an interaction standpoint, team member #2 did not perceive that members #3 or #4 displayed a high level of leadership during this time period.
- Team member #4 did not perceive that member #2 displayed a high level of leadership during this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team members #2, #3, and #4 were perceived to display low levels of leadership at this time period.

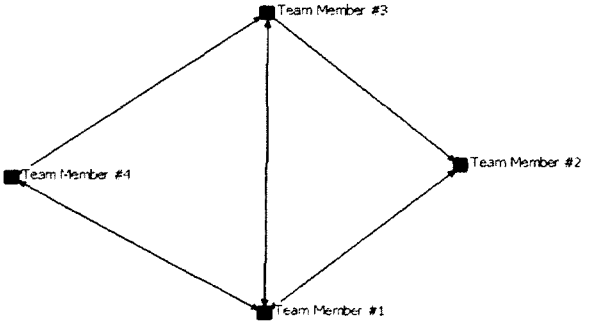

Figure 44: Team #5, Time Period #1 (Define Phase)

From the interpretation of Figure 45, at time period #2 (the Measure phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #3 and #4 (they displayed the same degree of leadership).
- Team member #2 was found to display the lowest degree of leadership at this time period.
- With respect to interaction, team member #1 did not perceive that member #2 displayed a high level of leadership.
- Team member #4 did not perceive that members #1 or #2 displayed a high level of leadership at this time period.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

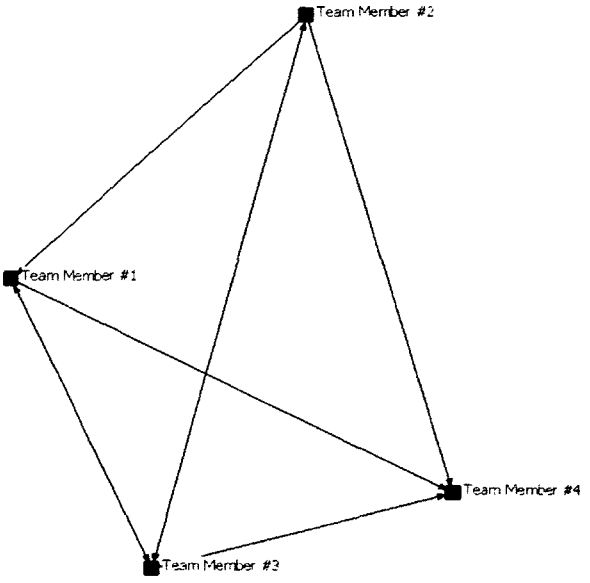

Figure 45: Team #5, Time Period #2 (Measure Phase)

From the interpretation of Figure 46, at time period #3 (the Analyze phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #3.
- Once again, team member #2 was found to display the lowest degree of leadership at this time period.

- Team member #1 did not perceive that member #2 displayed a high level of leadership.
- Team member #2 did not perceive that member #4 displayed a high level of leadership.
- Team member #3 did not perceive that member #2 displayed a high level of leadership.
- Team member #4 did not perceive that member #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

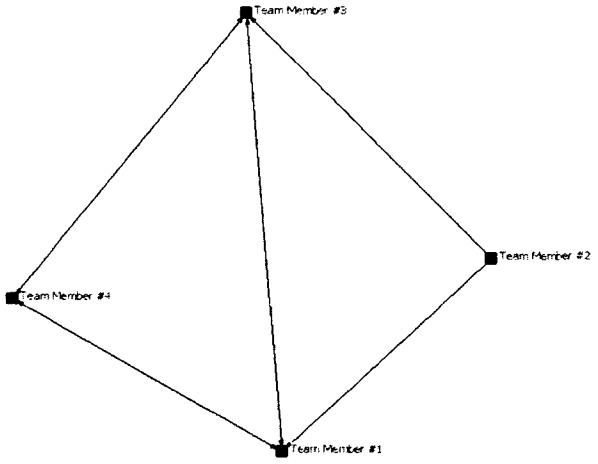

Figure 46: Team #5, Time Period #3 (Analyze Phase)

From the interpretation of Figure 47, at time period #4 (the Improve phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1, #3, and #4; they displayed the same degree of leadership
- Team member #2 was again found to display the lowest degree of leadership at this time period.

- Team member #1 did not perceive that member #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

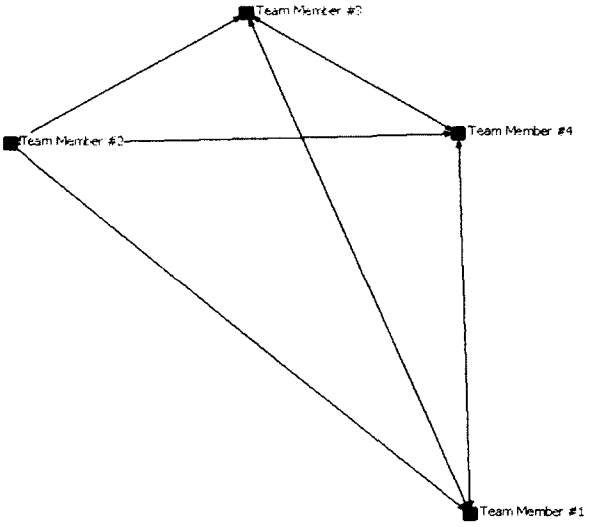

Figure 47: Team #5, Time Period #4 (Improve Phase)

When comparing the four networks as a whole throughout the project, the following findings were identified:

- The leadership role was not consistently centralized around any team member.
- Team member #2 was consistently perceived to display low levels of leadership throughout the project periods.
- Team member #1 was perceived to display the highest level of leadership at time periods #1, #3, and #4. But at time period #2, member #1 was found to display a level of leadership that was a value that was in the middle of the spectrum.
- At time periods #1 and #4, team member #2 was perceived to display a middling level of leadership, but was found to display little to no leadership at time periods #2 and #3.

- At time period #1, team member #3 was perceived to display a level of leadership that was a value that was in the middle of the spectrum, but achieved the highest level of leadership for time periods #2, #3, and #4. Once member #3 moved into the second time period, he/she remained consistent at providing a highest level of leadership.
- At time periods #1 and #3, member #4 was perceived to display a middling level of, but achieved the highest level of leadership for time periods #2 and #4. Member #4 started at a middle value of leadership in time period #1, then in time period #2, member #4 had the highest level of leadership; but in the third time period, member #4 decreased to a middle value of leadership and in the final phase of the project, member #4 moved back into the highest level of leadership.
- By the end of the project, the leadership role was shared between team members #1, #3, and #4; all of these members achieved and maintained the highest degree of leadership.

General notes regarding team #5:

- Team member #1 was the team's Blackbelt.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was a Greenbelt on the team.

4.5.6 Team #6 (Four Leadership Networks)

From the interpretation of Figure 48, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #4.
- Team member #2 was found to display the lowest degree of leadership at this time period.
- Team member #1 did not perceive that members #2 or #3 displayed a high level of leadership.
- Team member #3 did not perceive that member #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.

• Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

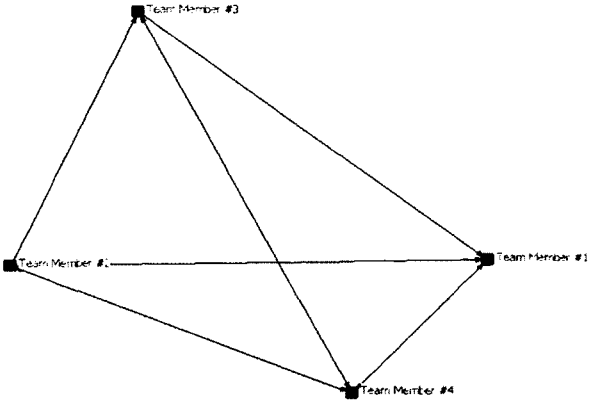

Figure 48: Team #6, Time Period #1 (Define Phase)

From the interpretation of Figure 49, at time period #2 (the Measure phase), the following findings were identified:

• The degree of shared leadership was centralized around team member #4.

• Team member #2 was found to display the lowest degree of leadership at this time period.

• Team member #3 did not perceive that members #1 or #2 displayed a high level of leadership.

• Team member #4 did not perceive that members #2 or #3 displayed a high level of leadership.

• All other interactions among members were perceived to have a high degree of leadership.

• Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

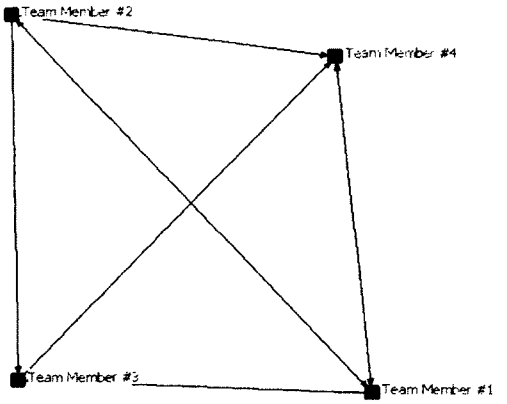

Figure 49: Team #6, Time Period #2 (Measure Phase)

From the interpretation of Figure 50, at time period #3 (the Analyze phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #3.
- Team member #4 was found to display the lowest degree of leadership at this time period.
- From an interaction standpoint, team member #1 did not perceive that member #4 displayed a high level of leadership.
- Team member #3 did not perceive that members #2 or #4 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #4 was perceived to display low levels of leadership at this time period.

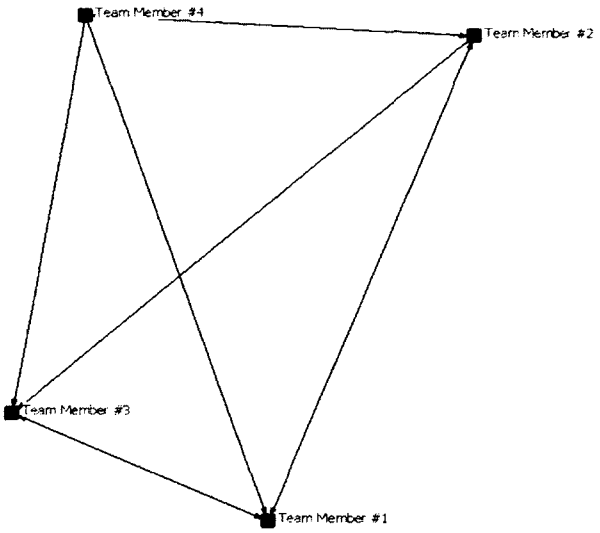

Figure 50: Team #6, Time Period #3 (Analyze Phase)

From the interpretation of Figure 51, at time period #4 (the Improve phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #3.
- Team member #4 was found to display the lowest degree of leadership at this time period.
- From an interaction level, team member #1 did not perceive that member #4 displayed a high level of leadership.
- Team member #2 did not perceive that member #4 displayed a high level of leadership.
- Team member #3 did not perceive that member #2 displayed a high level of leadership. In addition, team member #2 did not perceive that member #4 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #4 was perceived to display low levels of leadership at this time period.

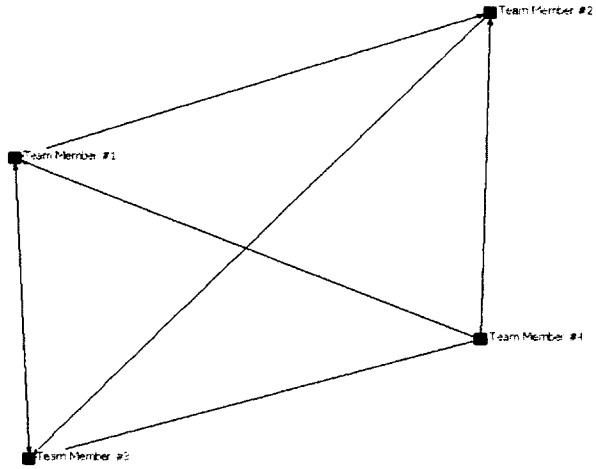

Figure 51: Team #6, Time Period #4 (Improve Phase)

When comparing the four networks as a whole throughout the project, the following findings were identified:

- The leadership role was not consistently centralized around any one team member.
- Team members #1 and #4 were consistently perceived to display low levels of leadership throughout the project.
- At time periods #1, #3, and #4, team member #1 displayed the highest degree of leadership. But at time period #2, member #1 was perceived to display a middling level of leadership. This member had a dip from time period #1 to #2, but improved his/her leadership level when he/she moved into time period #3.
- At time periods #1 and #2, team member #2 was perceived to display little to no leadership, but in time periods #3 and #4, member #2 achieved a middling level of leadership. Team member #2 began the project with providing little to no leadership (at time periods #1 and #2), but by the last two phases of the project, member #2 was able to achieve a level of leadership that was a value that was in the middle of the spectrum.
- At time periods #1 and #2, team member #3 was perceived to display a middling level of leadership. In time periods #3 and #4, member #3 achieved the highest degree of leadership. Team member #3 began the project with providing a middling value of leadership, but in the last two phases of the project, member #3 was able to achieve the highest degree of leadership.

- At time periods #1 and #2, member #4 achieved the highest degree of leadership, but at time periods #3 and #4, member #4 was perceived to display little to no leadership. This team member started with a high level of leadership in both time periods #1 and #2, but as they moved into the third and fourth time periods, their level of leadership decreased significantly to a low to zero value.
- By the end of the project, the leadership role was centralized around team members #1 and #3, while member #4 displayed a level of leadership with a zero value.

General notes regarding team #6:

- Team member #1 was the team's Blackbelt.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was a Greenbelt on the team.

4.5.7 Team #7 (Four Leadership Networks)

From the interpretation of Figure 52, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1, #2, and #4 (they displayed the same degree of leadership); this signified that the team members perceived a high degree of leadership from members #1, #2, and #4. Note that they all shared a leadership value that was in the middle of the spectrum.
- On the other side of the continuum, team member #3 was found to display the lowest degree of leadership at this time period.
- From the interaction level, team member #1 did not perceive that member #3 displayed a high level of leadership.
- Team member #2 did not perceive that members #3 or #4 displayed a high level of leadership.
- Team member #4 did not perceive that members #1 or #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.

• Overall, from this network, it was determined that team member #3 was perceived to display low levels of leadership at this time period.

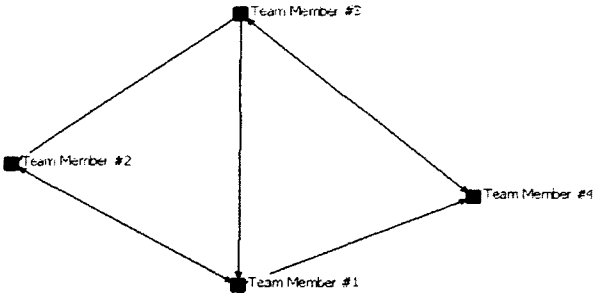

Figure 52: Team #7, Time Period #1 (Define Phase)

From the interpretation of Figure 53, at time period #2 (the Measure phase), the following findings were identified:

• The degree of shared leadership was centralized around team member #4.

• Team member #3 was found to display the lowest degree of leadership at this time period.

• From an interaction standpoint, team member #1 did not perceive that members #2 or #3 displayed a high level of leadership.

• Team member #2 did not perceive that member #3 displayed a high level of leadership.

• Team member #4 did not perceive that member #1 displayed a high level of leadership.

• All other interactions among members were perceived to have a high degree of leadership.

• Overall, from this network, it was determined that team member #3 was perceived to display low levels of leadership at this time period.

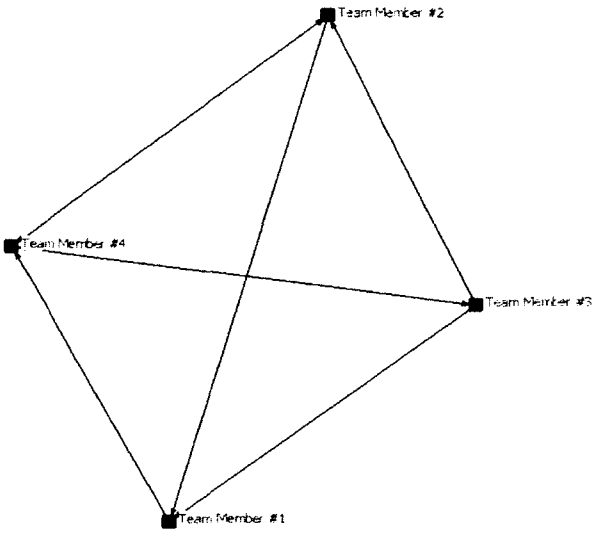

Figure 53: Team #7, Time Period #2 (Measure Phase)

From the interpretation of Figure 54, at time period #3 (the Analyze phase), the following findings were identified:

- The degree of shared leadership was centralized around team member #4.
- On the other side of the continuum, team member #3 was found to display the lowest degree of leadership at this time period.
- From the interaction level, team member #1 did not perceive that members #2 or #3 displayed a high level of leadership.
- Team member #2 did not perceive that member #3 displayed a high level of leadership.
- Team member #4 did not perceive that member #1 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #3 was perceived to display low levels of leadership at this time period.

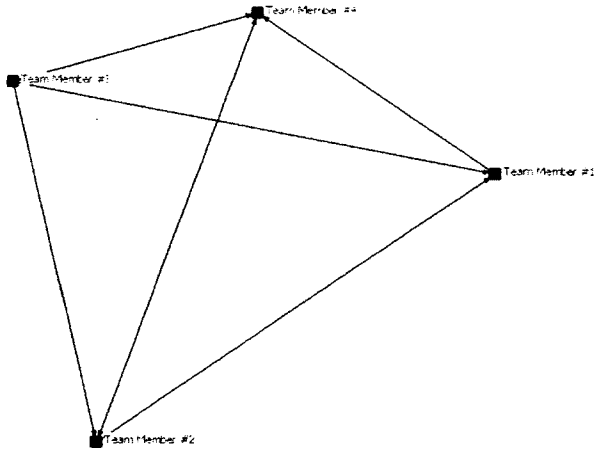

Figure 54: Team #7, Time Period #3 (Analyze Phase)

From the interpretation of Figure 55, at time period #4 (the Improve phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #1 and #4.
- Team members #2 and #3 were found to display the lowest degree of leadership at this time period (they displayed the same degree of leadership).
- With respect to interaction, team member #1 did not perceive that members #2 or #3 displayed a high level of leadership.
- Team member #2 did not perceive that member #3 displayed a high level of leadership.
- Team member #4 did not perceive that member #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team members #2 and #3 were perceived to display low levels of leadership at this time period.

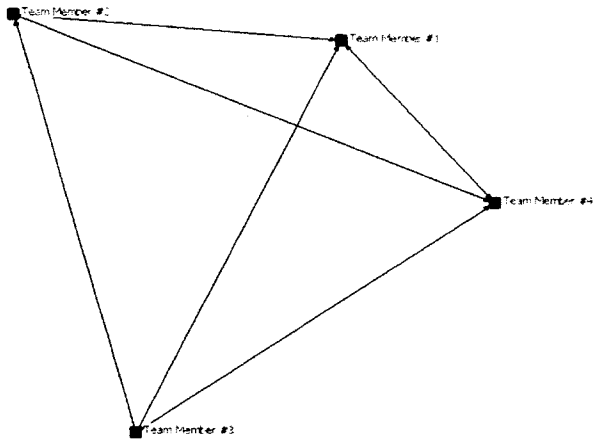

Figure 55: Team #7, Time Period #4 (Improve Phase)

When comparing the four networks as a whole throughout the project, the following findings were identified:

- The leadership role was consistently centralized around team member #4; team member #4 achieved and maintained a high degree of leadership throughout each time period of the project.
- Team member #3 was consistently identified as displaying little to no leadership throughout each time period of the project. The value of team member #3's degree of leadership did not change at any period in the project; member #3 maintained the same low level of leadership throughout the project.
- From time periods #1, #2, and #3, team member #1 was perceived to display a middling level of leadership. But in the final time period (#4), team member #1 was able to achieve the highest level of leadership. Team member #1 displayed a middle value of leadership for the first three periods of the project, but by the end of the project, achieved the highest degree of leadership in the environment.
- From time periods #1, #2, and #3, team member #2 was perceived to display a middling level of leadership. In the final time period (#4), team member #2 had a decrease in his/her level of leadership and was perceived to display little to no leadership in the environment. Team member #2 was able to maintain a middle value of leadership for the first three time periods, but in the final time period, member #2 was not able to maintain their middle value of leadership, but instead decreased to displaying little to no leadership in the environment.

- By the end of the project, the leadership role was centralized between team members #1 and #4, while members #2 and #3 displayed low levels of leadership.

General notes regarding team #7:

- Team member #1 was a Greenbelt on the team.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was the team's Blackbelt.

4.5.8 Team #8 (Four Leadership Networks)

From the interpretation of Figure 56, at time period #1 (the Define phase), the following findings were identified:

- The degree of shared leadership was centralized around team member #4.
- Team members #1 and #3 were found to display the lowest degree of leadership at this time period.
- Team member #1 did not perceive that member #3 displayed a high level of leadership.
- Team member #2 did not perceive that members #1 or #3 displayed a high level of leadership.
- Team member #3 did not perceive that member #1 displayed a high level of leadership.
- Team member #4 did not perceive that members #2 and #3 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team members #1 and #3 were perceived to display low levels of leadership at this time period.

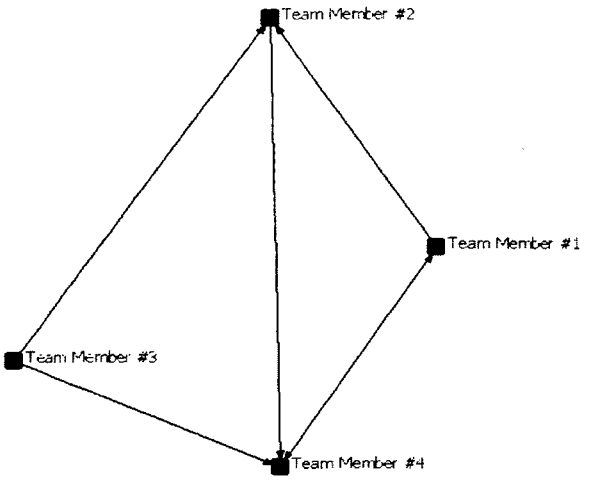

Figure 56: Team #8, Time Period #1 (Define Phase)

From the interpretation of Figure 57, at time period #2 (the Measure phase), the following findings were identified:

- The degree of shared leadership was centralized around team members #3 and #4.
- Team member #2 was found to display the lowest degree of leadership at this time period.
- From the interaction level, team member #1 did not perceive that member #2 displayed a high level of leadership.
- Team member #3 did not perceive that member #1 displayed a high level of leadership.
- Team member #4 did not perceive that member #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

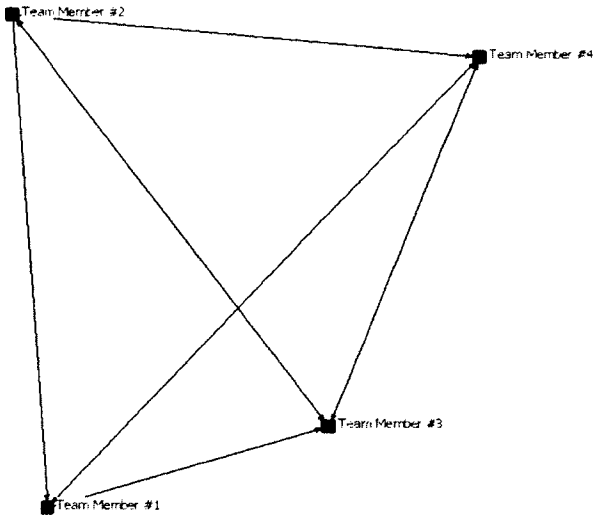

Figure 57: Team #8, Time Period #2 (Measure Phase)

From the interpretation of Figure 58, at time period #3 (the Analyze phase), the following findings were identified:

- The degree of shared leadership was centralized around team member #3.
- Once again, team member #2 was found to display the lowest degree of leadership at this time period.
- From an interaction standpoint, team member #1 did not perceive that member #2 displayed a high level of leadership.
- Team member #2 did not perceive that members #1 or #4 displayed a high level of leadership.
- Team member #3 did not perceive that member #2 displayed a high level of leadership.
- Team member #4 did not perceive that member #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

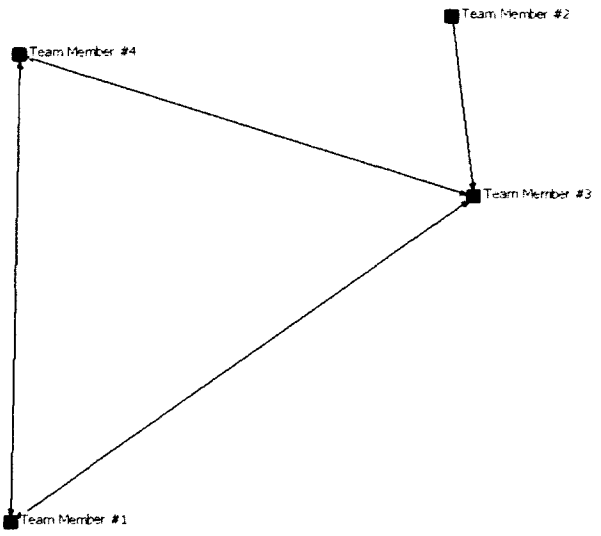

Figure 58: Team #8, Time Period #3 (Analyze Phase)

From the interpretation of Figure 59, at time period #4 (the Improve phase), the following findings were identified:

- The degree of shared leadership was centralized around team member #3.
- Team member #2 was found to display the lowest degree of leadership at this time period.
- Team member #1 did not perceive that member #2 displayed a high level of leadership.
- Team member #2 did not perceive that members #1 or #4 displayed a high level of leadership.
- Team member #3 did not perceive that member #2 displayed a high level of leadership.
- Team member #4 did not perceive that member #2 displayed a high level of leadership.
- All other interactions among members were perceived to have a high degree of leadership.
- Overall, from this network, it was determined that team member #2 was perceived to display low levels of leadership at this time period.

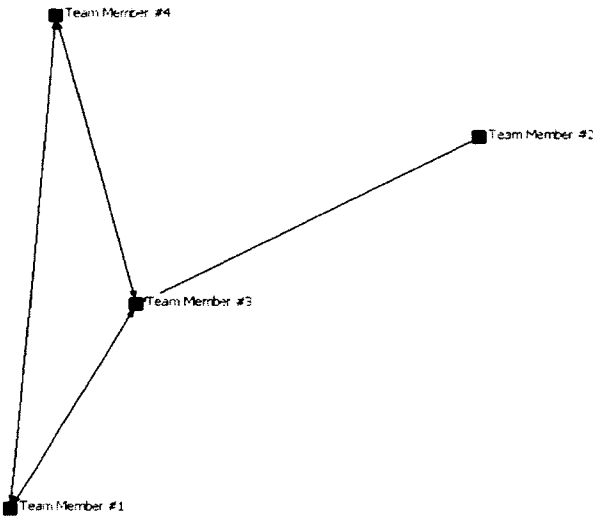

Figure 59: Team #8, Time Period #4 (Improve Phase)

When comparing the four networks as a whole throughout the project, the following findings were identified:

- The leadership role was not consistently centralized around any specific team member.
- The lowest level of leadership displayed was not consistently centralized around any specific team member.
- At time period #1, team member #1 displayed little to no leadership, but at time periods #2, #3, and #4, team member #1 was perceived to display a middling level of leadership. At the start of the project, member #1 displayed a small degree of leadership, but after member #1 moved into time period #2, member #1 was able to achieve a middle value of leadership that they maintained for the remaining periods (time periods #3 and #4).
- At time period #1, member #2 was perceived to display a middling level of leadership. At time periods #2, #3, and #4, team member #2 was perceived to display little to no leadership in the environment. Team member #2 was able to begin the project (at time period #1) with a middle value of leadership, but from time period #2 through the end (period #4), member #2's level of leadership decreased to the point that they were perceived to display very little to no leadership.

- At time period #1, member #3 was perceived to display little to no leadership in the environment, but at time periods #2, #3, #4, team member #3 was able to achieve the highest degree of leadership in the environment. At the start of the project (period #1), team member #3 was perceived to display no leadership in the environment, but as member #3 moved into time period #2, member #3 was able to achieve the highest level of leadership and was able to maintain the highest degree of leadership throughout the remaining periods of the project (periods #3 and #4).
- In time periods #1 and #2, team member #4 was perceived to display the highest level of leadership in the environment, but in time periods #3 and #4, team member #4 was perceived to display a level of leadership that was a value that was in t #4he middle of the spectrum. Team member was able to achieve and maintain the highest level of leadership at the start of the project and into the second time period (periods #1 and #2), but as member #4 moved into period #3, team member #4's level of leadership decreased to a middling value and remained so for the remainder of the project (periods #3 and period #4).

General notes regarding team #8:

- Team member #1 was a Greenbelt on the team.
- Team member #2 was a Greenbelt on the team.
- Team member #3 was a Greenbelt on the team.
- Team member #4 was the team's Blackbelt.

The analysis above highlights the findings and conclusions identified from the qualitative analysis of the leadership networks, which was performed at both the time period level as well as whole project level for each team. These findings and conclusions were used to develop the subsequent discussion section. Table 20 summarizes the qualitative analysis performed on the leadership networks for each team. From the networks, the following high-level conclusions were drawn:

- Leadership typically revolved around Blackbelt but in some cases, revolved around 1-2 members of the team
  - Usually the Blackbelt or a specific Greenbelt

- In one or two teams, the Blackbelt was never central figure (would be a specific Greenbelt)

• In all teams, there was usually 1 member that was consistently rated the lowest performer for leadership from phase to phase

• Some teams remain stagnant with their networks and SL values from phase to phase but only changed at the very last period

• Networks and SL values fluctuated from phase to phase. There was no clear pattern for any team from Define to Improve

• Leadership style changed based on deliverables and change mgmt

• Low points in shared leadership appeared to relate to periods where there were highly complex deliverables and change management needs

• How team's made decisions was influenced by the style of leadership (and vice versa)

Table 20: Summary of Qualitative Analysis For Leadership Networks

Team #	Team Member Breakdown	Time Period #1 (Define)	Time Period #2 (Measure)	Time Period #3 (Analyze)	Time Period #4 (Improve)	General Conclusions
1	• Team member #1 was the team's Blackbelt. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was a Greenbelt on the team.	Centralized around team members #1 (BB) and #3 (GB). Shared Leadership Value = 0.500	Centralized around team members #1 (BB) and #3 (GB). Shared Leadership Value = 0.333	Centralized around team members #1 (BB) and #3 (GB). Shared Leadership Value = 0.500	Centralized around team members #1 (BB), #2 (GB), and #3 (GB). Shared Leadership Value = 0.1667	Leadership was centralized around the Blackbelt (Team Member #1) and one Greenbelt (Team Member #3).
2	• Team member #1 was the team's Blackbelt. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was a Greenbelt on the team.	Centralized around team members #1 (BB) and #2 (GB). Shared Leadership Value = 0.500	Centralized around team members #1 (BB) and #2 (GB). Shared Leadership Value = 0.333	Centralized around team member #1 (BB). Shared Leadership Value = 0.667	Centralized around team members #1 (BB), #2 (GB), and #4 (GB). Shared Leadership Value = 0.167	Leadership was centralized around Blackbelt (Team Member #1) but Greenbelts accepted some leadership responsibility at points in the project (Team Members #2 and #4).
3	• Team member #1 was the team's Blackbelt. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was a Greenbelt on the team.	Centralized around team members #1 (BB), #3 (GB), and #4 (GB). Shared Leadership Value = 0.333	Centralized around team members #1 (BB), #3 (GB), and #4 (GB). Shared Leadership Value = 0.167	Centralized around team members #1 (BB), #3 (GB), and #4 (GB). Shared Leadership Value = 0.500	Centralized around team members #1 (BB) and #3 (GB). Shared Leadership Value = 0.500	Leadership was centralized around Blackbelt (Team Member #1) but Greenbelts accepted some leadership responsibility at points in the project (Team Members #3 and #4).
4	• Team member #1 was a Greenbelt on the team. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was the team's Blackbelt.	Centralized around team members #3 (GB) and #4 (BB). Shared Leadership Value = 0.500	Centralized around team members #3 (GB) and #4 (BB). Shared Leadership Value = 0.500	Centralized around team member #3 (GB). Shared Leadership Value = 0.500	Equally distributed and shared among the four team members. Shared Leadership Value = 0.000	Leadership role was typically centralized around the Blackbelt (Team Member #4) and one Greenbelt (Team Member #3), but by the end of project, the team achieved the maximum level of shared leadership.
5	• Team member #1 was the team's Blackbelt. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was a Greenbelt on the team.	Centralized around team member #1 (BB). Shared Leadership Value = 0.500	Centralized around team members #3 (GB) and #4 (GB). Shared Leadership Value = 0.500	Centralized around team members #1 (BB) and #3 (GB). Shared Leadership Value = 0.667	Centralized around team members #1 (BB), #3 (GB), and #4 (GB). Shared Leadership Value = 0.167	Leadership role was typically centralized around the Blackbelt (Team Member #1) and two Greenbelts (Team Members #3 and #4). Notice that in time period #2, the leadership role was shared between the two Greenbelts and no Blackbelt.
6	• Team member #1 was the team's Blackbelt. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was a Greenbelt on the team.	Centralized around team members #1 (BB) and #4 (GB). Shared Leadership Value = 0.500	Centralized around team member #4 (GB). Shared Leadership Value = 0.667	Centralized around team members #1 (BB) and #3 (GB). Shared Leadership Value = 0.500	Centralized around team members #1 (BB) and #3 (GB). Shared Leadership Value = 0.667	Leadership role was typically centralized around the Blackbelt (Team Member #1) and two Greenbelts (Team Members #3 and #4). Notice that in time period #2, the leadership role was centralized around a Greenbelt and not a Blackbelt.
7	• Team member #1 was a Greenbelt on the team. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was the team's Blackbelt.	Centralized around team members #1 (GB), #2 (GB), and #4 (BB). Shared Leadership Value = 0.167	Centralized around team member #4 (BB). Shared Leadership Value = 0.667	Centralized around team member #4 (BB). Shared Leadership Value = 0.667	Centralized around team members #1 (GB) and #4 (BB). Shared Leadership Value = 0.667	Leadership role was typically centralized around the Blackbelt (Team Member #4) and one Greenbelt (Team Member #1).
8	• Team member #1 was a Greenbelt on the team. • Team member #2 was a Greenbelt on the team. • Team member #3 was a Greenbelt on the team. • Team member #4 was the team's Blackbelt.	Centralized around team member #4 (BB). Shared Leadership Value = 1.000	Centralized around team members #3 (GB) and #4 (BB). Shared Leadership Value = 0.500	Centralized around team member #3 (GB). Shared Leadership Value = 0.833	Centralized around team member #3 (GB). Shared Leadership Value = 0.833	Leadership role consistently centralized around one Greenbelt (Team Member #3) and the Blackbelt (Team Member #4) at times in the project. Notice that the Greenbelt was seen as a leader more often than the Blackbelt.

The purpose of the quantitative analysis was to evaluate the five pre-defined hypotheses and identify what relationships (if any) existed between the five variables studied in the research. The quantitative analysis sought to utilize the quantitative data to prove (or disprove) the relationship defined by the five hypotheses as well as identify the specific phases of Six Sigma where these relationships may or may not exist. Inferential statistical methods served as the basis for evaluating the five hypotheses and as the tools that allowed me to make credible and accurate conclusions about the five hypotheses. The quantitative (graphical and statistical) analysis performed in this section provided substantial information and evidence required to accurately assess and validate (or invalidate) the five pre-defined hypotheses.

The qualitative analysis included two sections, one which analyzed the data from the qualitative questions and a second section that focused on analyzing the leadership networks developed for each team at each time period. The purpose of the analysis of the data from the qualitative questions was to identify concerns, issues, trends, patterns, and justifications that could help support (and explain) the conclusions drawn from the quantitative analysis of the five hypotheses. The purpose of the analysis of the leadership networks was to enable me to study the leadership interactions that each member had with each of their team members and the changes of these interactions from time period to time period. The ability to see how interactions change within a team as the team progresses from time period to time period is a unique feature of social network theory (i.e. leadership networks); this is not a feature that is readily available with other leadership analysis methods. An additional purpose of analyzing the leadership networks is that it also enabled me to understand how the concerns, issues, trends, patterns, and justifications identified from the analysis of the qualitative data impacted (and helped to explain) the conclusions drawn from the quantitative analysis of the five hypotheses.

When the results of all three segments of the analysis were woven together, this offered robust and accurate answers to not only the research hypotheses but also helped to achieve the main goal of the research. The quantitative analysis provided the identification of any relationships between these five variables and where they existed in the DMAIC process. But the two pieces of the qualitative analyses performed helped to not only identify the concerns, issues, trends, patterns, and justifications that impacted the

five variables (and hypotheses), but to also understand how these concerns, issues, trends, patterns, and justifications impacted the five variables (and hypotheses). The qualitative pieces of the analysis helped to shed light on how and why the conclusions for the five hypotheses turned out the way they did in the study.

All of this data and analysis enabled me to dive deeper into the five variables in order to develop a rich and robust discussion that is presented in Chapter Five, which will be utilized to not only answer the five hypotheses but also sufficiently address the main goal of the research as well.

CHAPTER 5
5. DISCUSSION OF RESULTS

5.1 Summary of Chapter Five

In order to have a discussion on the results of the analysis and research related to the shared leadership variable, a few key notes have to be outlined. Note that in shared leadership environments, the lower the variance, the greater the degree of shared leadership in the team. Recall that the values calculated from the formula discussed in the theories/model section of the dissertation were dependent on the number of team members that made up the team. Since all of the teams selected for the research study had four team members, the values for this variable were limited to [0.000, 0.167, 0.333, 0.500, 0.667, 0.833, and 1.000]. From this preset list of values, based on previous research efforts, the following qualitative scale was defined: a low value of shared leadership implied a value equal to [1.000, and 0.8333]; a moderate value of shared leadership signified a value equal to [0.667, 0.500, and 0.333]; and a high value of shared leadership implied a value equal to [0.167, and 0.000]. This qualitative scale will be used on Chapter Five to discuss the shared leadership variable.

Recall that the main goal of this research was to evaluate the five pre-defined hypotheses in order to identify the relationship(s) that the internal team environment and external coaching variables had on the degree of shared leadership throughout the DMAIC process used by the Six Sigma teams from the NSLIJ Health System. The research also sought to ascertain the relationship(s) that shared leadership has with two performance metrics: the perceived effectiveness of a team's ability to complete the assigned project deliverables (i.e. project completion) and the perceived effectiveness of a team's ability to satisfy the requirements of the customer (i.e. customer satisfaction). The main goal of this research also sought to understand additional factors or issues that affected the five pre-defined hypotheses and the five variables studied in the research.

To aid in the identification of conclusions and findings from this study, each section of Chapter Five begins with a bolded summary in order to stand out to the reader. In addition, to provide a summary of all of the findings from this research, for each hypothesis investigated in this study, Table 21 highlights: the variables studied, the operational definitions for each variable, the method of measurement, the results of the hypothesis testing, the factors and concepts influencing the results of the hypothesis, and the outcomes affected by the results of the hypothesis.

Table 21: Summary of Findings and Conclusions from Research Study

Hypothesis	Hypothesis Definition	Variables Tested	Acceptance of Hypothesis	Conclusion	Factors And Concepts Influencing the Results of the Hypothesis	Outcomes Affected By Results of the Hypothesis
1	To examine whether there is an increase in shared leadership from Time Point #1 (Define phase) to Time Point #4 (Improve phase) of the DMAIC structure.	Shared Leadership	Rejection of the Hypothesis. Test failed at all time periods.	There is no consistent increase in a team's degree of shared leadership as they progress from the Define phase to the Improve phase. When looking at either the sequential or before and after perspective, the results showed that the shared leadership values did not increase from the Define phase to the Improve phase.	• Complexity of the deliverables that were associated with the phase. • Complexity of Change Management. • Type of Decision-Making Used By Team. • Team Dynamics (Internal Team Environment) and Team Members Traits: Being open-minded and Having Confidence/Assertiveness. • Level and Style of External Coaching. • Internal and external communication. • External Coaches' Method(s) to Explain Expectations and Deliverables For Each Phase. • General Factors: Training & Educational Model, Time and Resource Commitment of Internal Team Members. •Effective Use of Six Sigma Tools.	• The type of decision-making approach (single vs. shared) employed in subsequent phases. • The type of leadership approach (single vs. shared) employed in subsequent phases. • Team ability to satisfy the quality requirements of their customer. • How team dynamics change (internal team environment variable) in subsequent phases. • Type of external coaching employed in subsequent phases by the external coach. • Effective use of the Six Sigma model.
2	To examine if there is a relationship between shared leadership and the internal team environmental condition at each phase of the DMAIC structure.	Shared Leadership / Internal Team Environment	Acceptance of the Hypothesis. Test passed at all time periods.	There is relationship between shared leadership and the internal team environmental condition as a team progresses through each phase of the DMAIC structure. A direct relationship between the internal team environment and shared leadership variables throughout each phase of the DMAIC structure.	• Same Issues Identified in Hypothesis #1 in Addition To: • Presence and Style of External Coach. • The presence of the three dimensions (shared purpose, social support, and voice) of the internal team environment variable.	• Same Outcomes Identified in Hypothesis #1 in Addition To: • Establishing a clear and consistent team direction. • Establishing an environment where each member had an equal voice and had unwavering team support. • Cohesiveness of the internal team members. • Relationship and dependency of the internal members on their external coach. • Delegation of responsibilities.
3	To examine if there is a relationship between shared leadership and the external coaching environmental condition at each phase of the DMAIC structure.	Shared Leadership / External Coaching	Rejection of the Hypothesis. Test passed three of four time periods.	There is no consistent relationship between shared leadership and the external coaching environmental condition at each phase as a team progresses through each phase of the DMAIC structure. Relationship is only present at the Measure, Analyze, and Improve phases.	-Same Issues Identified in Hypothesis #1 in Addition To: -Complexity of the deliverables and the degree change management complexity that were associated with the phase. -Critical Traits of the External Coach (external coach's willingness to provide mentorship and help the team at any point in the project).	• Same Outcomes Identified in Hypothesis #1 in Addition To: • Team ability to complete deliverables by a deadline. • Team's ability to have a clear direction the deliverables and expectations for each phase of the projects. • External coach's ability to provide clear directions about the deliverables and expectations for each phase of the projects. • External coach's ability to manage the team to ensure that they remained focused on the task and project deliverables. • Clear and shared understanding about direction and needs of the project. • Remaining focused on the task at hand.
4	To examine if there is a relationship between shared leadership and the project completion performance metric at each phase of the DMAIC structure.	Shared Leadership / Project Completion	Rejection of the Hypothesis. Test passed two of four time periods.	There is no consistent relationship between shared leadership and the project completion performance metric at each phase of the DMAIC structure. Relationship is only present at the Measure and Improve phases.	• Same Issues Identified in Hypothesis #1 in Addition To: • Complexity of the deliverables and the degree of change management complexity that were associated with the phase. • Utilizing the project management and Six Sigma tools (WWWs, action plans, CTQs trees) to management the deadlines and requirements of the project. • Ability to work collaboratively together to meet deadlines and quality requirements.	• Same Outcomes Identified in Hypothesis #1 in Addition To: • Overall degree of project completion (i.e. ability to meet deadlines and complete project deliverables). • How to effectively and successfully a team completes the deliverables and tasks for each phase of a DMAIC project. • Making decisions and completing tasks in a timely manner. • Obtaining and maintaining the support and buy-in from their customer and stakeholders. • Aligning the team's focus and direction with the expectations and requirements of the customers. • Establishing realistic goals and timelines. • Setting deadlines and schedules for each project tasks and ensuring that the team sticks (works) to the specific deadlines and schedules.
5	To examine if there is a relationship between shared leadership and the customer satisfaction performance metric at each phase of the DMAIC structure.	Shared Leadership / Customer Satisfaction	Rejection of the Hypothesis. Test passed two of four time periods.	There is no consistent relationship between shared leadership and the Customer completion performance metric at each phase of the DMAIC structure. Relationship is only present at the Measure and Improve phases.	• Same Issues Identified in Hypothesis #1 in Addition To: • Complexity of the deliverables and the degree of change management complexity that were associated with the phase. • Utilizing the project management and Six Sigma tools (WWWs, action plans, CTQs trees) to management the deadlines and requirements of the project. • Ability to work collaboratively together to meet deadlines and quality requirements.	• Same Outcomes Identified in Hypothesis #1 in Addition To: • Overall degree of customer satisfaction (i.e. ability to meet customer requirements and quality features on a consistent basis). • Making decisions that align with the quality requirements of the customer. • Deliverables that are not only completed by a deadline but also meet the quality requirements of the customer. • Overall degree of customer satisfaction (i.e. ability to meet customer requirements and quality features on a consistent basis). • Minimal variation in terms of compliance to quality requirements for project deliverables.

5.2 Shared Leadership over Time (Hypothesis #1)

5.2.1 General Discussion of Hypothesis #1 Results

This section highlights the conclusion that quantitative and qualitative analysis has proven that Hypothesis #1 was not valid and could not be confirmed for this study. When looking at either the sequential or before and after perspective, the results showed that the shared leadership values did *not* increase from the Define phase to the Improve phase.

Recall that Hypothesis #1 sought to examine whether there is an increase in shared leadership from Time Point #1 (the Define phase) to Time Point #4 (the Improve phase) of the DMAIC process. For this hypothesis, the shared leadership data measured in sequential time periods indicated that the shared leadership values did *not* increase from the Define phase to the Improve phase. The results from this hypothesis testing identified that the changes in the shared leadership values between each time period were not statistically significant. When Hypothesis #1 was also evaluated through the comparison of initial and final time periods, the evidence was insufficient to validate the accuracy of Hypothesis #1.

The conclusion based upon the statistical analysis was further supported by the qualitative data collected from the project participants. The data from the qualitative questions and leadership networks provided the means to gain further insight and understanding into why the theory that formed the basis for Hypothesis #1 was not statistically valid. The qualitative questions from the teams identified that over 90% of the respondents felt that each team member displayed good levels of leadership at each phase in the DMAIC project. The respondents typically identified either the team's Blackbelt or a particular Greenbelt as the primary leader(s) of the team. The qualitative analysis also indicated that the respondents often believed that the team's overall degree of shared leadership improved from the previous phase throughout the DMAIC project, but that the improvement was due to the influence of the team's Blackbelt/ particular Greenbelt. The remaining 10% of the respondents felt that many of the team members displayed good levels of leadership but that a few of the members needed to improve on their degree of leadership. This 10% also believed that overall the team's overall degree of shared leadership improved from the previous phase throughout the DMAIC process,

and that only a few team members needed to improve their degree of leadership throughout it.

These findings are consistent with the leadership networks developed for each team. The networks support the conclusion that the members of six of the eight teams consistently associated the leadership role with the team's Blackbelt or a particular Greenbelt, despite the fact that these teams' members often rated every member on the team with high degrees of shared leadership. The networks developed for these teams often had the leadership role centralized around the team's Blackbelt and/or a particular Greenbelt, but they also highlighted the fact that each member of the team was often thought to display high degrees of shared leadership. The qualitative analysis highlighted that the Blackbelts or particular Greenbelts were often associated with the leadership role and rated with higher values of shared leadership since they were perceived to have a higher level of formal "authority" or "influence." In cases where the team's Blackbelt was not perceived to be the primary leader, a particular Greenbelt was then often perceived to be so, since this Greenbelt typically had a higher level of defined authority outside the project. This authority appeared to carry over and influence the team dynamic, despite the lack of formal authority within the scope of the project. The networks for the two teams that did not associate the leadership role with the team's Blackbelt and/or a particular Greenbelt showed that the members of these teams did not centralize the leadership role around any specific member, but that all members were consistently rated to display low degrees of shared leadership. The formal authority of the Blackbelt on these teams did not influence or affect how the members of these teams perceived the leadership of that individual and did not sway the perceptions or expectations of the team members on these teams.

5.2.2 Shared Leadership from the Individual Team Perspective

This section provides discussion of how the theory behind Hypothesis #1 was present for some teams when the data was viewed at the individual team level. From the individual team level, one could see how the complexity of the deliverables as well as the need for varying degrees of change management from each phase impacted the degrees of shared leadership that were present for each team as the teams progressed through the DMAIC structure. The data from the individual team level and the qualitative data were

utilized to identify a potential shared leadership structure that a team should be expected to have during a Six Sigma DMAIC project: a moderate degree of shared leadership at the Define phase of a project; a low to moderate degree of shared leadership at the Measure and Analyze phases of the DMAIC structure; and a high degree of shared leadership at the Improve phase of the DMAIC structure. The structure of shared leadership in Six Sigma teams outlined above resulted in the differences from the time periods to be not statistically significant.

The statistical analysis performed on hypothesis #1 did not support that the changes in the degree of leadership for each team, from each sequential time period as well as the before and after comparison of the Define and Improve phases, were statistically significant. When one looked at the shared leadership values for each individual team (instead of a data set as whole), it was found that the theory behind Hypothesis #1 was present in some of the team environments at specific time periods. When comparing the sequential time periods/phase, from the individual team perspective, the theory was present for seven of the eight teams.

At the individual team level, it was found that Team #1 improved its degree of shared leadership when one compared the values at the Define phase to the values at the Measure phase as well as from the Analyze phase to the Improve phase. Additionally, Team #2 improved its degree of shared leadership from the Define phase to the Measure phase and again from the Analyze phase to the Improve phase. Results at the individual team level revealed that Team #3 was able improve its degree of shared leadership from the Define phase to the Measure phase. Teams #4 and #5 saw an improvement in shared leadership between the Analyze phase and the Improve phase, while Team #6 experienced success between the Measure and Analyze phases. Team #8 was able improve its degree of shared leadership from the Define phase to the Measure phase.

The analysis at the individual team level identified that for seven of the eight teams, an improvement in the degree of leadership could not be found when comparing the values of the Measure phase to the Analyze phase. Analysis between these time periods found that the degree of the shared leadership for seven of the eight teams had worsened when the values of the Measure phase were compared to those of the Analyze phase. Team #7 was the only team that did not observe any improvement in its degree of shared

leadership when comparing the shared leadership values at each time period. Throughout the four time periods, Team #7 had significantly worse leadership values relative to the other teams in the study.

When comparing the before and after time periods (Define and Improve phases) from the individual team perspective, the theory was present for five of the eight teams. These five teams improved their degree of shared leadership from the beginning of the project to the end. Team #1, for example, began the project with a shared leadership value of 0.500 but finished with a shared leadership value of 0.167; this same finding was identified for five of the eight teams. The other three teams saw a net worsening of shared leadership from the start of the project (Define phase) to the end of the project (Improve phase). These three teams began their projects with moderate to high degrees of shared leadership but by the conclusion of their projects, these teams had moderate degrees of shared leadership. In most cases, the difference for these teams was not greater than 0.333, which is not a significantly large difference when one considered the whole continuum of the shared leadership variable.

5.2.3 Shared Leadership and the Demands of a Six Sigma Project

This section highlights the fact that the degree of shared leadership that a displayed at any phase of a Six Sigma project was dependent on the complexity of the deliverables and the degree of change management complexity that were associated with the phase. In order to satisfactorily complete the project deliverables and meet the needs of their customers at any phase in the DMAIC process, if the phase required a high degree of change management (people piece) as well as logistics to complete the phase's deliverables, then the Six Sigma quality improvement teams needed to rely on a shared leadership environment to properly accomplish the objectives of the phase; this held true for the Measure and Improve phases. If a high degree of change management was not a critical aspect of the phase, the Six Sigma quality improvement teams could satisfactorily complete the project deliverables and meet the needs of their customers by relying on a leadership environment that is centralized around one or two key team members instead of utilizing the shared leadership approach; this held true for the Define and Analyze phases.

According to the qualitative data, the teams typically began the projects with a moderate degree of shared leadership. At this stage, the teams were newly formed and the data indicated that the members were very anxious to begin the project. Cohesiveness quickly developed since all the members were sincerely interested in pursuing common objectives in order to improve their process and resolve outstanding issues. The beginning phase of the DMAIC structure is often the well-received since it is the point in the project where the team identifies and defines the problem as well as identifying and defining the goal of the project. From a training and education perspective, the Define phase includes tools (project charter, Critical to Quality (CTQ) tree, in and out of frame, etc) that are most often the easiest for teams to understand and apply to their projects. The Define phase also includes a set of deliverables that are not too complex or tedious for the team to complete by the specified deadlines. This resulted in the teams beginning their projects with moderate degrees of shared leadership. In the Define phase, the degree of complexity for change management was found to be moderate, but the data showed that the teams displayed moderate degrees of shared leadership.

All of the individual team level data indicated that after entering the Measure phase of the DMAIC process, the teams saw low to moderate degrees of shared leadership (as well as perhaps no change in the value from the Define phase). The qualitative data support the belief that the low to moderate degrees of shared leadership for the teams at this phase were due to the complexity and difficulty associated with the Measure phase. The Measure phase of Six Sigma structure is typically were teams begin to show signs of resistance and less active participation, since this phase includes a set of tedious deliverables that need to be completed in a relatively short time frame. This is the phase were the teams must establish a measurement system, perform a measurement system analysis in order to validate their measurement system, and collect a sufficient amount of data (sufficient being: random, adequate, and representative of the process) to establish a baseline of performance, and perform a process capability analysis in order to establish a baseline of performance.

The training and educational component for this phase was often perceived as difficult and confusing for the team members since the tools and concepts taught in this phase of the training program were based heavily on statistics (i.e. process capability

analysis), which was often unwelcomed by the team members. Overall, the qualitative data highlighted that the complexity and tediousness of the deliverables from this task were the primary driver behind the teams' low to moderate degrees of shared leadership for this phase of the projects. Another driver behind the teams' degree of shared leadership was related to change management. In the Measure phase, the degree of complexity for change management was found to be high and the data indicated that most teams displayed moderate degrees of shared leadership, even though two of the eight teams displayed low degrees of shared leadership. Despite these two teams displaying low levels of shared leadership, the teams were able to manage the change management piece by relying on the active coaching and support from their external coach (i.e. high degrees of external coaching variable, discussed in section 5.4).

The individual team level data from the Analyze phase indicated that the teams also saw low to moderate degrees of shared leadership (as well as perhaps no change in the value from the measure phase). The qualitative data from the participants support the theory that the low to moderate degrees of shared leadership for the teams at this phase is due the complexity and difficulty associated with the Analyze phase. The Analyze phase of Six Sigma structure is typically were teams continue to show signs of resistance and less active participation, since this phase includes a set of tiresome deliverables that need to be completed in a short time frame. This is the phase were the teams must complete a cause and effect diagram, complete a failure modes and effects analysis, develop a hypothesis testing plan, execute the hypothesis testing plan, perform a five-why analysis, and identify the vital factors that drive the performance of their process and metric. The training and educational component for this phase was typically seen as difficult for the team members since the tools and concepts taught in this phase of the training program are based heavily on statistics, which was often unwelcomed by the team members.

By and large, the qualitative data highlighted that the complexity and tediousness of the deliverables from this task are the primary driver behind the teams' low degrees of shared leadership for this phase of the projects. In the Analyze phase, the degree of complexity for change management was found to be moderate and the data showed that the teams displayed moderate degrees of shared leadership, even though two of the eight teams displayed low degrees of shared leadership. Despite these two teams displaying

low levels of shared leadership, the teams were able to manage the change management piece by relying on the active coaching and support from their external coach.

The data from the individual team level indicated that as the teams progressed into the Improve phase of the DMAIC structure, they displayed moderate-high value in this phase (as well as perhaps no change in the value from the Analyze phase). The qualitative data highlighted that many of the team members were very receptive to this phase of the DMAIC process since this was the point in the project where the teams were able to identify their improvement strategies and to implement them in order to improve the performance of their process and metric(s). The Improve phase was often well received since this portion of the training not only provided the teams with practical tools and concepts that they could utilize in environments beyond their project environments, but it also gave them the skills and tools they needed in order to effectively develop, test and implement their improvement strategies. In the Improve phase, the degree of complexity for change management was found to be high and the data also indicated that the teams displayed high degrees of shared leadership. This level of shared leadership was found to be effective in helping the teams to accomplish the deliverables of the improve phase as well as management the change management portion of the quality improvement project.

5.2.4 Shared Leadership and Change Management

This section highlights the finding that change management was found to have a significant effect on the degree of shared leadership displayed in a team environment. The research showed that as the degree of complexity for change management adjusted from each phase, the type of leadership that the teams also employed also changed in the same manner.

The study showed that change management was a large and complex segment of the DMAIC approach to quality improvement. The degree of change management that needed to be displayed by the Six Sigma quality improvement teams was dependent on deliverables of the phases and the level of involvement that the phases required from the stakeholders. Some of the phases required higher level of participation and input from the stakeholders, which in turn meant that the level and complexity of the change management responsibility that the Six Sigma quality improvement teams displayed in these phases had to be higher in these phases. The evidence suggested that as the degree

of complexity for change management adjusted from each phase, the type of leadership that the teams also employed also changed in the same manner. The analyses indicated that as the degree of change management increased for a phase, the Six Sigma quality improvement teams' degrees of shared leadership would also be effected since the teams had to spread the change management accountability and responsibility among all of the internal team members in order to ensure that the change management task was managed effectively by the team as a whole. As the team environment became more complex, due to the degree of complexity for change management and the complexity of the deliverables for the phases, the teams had to modify their degrees of shared leadership in order to ensure that they manage the deliverables and change management tasks in an effective manner.

More specifically, the quantitative analysis identified that the Measure and Improve phases had high degrees of complexity for change management and concurrently, the data also highlighted that these were points in the DMAIC process where the teams displayed high degrees of shared leadership. In the Define and Analyze phases, the while the degrees of complexity for change management was moderate, the teams displayed moderate degrees of shared leadership; the moderate value of shared leadership implied that the teams relied on a centralized leadership approach in these phases rather than a shared leadership approach. These findings supported the takeaway that the degree of complexity for change management impacted the type of leadership that an internal team had to utilize in order to manage not only the deliverables of the phases but also manage the change management piece of the quality improvement project. The degree of complexity for change management also affected how heavily the teams relied on their external coaches, especially in team environments that had consistently low degrees of shared leadership. In environments with a low to moderate degree of shared leadership, the teams relied more on the support and coaching from their coaches in order to help them manage the "change" pieces of the DMAIC process.

5.2.5 Decision-Making and Shared Leadership Environments

This section discusses the existence of a relationship between shared leadership conditions and decision-making. Further review of the data identified that this relationship is some type of direct relationship, in which one evolves for the better as the

other concept also evolves. The results from the research have shown that shared leadership and decision-making are linked together and that the type of decision-making employed by a team has a strong effect on the effectiveness and quality decisions made by a team. At points in a project where teams had low degrees of shared leadership, they typically relied on a "single leader individual decision method" to make decisions related to their projects. In cases where the teams had moderate to high levels of shared leadership, the consensus decision-making approach was decision-making method typically employed by the teams. In addition, the results of the research highlight the belief that a team's level of effectiveness and success in decision-making is directly linked to the degrees to which team members are actively engaged in decision-making, which in turn implies that a team's level of effectiveness and success in decision-making is directly related to the type of decision-making approach being employed by the team.

The results from the research have shown that shared leadership and decision-making are linked together and that the type of decision-making employed by a team has a strong effect on the effectiveness and quality decisions made by a team. The results of the study highlighted the belief that the degree of shared leadership present in a team environment impacted the decision-making approach employed by a team. From the analysis, the research leads to a belief that in situations of low degrees of shared leadership, a team would rely on a "single leader individual decision method" for making decisions, but in cases when there were moderate to high levels of shared leadership, the "consensus decision-making approach" was typically employed to make decisions in the team environment. The research found that both decision-making methods enabled a team to make decisions related to their projects, but the quality and effectiveness of the decisions were different when you compared the two decision-making methods. The findings from the research showed that the decision-making approach utilized by a team in a Six Sigma environment had significant impacts on the effectiveness of a decision; the data implied that decision-making approach of a team impact not only on making timely decisions, but also making effective quality solutions. In situations where the "single leader individual decision methods" were utilized by a team, the decisions were made in a timely manner but the quality of the decision was not as strong. In situations where the "consensus decision-making approach," the results showed that the decisions could be made in a

timely manner but the quality of the decisions was usually more effective and robust since these decisions included the input, rationale, and experience from all members of the quality improvement team.

The results of the research highlight the fact that at points in a project where teams had low degrees of shared leadership, they typically relied on a "single leader individual decision method" to make decisions related to their projects; this is represented by having the decision-making responsibility being managed by the external coach or one specific internal team member. The results from the analyses has shown that one of the vital aspects of providing high levels of external coaching is that the external coach needs to provide the team members with the opportunity to perform leadership responsibilities, especially in the form of decision-making. In the sense of team decision-making, the role of the external coach was two-fold, which the external coach had to have the ability to empower the team to make its own decisions as well as provide the support the team needs. In order for a team to develop a sound decision-making methodology, the external leader must provide the guidance and experience that the team needs to help the members learn about decision-making and how effective decisions can be made in their team environment.

In a shared leadership environment, since the leadership role and decision-making responsibilities are typically new to team members, the external coach had a significant role in guiding them to develop a sound decision-making process, which is based on the core principles and ideas of shared leadership and shared decision-making. As members evolved from a individual leadership model to a shared leadership model, the team adopted more decision-methods that were based on member input and distributed decision-making power and influence across the whole team and not only a single individual. As shared leadership developed in a team environment, the teams began to shift from a decision-making approach focused around a single leader/individual to a shared decision-making method that enabled all members to have input in the decision-making process as well as a sharing of power/influence in regards to the decisions being made by the team.

As a team became more developed in a shared leadership model, the team adopts decision-making methods that involve a more visible distribution of power, influence,

and responsibility over decision-making. From the results of the research, it can be concluded that the consensus decision-making approach is the method that is the most effective in satisfying the functional conditions of shared leadership. Past research have shown (reference Chapter Two) efforts show that the consensus decision-making approach is the method that resembles the fundamental requirements and conditions of true shared leadership. Many researchers (reference Chapter Two) believe that the consensus decision-making approach represents the embodiment of the relationship between shared leadership and decision-making and that it is the method that enables a team to make the most effective decisions. A shared leadership environment is an atmosphere that requires all participants to have the opportunity to provide their input into decisions as well as have accountability and responsibility for decisions. In addition, a shared leadership environment is an environment that pushes the members to provide support for each of their members as well as enable them to have a voice in the leadership of the team.

The consensus decision-making approach was evident in several aspects of the Six Sigma projects that were investigated in this study. When the teams had moderate to high levels of shared leadership, the consensus decision-making approach was decision-making method typically employed by the teams, especially when making decisions related to change management and the deliverables for each phase of the projects. In the cases when the team had moderate to high levels of shared leadership, the consensus decision-making method was a technique that meet these needs of the project teams since it encouraged members to express their opinion and provided input to the team's decisions. This method pushed the members to use active listening and support for all members in order for the team to have the ability to consider every member's inputs and to have an environment that encouraged input from all members.

When this decision-making technique was utilized at times of moderate-high degree of shared leadership, a final decision was not made until all members had the opportunity to provide their input and had the ability to share in the responsibility and accountability of the team's decision. This technique enabled members to not only provide input for a decision, but also share in the responsibility and accountability of the leadership and decision-making tasks. The other decision-making methods were effective in meeting

some needs of a shared leadership team in the Six Sigma environments, but the consensus method provided the team with the ability to produce the most effective decisions and attain the highest levels of shared leadership.

5.2.6 Factors Affecting Shared Leadership

This section highlights the fact that many of the issues and factors that contributed to the lack of statistical significance in Hypothesis #1, including: the complexity of change management, the delegation of responsibilities, team members being open-minded in the team environment, the confidence and assertiveness of team members, setting deadlines and establishing action plans or What, Who, When action plan (WWWs), establishing clear expectations, and internal and external communication. These factors affected the how shared leadership developed for each team at each phase of their Six Sigma projects; these factors also contributed to relationships that shared leadership developed with the four other variables studied in this research. These factors also influenced the team dynamics and team effectiveness and performance that were present for each team throughout their Six Sigma projects.

The results of the qualitative analysis identified several issues that could account for the lack of statistical significance of Hypothesis #1. These issues included: the complexity of change management, the delegation of responsibilities, team members being open-minded in the team environment, the confidence and assertiveness of team members, setting deadlines and establishing What, Who, When action plans (WWWs), establishing clear expectations, and internal and external communication. Change management was a large and complex segment of the DMAIC approach to quality improvement. Change management involves the aspects of change that relate to the human condition and the various forms of resistance that may be displayed by stakeholders throughout the phases of the project. The effectiveness of any quality improvement project is based on two aspects: the quality of the solutions and deliverables and the acceptance of the solutions by the stakeholders and customers. The acceptance requires an effective change management methodology. The change management task was a responsibility of the internal team members of each team and in some cases the external coach as well. The qualitative analysis indicated that as the degree of change management increased for a phase, the internal teams' degrees of shared leadership was

also affected since the teams had to spread the change management accountability and responsibility among all of the internal team members. This ensured that the team as a whole effectively managed the change management task. As the team environment became more complex, the teams had to modify their degrees of shared leadership in order to ensure that they managed the deliverables and change management tasks effectively.

The evidence suggests that as the degree of complexity for change management adjusted from each phase, the degree of shared leadership that the teams employed also changed. As the degree of complexity for change management increased, the teams increased their degrees of shared leadership in order to spread the change management accountability and responsibility among all of the internal team members. The data indicated that the Measure and Improve phases had high degrees of complexity for change management and that these were the points in the DMAIC process where the teams displayed low/moderate (Measure phase) and high (Improve phase) degrees of shared leadership. In the Define and Analyze phases, where the degrees of complexity for change management were moderate, the teams displayed moderate (Define phase) to low/moderate (Analyze phase) degrees of shared leadership. These findings supported the takeaway that the degree of complexity for change management impacted the degree of shared leadership that an internal team needed to utilize in order to manage the deliverables of the phases and also the change management piece of the quality improvement project. In the Measure and Analyze phases, two of the eight teams displayed low degrees of shared leadership. Despite this, those two teams were able to manage the change management piece by leveraging the active coaching and support from their external coach.

The qualitative surveys revealed that 40.63% of the participants identified that the delegation of responsibilities was a significant issue in the team environments, and they believed that this contributed to the changes in the degrees of leadership that the teams saw from time period to time period. The team members felt that the responsibilities of the leadership were not shared or delegated to all of the team members during the execution of the project, which in turn affected the degree of decentralization of leadership in the team environment. By not delegating the leadership role's

responsibilities among the members of a team, the leadership role remained centralized around a specific person, typically the team's Blackbelt.

The qualitative analysis also identified that 40.63% of the participants believed that team members were not open-minded to new ideas or sharing the leadership role throughout the project, and that this affected how much "equal" input each team member had with respect to decision-making and delegation of responsibility. The data indicated that throughout the projects, team members consistently found that their peers were not open to their ideas or thoughts on the project and did not value their input. This implied that the value of a members' input was not equal to the value of other members, which affected how each member perceived the other members as leaders and the overall degree of shared leadership for the team. If a member felt that their input was undervalued or not accounted for, the data showed that this member typically perceived that their team members were not displaying the traits of a good leadership (i.e. that a good leader equally listens and considers the input from all team members).

The qualitative analysis also recognized that 56.25% of the participants believed that the levels of "confidence and assertiveness" displayed by fellow team members impacted how these members were perceived as leaders by their fellow team members. The data showed that many team members felt that several of their fellow members lacked confidence and assertiveness. Many members noted that they sought input from their fellows throughout the project, but that the others did not provide input or did not want to contribute to decision-making for the project. When specific team members saw this type of issue, it affected how they perceived the leadership skills of some of their fellow members, which in turn impacted the overall degree of shared leadership for the team. This finding is contradictory to the issue identified in the previous paragraph that indicated that several members did not feel that their opinions and input were valued and listened to by their fellow members.

For each phase of the DMAIC projects, the teams had a specific set of deliverables and deadlines. The survey data revealed that 62.50% of the respondents believed that setting deadlines for each phase was a critical task for each team. The data also indicated that when a team did not set deadlines and establish action plans or WWWs, the shared leadership between the members would often suffer since the members would place

blame on each other and then resort to having one individual take charge in order to ensure that the deliverables for the phase were completed by the deadlines imposed by their external coach. The development of deadlines and action plans for each phase was important to the distribution of the leadership role among the team members since the deadlines and action plans enabled the team members to divide and delegate the responsibilities of the leadership role amongst themselves and to establish a system of leadership accountability for each member of the team. The use of deadlines and action plans also provided the team members with a mechanism to monitor the progress of the project and provides support to their team members as needed in order to ensure that all members successfully completed their tasks and deliverables by the deadlines. The use of deadlines and action plans help to ensure that all members are successful because in a shared leadership environment, if one member was unsuccessful in their leadership role, then the team as a whole was unsuccessful since the success of all members in their leadership roles was required in order for the project to be successful.

Since each phase of the DMAIC process is different, each phase required a different set of expectations and deliverables. These expectations were always outlined by the teams' external coaches at the start of each phase of the project. The qualitative data showed that 87.50% of the members felt that the defined expectations were often unclear and needed to be explained more clearly by their external coach in order for the team to have the ability to set the deadlines and establish their action plans. According to the data, the confusion surrounding the expectations for each phase of the project was mainly due to the fact that many of the team members had not been previously exposed to the Six Sigma methodology. This proved challenging, since a team's external coach often outlined the expectations in Six Sigma terms. Therefore, the members were often confused and required clarity on project expectations from their external coach. The team members indicated that confusion with respect to the expectations for a particular phase often led to inaccurate action plans and deadlines for the team. It also required the team members to rely on the leadership of the one or two members who were able to understand the expectations. These consequences resulted in a low degree of shared leadership for a team at any phase of the project. The ability to clearly understand the expectations of a phase of the project enabled the team to develop accurate deadlines and

actions plans, which in turn allowed the team to actively involve all members and divide the leadership role's responsibilities among the team members.

Throughout the execution of the Six Sigma projects, clear and consistent internal and external communication was deemed to be a critical issue that contributed to the distribution of leadership among the team members as well as the successful completion of the project deliverables. According to the qualitative data, 100.00% of the respondents highlighted the fact that internal and external communication was vital to establishing a cohesive team environment and accomplishing the objectives of each phase and the project overall; the respondents highlighted the fact there were times of minimal communication internally among the team members, which made it very difficult to build trust among the team members and manage the actions plans and deadlines established by the team in order to build accountability for each member. Lack of internal communication made it difficult to have a shared leadership environment.

The survey data also highlighted the fact that communication between the team members and the external coach was lacking on occasion, which in turn made it very difficult to resolve conflicts and remove barriers that the teams faced as they were executing the project. The teams relied on their external coaches to provide guidance and support in resolving conflicts and removing barriers that the team faced. When the team could not communicate with their external coach, it resulted in the team not being able to complete deliverables or action plans according to deadlines. In addition, the survey data indicated that on occasion, the external coaches would communicate directly with the team's Blackbelt or a specific Greenbelt, and then that Blackbelt or specific Greenbelt would be responsible for conveying the message to the rest of the team; this communication method was considered to cause more confusion among the team since it could affect the trust among the team members and meant that the team members could be receiving a different filtered message from the Blackbelt/Greenbelt proxy who received the original message from the external coach.

Lack of external communication made it difficult (at times) for the establishment of shared leadership environments since the internal team members relied on the support and guidance of the external coach throughout the project. The external coaches acted as mentors for the internal team members since they helped to not only provide guidance but

also aided in resolving conflict and removing barriers for the team, all of which are critical responsibilities of the external coach.

5.3 Shared Leadership and Internal Team Environment (Hypothesis #2)

5.3.1 The Relationship between Shared Leadership and Internal Team Environment

This section concludes that the qualitative and quantitative analyses have validated Hypothesis #2 and identified a direct relationship between the internal team environment and shared leadership variables throughout each phase of the DMAIC structure. The results of the hypothesis tests showed that there is a statistically significant relationship between the internal team environment and shared leadership variables throughout each phase of the Six Sigma DMAIC process. This section highlights the relationship between these two variables developed throughout the project since the internal team members placed almost comparable significance on all three dimensions of the internal team environment variable. The internal team members equally identified that all three dimensions of the internal team environment variable had to be improved in order to improve the degrees of the internal team environment and shared leadership variables for each team.

Hypothesis #2 examined the relationship between shared leadership and the internal team environmental condition at each phase of the DMAIC process. The data analysis showed that there is a statistically significant direct relationship between the internal team environment and shared leadership variables throughout each phase of the Six Sigma DMAIC process. An in-depth review of the quantitative data for both variables, though, showed that the rate of change that each variable saw was not equal for both variables.

The direct relationship between these two variables is supported by the findings from the qualitative analysis. The survey data indicated that throughout the projects, 78.13% of the internal project team members believed that their teams worked cohesively, while 21.88% of the internal project team members believed that their teams were working cohesively together but that some improvement was needed. All of the internal project team members did note that they believed that their team's degree of cohesiveness had a significant impact on how well the projects were performed as well as the degree of shared leadership that the team displayed at each phase of the projects.

The relationship between the two variables appeared to develop throughout the project since the team members placed almost equal significance on all three dimensions of the internal team environment variable. 43.75% of the internal project team members believed that the "shared vision" component of the variable was the most significant dimension of the internal team environment variable and that this component had the strongest impact on a team's ability to complete a project and to display a strong degree of shared leadership. 31.25% of the internal project team members responded that the most important factor of the internal team environment variable was the "voice" component of the variable. They believed that this component had a significant role in the performance of a team's project as well as a team's ability to exhibit a strong degree of shared leadership. 21.88% of the internal participants believed that the "social support" factor was the most significant dimension of the internal team environment variable and that this component had the strongest impact on a team's ability to complete a project and its ability to display a strong degree of shared leadership.

The qualitative data identified that 40.63% of the internal respondents believed that the level of "social support" that the team members displayed had to be improved; 34.38% of the internal team members felt that the level of "voice" that each member is given had to be improved; and 25.00% of the internal respondents believed that the level of "shared vision" among the team members had to be improved. The data shows that the internal project team members believed that all of the dimensions of the internal team environment variable were essentially similarly important for a team to possess in order to have a high degree of internal team environment. Though the degree of importance for these three dimensions may not equal, the internal project team members noted that all three dimensions needed to be present within a team in order for the team to work cohesively together and to have a high value of internal team environment.

The qualitative data noted that during the execution of the projects, at the times when the when the internal team environment variable and its dimensions were low or moderate, the internal participants also rated the team's degree of shared leadership similarly, showing that the value of the internal team environment variable was a true indication of how strong a team's degree of shared leadership would be for a particular time period. The qualitative and quantitative evidence supported the takeaway that when

a team had a low presence of one or more dimensions of the internal team environment variable, it would also have a low to moderate degree of shared leadership.

5.3.2 Effects of Shared Leadership and Internal Team Environment on Team Performance

This section concludes that a team's degree of internal team environment and its relationship with the shared leadership value had a significant impact on how effectively and successfully a team completes the deliverables and tasks for each phase of a DMAIC project. Of particular importance were the areas of: making decisions and completing tasks in a timely manner; establishing a clear and consistent team direction; and establishing an environment where each member had an equal voice and had unwavering team support. The qualitative data from the external coaches identified that there were two key areas of the internal team environment that need to be improved in order to enable the team to effectively complete the phases of the DMAIC process and to improve the relationship between the internal team environment and shared leadership variables. The external coaches' qualitative data also identified three recommendations that the teams could use to improve the three dimensions of the internal team environment and subsequent improvement in the degrees of the internal team environment and shared leadership variables for each team. The internal member perspective and external coaching perspective identified similar areas of concern that if improved would lead to improvements in the degrees of the internal team environment and shared leadership variables for each team.

The qualitative data also highlighted that the internal team members believed that a team's degree of internal team environment and its relationship with the shared leadership value impacted the following areas of a team's performance: making decisions and completing tasks in a timely manner (40.63% of the internal members identified this area); establishing a clear and consistent team direction (34.38% of the internal members identified this area); and establishing an environment where each member had an equal voice and had unwavering team support (21.88% of the internal members identified this area). The internal members gave similar weights of importance to each of these three areas; demonstrating that all three areas are essentially equally affected by a team's degree of internal team environment and its relationship with the shared leadership value.

In order to effectively address these three areas, the teams needed to identify methods to maximize their internal team environment and subsequently their degree of shared leadership. The responsibilities and tasks associated with each area needed to be distributed among the team members. If strong values of these two variables were not present, the data indicated that the teams would have a difficult time addressing these areas and often resulted in effecting the team's ability to complete the deliverables of each phase in a timely manner and therefore not meet the quality requirements of their customer.

The qualitative analysis also provided insight into the teams' internal team environments and shared leadership environments, but from the external coaching perspective. The qualitative data captured from the "general questions," which were completed by the external coaches, highlighted areas of the internal team environment that needed to be improved in order to enable the team to effectively complete the phases of the DMAIC process and to improve the relationship between the internal team environment and shared leadership variables. The areas for improvement that were identified from the external coaches' qualitative data were very similar to the areas that were identified from the internal members' qualitative data. The external coaches' qualitative data found that the following areas of the internal team environments and shared leadership environments needed to be improved: the team's ability to set priorities and keep all members actively participating in the project (40.63% of the external coaches identified this area); the team's ability to stay on task and adhere to schedules and deadlines (28.13% of the external coaches identified this area). The areas identified by the external coaches are directly related to the three dimensions of the internal team environment variable; the external coaches indicated that by improving these two areas of a team's internal environment, the teams would be able to improve the dimensions of their internal team environments as well as their degrees of shared leadership. The external coaches outlined the following recommendations for improving the teams' internal environments and shared leadership environments: the teams should establish methods to stay on task and set schedules and deadlines through the use of actions plans or WWWs (37.50% of the external coaches made this recommendation); the teams should set priorities to balance workload and project responsibilities amongst the internal

team members (28.13% of the external coaches made this recommendation); and the teams need to establish a clear communication plan for the members and outline how the tasks and responsibilities will be delegated to the team members (28.13% of the external coaches made this recommendation). The external coaches believed that by implementing these recommendations, the teams would be able to improve the two areas of concern and thus improve the three dimensions of the internal team environment.

5.4 Shared Leadership and External Coaching (Hypothesis #3)

5.4.1 General Discussion of Hypothesis #3 Results

This section highlights that no association existed between the external coaching and shared leadership variables in the Define phase, but that a direct relationship between the two manifested at all subsequent phases of the Six Sigma DMAIC process.

The purpose of Hypothesis #3 was to examine the relationship between shared leadership and the external coaching environmental condition at each phase of the DMAIC process. The data analysis identified that the theory was valid in only some of the phases of the Six Sigma DMAIC process. The findings from the hypothesis tests led to the conclusion that there was *not* a statistically significant difference between the external coaching and shared leadership variables at time period #1 but that there *was* a statistically significant difference between the external coaching and shared leadership variables at time periods #2, #3, and #4. Specifically, the statistical analysis indicated the existence of a direct relationship between the external coaching and shared leadership variables at the Measure, Analyze, and Improve phases of the DMAIC process. An in-depth review of the quantitative data for both variables showed that the rate of change that each variable saw was not the same for both variables.

5.4.2 The Relationship between Shared Leadership and External Coaching

This section provides an in-depth discussion about why no association was identified between the two variables at the Define phase as well as why an association existed between the two variables at the Measure, Analyze, and Improve phases of the projects. In the Define phase, the internal teams relied on the external coaching variable to help them accomplish their deliverables. Due to the complexity of the Measure, Analyze, and Improve phases, the teams needed to rely on both high degrees of shared leadership as well as the external coaching variable.

The Define phase of the projects showed no relationship between the external coaching and shared leadership variables. The quantitative data showed that at the start of any project, the teams' values of external coaching were relatively high since the team relied on the external coach to set the focus for the team and ensure that the team began the project in the proper direction. The quantitative data also indicated that at the start of any project, the teams' degrees of shared leadership were low to moderate since the team was only beginning to form and the internal environment was beginning to be developed. The finding that no relationship existed between the two variables at the Define phase implied that the values of the two variables could have been mutually exclusive. It is also possible that the effects of the external coaching took time to manifest themselves with respect to the improvement in shared leadership. The mentorship and guidance from the external coaches at the beginning of the project perhaps ensured that the teams moved forward with the proper focus, clear expectations, and a clear direction.

During the Define phase, the level of external coaching that a team received at the start of the project was pivotal and most likely the primary driver behind beginning a project in the right direction. In the Define phase, the data indicated that the level of external coaching that a team received was more critical than the team's degree of shared leadership and internal environment. The majority of the responsibility of the leadership role fell to the external coach. The internal leadership role and direction came from the external coach, who assumed a large amount of the internal leadership responsibility until the team was able to form its own shared leadership structure. The external coach provided direction and oversaw the tasks and actions completed by the internal team members and also performed some external leadership actions, such as providing guidance for the internal team members, securing funding and resources, and removing barriers or obstacles.

The relationship between the external coaching and shared leadership variables became evident and remained intact once the teams progressed to the Measure phase of the DMAIC process. At this stage, the teams' degree of shared leadership and the level of external coaching that they received were equally important towards successfully completing the deliverables and tasks associated with the Measure phase. As the teams progressed into the Measure phase, they started to develop their internal team

environments and improved their shared leadership values. The relationship with the external coaching variable was evident since the value of the external coaching was also high in the Measure phase. This same pattern held for both the Analyze and Improve phases of the projects. The quantitative data indicated that throughout all of the phases of the DMAIC process, the values of the external coaches were consistently very high. The internal team members regularly relied on the guidance of their external coaches even though the teams' internal team environments were becoming more autonomous and the teams' degrees of shared leadership were improving. As the projects progressed further into the DMAIC process, the needs, deliverables and tasks for each phase became much more tedious and complex, which required the leadership to be managed from both an individual internal and external perspectives; it was not effective to have the external coach manage the leadership responsibilities for both the internal and external roles.

As the teams developed their internal team environments and increased their levels of shared leadership, the internal team members were able to assume more of the responsibilities of the internal leadership role. As the internal teams became more autonomous and accepted the leadership responsibilities of the internal leader, the external coach was able to manage the growing complexity of the actions and tasks associated with their external leadership role, including: managing competing priorities and customer demands, providing guidance for the internal team members, securing funding and resources, and removing barriers or obstacles. Based on the changing needs and demands of the phases of the DMAIC structure, the relationship between the external coaching and shared leadership had to emerge. The data indicated that both variables needed to be present in moderate to high levels in order for the teams to experience success at the Measure, Analyze, and Improve phases. Throughout the execution of these projects, 93.75% of the internal team members believed that their external coaches provided a high and consistent level of guidance and support. 6.25% of the internal team members believed that their external coaches provided good guidance and support throughout the execution of the project, but needed to provide higher level and more consistent guidance.

5.4.3 The Critical Traits of an Effective External Coach

There were critical traits that the external coaches had to possess in order for the external coaching variable to be high. The presence or absence of these traits impacted the effectiveness of team completing their project phases and how effective these teams' shared leadership environments were. The discussions highlighted areas and traits of the external coaching role that the internal team members believed had to be improved in order to further strengthen the relationship between the external coaching and shared leadership variables.

The qualitative data found that 62.50% of the internal team members believed that the primary external coaching trait that impacted the success of the project and the degree of shared leadership was the external coach's willingness to provide mentorship and help the team at any point in the project. This trait had a significant impact on a team's ability to be successful at each phase of the projects as well as be successful in establishing a shared leadership environment. This trait was found to impact the level of shared leadership for a team since as the team became more autonomous and more cohesive, issues such as internal conflicts and resource availability became more frequent, requiring the internal team members to seek the guidance and mentorship from their external coach. The internal members indicated that in order to have a strong degree of shared leadership and internal team environment, the external coach needed to possess the willingness to provide mentorship and help the team at any point in the project.

The internal team members also identified additional significant traits that were critical for an external coach to possess. These included consistency of communication from the external coach to the team (18.75% of the respondents identified this trait) and the level of support and presence that the coach displayed (15.63% of the respondents identified this trait). The qualitative data indicated that the internal team members believed that these traits also had a significant impact on a team's ability to be successful at each phase of the projects as well as be successful in establishing a shared leadership environment. The internal members believed that external coaches should possess these traits since these traits would help influence a team in a similar manner as the primary trait identified above.

Since no relationship was identified between the two variables in the Define phase of the DMAIC process, it was important to identify what external coaching traits influenced the outcome of the teams' performance and their ability to establish shared leadership environments at that first stage. The qualitative data indicated that the internal team members believed that, in the Define phase, the external coaches did not provide sufficient levels of the following traits: the level of support and presence that the coach displayed, and consistency of communication from the external coach to the team. In the Define phase, the data indicated that 37.50% of the internal team members believed that the external coaches needed to improve how well and how consistently they communicated with the team. 37.50% of the internal team members considered that their external coaches needed to improve their level of support and how much time they spent with the teams to help them progress through the Define phase. The data indicated that these two external coaching traits were critical for the teams' success in the Define phase as well as the teams' ability to establish a shared leadership environment at this time period.

When it came to improving the level of external coaching that each coach displayed throughout the project, the internal members indicated that two specific external coaching traits needed to be improved, including: the external coach's willingness to provide mentorship and help the team at any point in the project (37.50% of the respondents identified this trait), and consistency of communication from the external coach to the team (37.50% of the respondents identified this trait). These traits also corresponded to the same external coaching traits that the internal team members identified as the most impactful to a team's ability to be successful at each phase of the projects as well as be successful in establishing a shared leadership environment.

5.4.4 The Impact of the Relationship on the Progress of a Project

The qualitative analysis identified that the relationship between the external coaching and shared leadership variables had a significant impact on two specific areas of a team's progress through the projects. Both of these areas have a significant impact not only on the relationship between the external coaching and shared leadership variables, but also on a team's ability to successfully complete the phases of the project and evolve their shared leadership environments.

The qualitative analysis identified that the relationship between the external coaching and shared leadership variables had a significant impact on two specific areas of a team's progress through the projects. From the internal team member perspective, 65.63% believed that relationship between the external coaching and shared leadership variables had the most significant impact on a team's ability to have a clear direction the deliverables and expectations for each phase of the projects. Internal team members responded that the ability of their external coaches to provide a clear direction on deliverables and advice to the team had an important effect on the team's ability to be successful at each phase of the projects and contributed to the establishment of a shared leadership environment. The external coach needed to establish and maintain a consistent level of communication with the team members and had to be available to provide the members with guidance and support as necessary.

The second area that this relationship impacted revolved around managing the team to ensure that they remained focused on the task and project deliverables; 28.13% of the internal team members believed that relationship between the external coaching and shared leadership variables had an important influence on the external coach's ability to ensure that the team remained focused on the task and project deliverables. The external coach had to consistently monitor the teams to make sure they remained focused on the project at hand and if they did become sidetracked, the external coach had to take action to adjust the team's focus. The external coach needed to establish and maintain a consistent level of communication with the team members as well as consistently review the progress of the teams' projects to compare their status against the expectations and deliverables for each phase.

5.5 Shared Leadership and Performance Metrics (Hypotheses #4 and #5)

5.5.1 General Discussion of Hypotheses #4 and #5 Results

The statistical analysis supported the conclusion that no association existed between the project completion and shared leadership variables or the customer satisfaction and shared leadership variables at either the Define or Analyze phases, but that a direct relationship *did* exist between both the project completion and shared leadership variables and the customer satisfaction and shared leadership variables at the Measure and Improve phases of the Six Sigma DMAIC process.

Hypotheses #4 and #5 sought to examine the relationship between shared leadership and the project completion (Hypothesis #4) and customer satisfaction (Hypothesis #5) performance metrics at each phase of the DMAIC process. The data analysis led to the conclusion that there was *not* a statistically significant difference between the project completion and shared leadership variables (Hypothesis #4) or the customer satisfaction and shared leadership variables (Hypothesis #5) at time period #1 and time period #3 but that there *was* a statistically significant difference between the project completion and shared leadership variables as well as customer satisfaction and shared leadership variables at time periods #2 and #4. The statistical analysis confirmed a direct relationship between the project completion and shared leadership variables as well as the customer satisfaction and shared leadership variables at the Measure and Improve phases but not at the Define and Analyze phases of the DMAIC process. The rate of change that each variable saw was not necessarily equivalent for the variables in both hypotheses.

5.5.2 How the Performance Relationships Fit into Six Sigma Environments

This section presents the reasons for the presence or lack of this relationship at each phase. The single largest driver of the relationship was change management and the complexity of the deliverables associated with the phase. The analyses supported the conclusion that in phases where a lot of change management was required, the shared leadership approach should be utilized by the internal team; if a phase did not require a lot of change management, then the shared leadership approach could be utilized but it would not add much value to the team's ability to have high degree of project completion and customer satisfaction.

The relationship between the project completion, customer satisfaction, and shared leadership variables were found to be necessary at both the Measure and Improve phases of the DMAIC structure for many reasons, including the complexity of these two phases. The Measure and Improve phases are stages of the DMAIC process that not only have many critical tasks and deliverables but also require a significant involvement on the part of the customer and extended team members (i.e. project stakeholders who are not on the core internal team but whose involvement in the project is required at different points or phases of the project). These phases are also points in the DMAIC process where the

internal core teams needed to manage the resistance and change management piece associated with quality improvement projects.

The Measure phase included several complex deliverables. The teams had to establish a measurement system, perform a measurement system analysis in order to validate their measurement system, collect a sufficient amount of data and perform a process capability analysis in order to establish a baseline of performance. The tasks related to data collection are often very tedious and time consuming. In order to level the workload and responsibilities for a team, the tasks associated with Measure phase had to be distributed amongst the team members. Based on the structured and sequential approach to the Measure phase, this phase required the involvement of not only the internal team members, but also the extended team members as well.

The Improve phase of the DMAIC process also included several difficult deliverables and tasks since it was the point in the project where the teams identified their improvement strategies and implemented them in order to improve the performance of their process and metric(s). They also had to prioritize the solution ideas in order to identify those vital improvement strategies that would provide the best impact for the process and performance metrics. Once prioritized, the teams had to develop implementation plans for each improvement strategy and perform a series of pilot tests to confirm the appropriateness of each improvement strategy. The implementation of improvement strategies required a lot of coordination of various pieces of the processes such as education, training, logistics, Information Technology systems, and approvals from leadership. In addition, the implementation of improvement strategies required the input and support from not only the leadership and customers, but also the frontline staff and stakeholders from the processes. The actual work and management required to implement improvement strategies was often seen as overwhelming and complex.

The Measure and Improve phases are points in the DMAIC process where the internal core team had to evolve how they handled the management of change since the extended team members and stakeholders began to show less involvement and support for the project due to the "resistance to change" issue as well as how much commitment these phases required from the extended team members. Based on the scope of the tasks and deliverables, stakeholders from throughout the process had to be involved in the Measure

and Improve phases. The core internal team could not complete the tasks and deliverables themselves since the deliverables touched too many areas of the process that were beyond the control of the team. In the Measure phase, without the active participation of the stakeholders and customer(s), the internal team would not have had the ability to obtain an accurate baseline of performance for the process. The involvement of the stakeholders and customer(s) enabled the internal core team to obtain a robust picture of how the process was currently performing, something that the internal core teams would not have been able to identify on their own. In the Improve phase, without the active participation of the stakeholders and customer(s), the internal team would not have the opportunity to effectively identify and implement the improvement strategies.

In either phase, if the deliverables are not completed within the proper timeframe, the core team would not be able to establish accurate baseline of performance for the process and therefore would not be able to identify the proper goals for the project, which in turn will affect a team's ability to meet the deadlines required for this phase and a team's ability to sufficiently satisfy the quality demands of their customer.

In order to properly manage and coordinate the involvement of all of the extended team members and customer(s), the internal core teams had to have a moderate to high value of shared leadership. The internal core teams knew that the responsibilities and actions associated with the leadership role in this phase was too complex for one member of their team to do by him or herself. They had to establish an effective shared leadership environment in order to evenly distribute the responsibilities and actions associated with the leadership role in this phase. Since the Measure and Improve phases not only included many deliverables and tasks, but also the management of the extended team members and customers who were actively helping to accomplish these tasks and deliverables, the internal core teams had to establish effective shared leadership environments for their projects in order to distribute the leadership responsibilities and accountability piece among the internal core team members.

Additionally, the internal core team had to contend with the resistance on the part of extended team members and the customers themselves. These extended team members and customers often felt that they had to do "more work" beyond their normal responsibilities. The issue of resistance also came about due to stakeholders being

resistant to change, as many people naturally are. This meant that the internal core team had to handle the responsibility of the change management aspect of the project. Due to the complexity of change management, the management of change was a responsibility that could not be managed by only one member of the internal core teams. The effectiveness of an improvement strategy is composed of both the quality of the solution as well as the acceptance of the solution. Without the buy-in and acceptance from the stakeholders and customer(s), the solution was not effective in improving the process and would have been difficult to sustain.

The buy-in and support piece of an improvement strategy had to be handled through effective change management. In both the Measure and Improve phases, the change management aspect was a critical aspect that had to be properly managed by the internal core team. In addition to managing the logistics involved with the participation of multiple extended team members and customers, the internal core team also had to manage the personalities and resistances displayed from the extended team members and customers. If the internal core teams did not handle these personalities and resistances appropriately, it would have had significant effects on their ability to meet the deadlines required for this phase. In order to manage these effectively, the internal core team had to establish a shared leadership environment that could handle the different forms of resistance that the internal core teams faced. The quantitative data showed a strong relationship between the teams' levels of shared leadership and their ability to successfully deliver on the project completion and customer satisfaction metrics during the Measure and Improve phases. Teams with low levels of shared leadership also had low to moderate values for the project completion and customer satisfaction performance metrics. Creating an effective shared leadership environment required the internal team to set up a team approach that enabled them to handle the logistical issues associated with the deliverables at each phase as well as the change management concern that was evident on all teams at both phases of the projects.

The data from the Define and Analyze phases indicated that while the values of the project completion and customer satisfaction variables were moderate to high for each team, the degrees of shared leadership were low to moderate at each of these phases. No direct association could be identified between these variables at these periods. The teams

were able to satisfactorily complete the project deliverables and meet the needs of their customers at these two phases by relying on team environments that were centralized around one or two specific team members for each team. One can therefore conclude that while a moderate to high degree of shared leadership may have helped the teams in these two phases of the DMAIC process, it was not required for the teams to provide their customers with satisfactory degrees of project completion and customer satisfaction. The statistical analyses found the primary drivers behind the lack of relationship between the variables at the Define and Analyze to be the degree of change management and the complexity of the deliverables associated with these phases.

The needs of the project and team were different during the Define and Analyze phases. In the Define phase of the DMAIC process, the teams had to complete several deliverables such as project scoping and problem definition, development of a project charter, identification of customer requirements, and the completion of a critical to quality (CTQ) tree. During the Analyze phase, the teams had to complete deliverables such as creating a cause and effect diagram, completing a failure modes and effects analysis, developing a hypothesis testing plan, executing the hypothesis testing plan; performing a five-why analysis, and identifying the vital factors that drive the performance of their process and metric. The degree of change management required in these phases was much less than the degree observed in the Measure and Improve phases.

The change management needs of these phases were different than the change management needs associated with the Measure and Improve phases, which in turn affected the overall degree of complexity for these two phases. The deliverables associated with the Define and Analyze phases were tasks that did not require a significant amount of input and involvement from stakeholders beyond the internal core team. By not requiring as much input and involvement from stakeholders, the degree of change management and managing the "people piece" was not as complex during the Define and Analyze phases as it was during the Measure and Improve phases.

In order to satisfactorily complete the project deliverables and meet the needs of their customers at any phase in the DMAIC process, the creation of a shared leadership environment is critical during phases that require a high degree of change management and logistics such as the Measure and Improve phases. If a high degree of change

management was not a critical aspect of the phase, the internal teams could satisfactorily complete the project deliverables and meet the needs of their customers by relying on a leadership environment that was centralized around one or two key team members; this held true for the Define and Analyze phases.

5.5.3 How to Improve the Performance Metrics in Six Sigma Environments

This section highlights that the external coaches believed that internal teams could improve their degrees of project completion and customer satisfaction by focusing these two key areas: "improved their mechanisms to set deadlines and schedules for each deliverable and task" and "improving their abilities to work collaboratively as a team and by establishing a more effective method to delegate tasks to each internal member of the team." From the customer satisfaction perspective, the external coaches' qualitative data implied that the internal teams should focus on these two key areas: "establish more effective mechanisms to obtain and maintain the support and buy-in from their customers and stakeholders throughout each phase of the projects" and "develop mechanisms to ensure that the team's focus and direction aligned with the expectations, needs, and requirements of their customers."

All teams had high values of the project completion and customer satisfaction variables throughout the phases of their projects. The qualitative data indicated that the external coaches believed that internal teams could improve their degrees of project completion by focusing on two key areas. The data indicated that 40.63% of the respondents believed that the internal teams could improve their degrees of project completion if they improved their mechanisms to set deadlines and schedules for each deliverable and task. Establishing a mechanism to oversee that the team members worked on task and worked to the specific deadlines and schedules was also deemed important. Additionally, the survey data indicated that 34.38% of the respondents thought that the internal teams could improve their degrees of project completion by improving their abilities to work collaboratively as a team and by establishing a more effective method to delegate tasks to each internal member of the team. The respondents highlighted these two areas of improvement since they believed that these areas had a significant influence on the teams' ability to complete the project deliverables and tasks in the proper timeframe for each phase of their projects. By focusing on improving these two areas of

the team environment, the respondents thought that the teams could see a significant improvement not only in their ability to complete the project deliverables in a timely manner but also improve the teams' shared leadership environments.

From the customer satisfaction perspective, the qualitative data indicated the internal teams could improve their degrees of customer satisfaction if they focused on a two key areas. The survey data indicated that 50.00% of the respondents thought that the internal teams could improve their values of customer satisfaction if they established more effective mechanisms to obtain and maintain the support and buy-in from their customers and stakeholders throughout each phase of the projects. In addition, the qualitative data identified that 25.00% of the respondents believed that the internal teams could improve their values of customer satisfaction if the team developed mechanisms to ensure that the team's focus and direction aligned with the expectations, needs, and requirements of their customers. The respondents highlighted these two areas of improvement since they believed that these areas had a significant influence on the teams' ability to develop solutions and deliverables that met the quality standards and needs of their customers. By focusing on improving these two areas of the team environment, the respondents thought that the teams could see a significant improvement not only in their ability to provide their customers with high quality solutions and deliverables but also improve the teams' shared leadership environments.

5.6 General Findings

5.6.1 External Coaching and Performance Metrics

This section discusses the belief that the external coaching variable had a significant impact on the customer satisfaction and project completion variables throughout each phase of the DMAIC process. The qualitative data also indicated that the high degrees of the external coaching contributed to the direct association that was identified for the project completion and shared leadership variables as well as for the customer satisfaction and shared leadership variables at both the Measure and Improve phases. Four key areas of improvement would enable the internal teams to further improve the values of their project completion and customer satisfaction variables as well as improve the overall teams' shared leadership environments: setting deadlines and schedules for each project tasks and ensuring that the team adheres to the specific deadlines and

schedules, working collaboratively as a team and delegating tasks to each member, obtaining and maintaining the support and buy-in from their customer and stakeholders, and aligning the team's focus and direction with the expectations and requirements of the customers.

The qualitative data indicated that the external coaching variable had a significant impact on the customer satisfaction and project completion variables throughout each phase of the DMAIC process. Specifically, high degrees of the external coaching variable were correlated with high degrees of project completion/shared leadership and customer satisfaction/shared leadership variables at both the Measure and Improve phases. The qualitative data showed that the level of support provided by the external coaches had a significant impact on the teams' ability to complete the project on time at each phase of the projects. More specifically, the survey data indicated that 56.25% of the respondents believed that the level of guidance displayed by the external coaches helped the teams to establish a clear direction and stay on task, which in turn helped improve the teams' ability to complete the project on time at each phase of the DMAIC process. The data also showed that 21.88% of the respondents believed that the level of support displayed by the external coaches helped the team to establish a collaborative environment, which also helped improve the teams' ability to complete the project on time at each phase of the DMAIC process.

The qualitative data also implied that the level of mentorship displayed by the external coaches had a significant impact on the teams' ability to complete the project deliverables associated with each phase of the DMAIC process. More specifically, the survey data indicated that 50.00% of the respondents believed that the level of mentorship, that the external coaches provided to the teams helped them to remain focused on the objectives of each phase and to effectively complete the project deliverables for each phase. 34.38% of the respondents believed that the level of support displayed by the external coaches helped the teams to effectively complete the project deliverables for each phase.

The survey data showed that the level of support displayed by the external coaches had a strong impact on the teams' ability to satisfy the expectations of the customer at each phase of their projects. The data showed that 43.75% of the respondents believed

that the level of support exhibited by the external coaches helped the teams to identify the customer expectations and requirements, giving them all the necessary information to satisfy the needs of the customer at each phase of the projects. Additionally, 28.13% of the respondents indicated that the level of mentorship displayed by the external coaches aided the teams in establishing a clear direction and focus that aligned with the expectations and requirements of the customer. The survey indicated that the external coaches were effective in helping the teams to identify the expectations and requirements of their customers, helping the teams to further evolve their shared leadership environments and subsequently the teams' degrees of customer satisfaction.

The qualitative data for the customer satisfaction variable also indicated that the level of guidance displayed by the external coaches had a significant impact on the degree of quality for the deliverables and tasks associated with each phase of the DMAIC process. 62.50% of the participants believed that the external coaches' level of support had the most impact when helping the team to align the deliverables and solutions with the needs and requirements of the customer. An additional 25.00% of the participants indicated that the external coaches' level of support had a lot of influence helping the team to obtain the buy-in and support from the customer and stakeholders. Together, these factors helped the team to provide the customer with deliverables and solutions in line with quality expectation as well as helped the teams to further evolve their shared leadership environments.

This qualitative data supports the conclusion that the external coaching variable had a significant impact on the teams' ability to complete the deliverables and tasks associated with each phase in a timely manner and to produce high quality solutions and deliverables at each phase of the DMAIC process.

5.6.2 General Factors Affecting the Five Study Variables

This section presents that the study identified several general components of the DMAIC structure that affected the five variables from the study as well as the teams' general ability to be successful in their projects. These general components included: the training and educational model utilized by the NSLIJ Health System, the complexity of change management in the team environment, time and resource commitment of the internal team members, external coaches' method to explain expectations and

deliverables for each phase, and the mechanism of communication between the external coaches and the teams. By focusing on improving these general issues, it is believed that the teams would be able to improve the five variables throughout the phases of the project as well as improve the ability of the teams to be successful in their projects.

The research study identified several general components of the DMAIC structure that affected how the five variables developed throughout the projects. These components also affected the overall execution of the DMAIC process from an organizational point of view. These general components consisted of: the training and educational model utilized by the NSLIJ Health System, the complexity of change management in the team environment, time and resource commitment of the internal team members, external coaches' methods to explain expectations and deliverables for each phase, and the mechanism of communication between the external coaches and the teams.

The educational components and training related to the DMAIC process was identified as a factor that contributed to the performance of the five variables. As explained in the literature review section, the NSLIJ Health System uses an educational model that provides concurrent training to Six Sigma teams as the teams perform Six Sigma projects. The model is set up such that before the teams begin a particular phase of the DMAIC model, they receive training on the concepts and tools associated with that phase. At the completion of the training, the teams then execute the phase by applying the tools and concepts they have just learned. The teams must satisfactorily complete the phase before receiving training on the tools and concepts of the subsequent phase.

The study found that while this approach is effective at providing the teams with the knowledge and skills that they need to complete each phase of the DMAIC model, the team members had a difficult time comprehending the concepts and tools associated with many of the phases, especially the Measure, Analyze and Improve phases. While the teams successfully achieved their project deliverables and objectives, many team members believed that concepts and tools taught in the educational model was a barrier to the team's overall effectiveness. The concepts they had to learn added another layer of complexity to their already complex projects. The students that took part in the Six Sigma projects were being exposed to Six Sigma and its associated concepts and tools for the first time; the members felt overwhelmed by the magnitude of training and complexity of

the material, which had a tendency to increase their apprehension when it came to participating in the Six Sigma projects. Many members indicated that before the projects started, they were not aware that the Six Sigma training material was difficult or complex. This in turn caused many of the team members to be overwhelmed by the entire Six Sigma model and as of a result, many of the teams tended to rely on the knowledge and comprehension of a particular member(s) of their teams. This member acted as the resource that helped the teams understand the tools and their application with respect to completing the deliverables for each phase by the required deadlines. This reliance on one or two members of the teams drastically affected the teams' degree of shared leadership and internal team environment, which in turn affected their ability to have satisfactory degrees of project completion and customer satisfaction.

Additionally, instead of the teams becoming more autonomous, they relied heavily on their external coaches throughout all phases to help them apply the tools and concepts and to clarify the expectations of each phase. The teams noted that many of the members typically left the training sessions without a solid understanding of the expectations of the phase and how the tools and concepts would help them to achieve these expectations. The complexity of the training material led the teams typically to consistently reach out to their external coaches. The internal members believed that the expectations and deliverables for each phase should have been more clearly conveyed by the external coaches during the training modules. The internal members believed that this would have enabled the teams to start the phases in the proper direction and not need to constantly ask their external coaches to clarify the deliverables and expectations for each phase throughout the projects. The quantitative data showed that the teams relied heavily on their external coaches throughout each phase of the project and that this reliance affected their degree of shared leadership. The high levels of external coaching were linked to the teams' ability to have satisfactory degrees of project completion and customer satisfaction.

While the members believed the training was necessary, they thought that the amount of material could have been reduced and simplified. More specifically, the internal members believed that the amount and difficulty of the material at the Measure, Analyze, and Improve phases could have been modified in order to help reduce the complexity of

the educational model for the team members. For example, the internal members identified that the measurement system analysis (MSA) and process capability tools tied to the Measure phase were complex and difficult to comprehend during the training module and difficult to execute in their real-life projects. With respect to the Analyze phase, the internal members believed that the hypothesis testing and failure modes and effect analysis (FMEA) tools and concepts were also difficult to understand during the training module and to implement. The design of experiments and "five-why analysis" tools and concepts from the Improve phase were similarly thought to be complex and difficult to carry out in the actual project. The study concluded that if educational materials for the tools and concepts outlined above were modified, the internal team members would not have perceived the Six Sigma training model as overwhelming and would have an increased comprehension of the material and tools. This may have helped the teams increase their degrees of shared leadership and internal team environment since all of the members of the teams could have been actively relied upon to lead the team with respect to using the tools and completing the deliverables.

Change management was a large and complex segment of the DMAIC approach to quality improvement. Change management involves the aspects of change that relate to the human condition and the various forms of resistance that may be displayed by stakeholders throughout the phases of the project. The effectiveness of any quality improvement project is based on two aspects: the quality of the solutions/deliverables and the acceptance of the solutions by the stakeholders and customers. The acceptance is the segment that requires an effective change management methodology and the change management task was a responsibility of the internal team members of each team and, in some cases, the external coach as well. The complexity of change management in the team environment appeared to have a significant impact on the performance of the five variables for each of the teams in this study. The varying degrees of complexity for change management that the teams were faced with at each phase of the projects had a significant impact on the degree of shared leadership that the teams displayed during those phases. The degree of complexity for change management also affected how heavily the teams relied on their external coaches, especially in team environments that had consistently low degrees of shared leadership. By affecting the shared leadership,

internal team environment, and external coaching variables, the degree of complexity for change management also impacted the teams' values for the project completion and customer satisfaction variables, since these two variables were found to have some degree of association with the shared leadership, internal team environment, and external coaching variables.

The data from the study identified that the internal team members consistently felt unprepared to handle the complexity of change management and the tasks involved with managing change. The team members felt that the Six Sigma training and educational model should be modified to include more change management material in order to ensure that they had the necessary skills to handle the responsibility of change management. More specifically, the members believed that the training and educational modules from the Measure, Analyze, and Improve phases should be modified to include more change management material since these were the phases of the projects where the members believed that change management was the most complex and where they typically experienced substantial resistance. The members indicated that they were able to "work through" the change management challenges, but felt that they could have managed these challenges more effectively if the teams were more prepared through training and education.

The time and resource commitment of the internal team members was also identified as a factor that affected the five variables in the study as well as the overall effectiveness of the teams. One of the requirements that internal members had to satisfy in order for them to take part in the Six Sigma projects was that their supervisors had to allow them to dedicate 25% of their time to the project itself. During the study, many of the internal participants realized that they could not dedicate the time and resources required for the projects, mainly due to conflicting priorities. The conflicting priorities caused the workload and leadership responsibilities to be unevenly distributed amongst each of the teams. This caused issues with the values of the teams' degrees of internal team environment and their shared leadership dynamics. A decrease in shared leadership negatively impacted the customer satisfaction and project completion variables as well. The study identified that in order to improve the internal team environment and shared leadership variables, all members had to dedicate the required time and resources

throughout the project as originally outlined when the projects began. This in turn would have helped the teams to further improve their customer satisfaction and project completion variables.

The study also identified that the method that the external coaches used to set the expectations for their teams for each phase was difficult to understand from the perspective of the internal team members, and the message was not uniform across all of the external coaches. The current Six Sigma structure employed by the NSLIJ Health System requires the external coaches to explain the expectations and requirements for each phase during the training modules. As explained earlier, the training approach used by the health system was often viewed as overwhelming for the students, due to the magnitude of the information and complexity of the information. Each phase includes a series of expectations and deliverables that need to be completed before the teams can proceed; the explanation of these expectations and requirements is critical since its purpose is to ensure that the teams begin the phases in the proper direction and successfully meet the deadlines for each phase. The data showed that often times the students did not understand the expectations and deliverables as explained by their external coaches, resulting in the teams needing to constantly ask for their external coaches to clarify expectations and help them to understand how to apply the tools and concepts to complete the deliverables of the various phases. The study also found that the external coaches did not convey the message to their teams in a uniform manner; some coaches were more specific than other coaches and some coaches required their teams to do other requirements and tasks in addition to the normal tasks and deliverables for the phases. A non-uniform explanation of the expectations and requirements made it more difficult for the teams to understand what they needed to do for each phase and how they needed to proceed through the DMAIC process. It is important for the external coaches to share a standard and universal method of explaining the expectations and requirements for each phase. It is critical for the external coaches to convey the same message and with the same level of detail across all of the teams since this will provide each team with the same opportunity to be successful in the phases of their projects and the overall project objectives. By improving how the expectations are explained and by having a uniform method that is used by all external coaches, the team would be given an opportunity to be

successful in the phases of their projects and in achieving high values of the five variables that were studied by this research.

Consistency of communication also had a significant effect on the five variables from the study. Throughout the projects, the external coaches held several coaching calls and coaching visits in order to check on the progress of the teams throughout the DMAIC process. The study found that the frequency of the calls and visits were not sufficient to ensure that the teams were making effective progress with their projects. Often, when a team encountered an obstacle or issue that required the help or support of their external coach, the teams would wait for the coaching call or visit to make their coach aware of the issue or obstacle. The teams were not aware that they should contact their coaches immediately if the teams were faced with an obstacle or issue that required the help or support of the coach; as a result, the coach's support was more reactive than proactive. The current frequency of communication between the external coaches and the teams was found to be insufficient for identifying and mitigating issues or obstacles in a proactive and timely manner. If the frequency of the communication or the mechanism of communication was modified and improved, the external coaches and teams would be able to proactively identify and resolve issues in a timely manner instead of waiting for them to become more severe.

CHAPTER 6
6. CONCLUSIONS

6.1 Contributions to the Body of Knowledge

This research study was a first step in studying how leadership, input variables, and performance metric variables develop and change in the realm of quality improvement teams. This study provided an effective foundation that can be used by future researchers to build this field of research. Since there was limited research performed in this field previous to this study, it is recommended that future research be performed in order to build a stronger research foundation and discover new conclusions and advancements.

Overall, the research effort successfully achieved the main goal for this study. The research analyzed the five variables in order to test the five hypotheses and assess the relationships that existed among the five variables at each phase of the DMAIC process. The research found that shared leadership had unique relationships with each of the four additional variables investigated in this study, but that there were also several factors that affected the performance of these five variables throughout the phases of the DMAIC process. The concurrent mixed methods approach that was used provided the researchers with the ability to collect the necessary qualitative and quantitative data to achieve the main objective that was defined for this project. The outcomes of the study can be used by researchers to build even more robust and effective research designs for future research efforts in this field. This study concluded that shared leadership has a statistically significant impact on a team's internal environment as well as the external coaching displayed by the external mentors for each team. This work also identified that at specific phases in the DMAIC model, shared leadership had a significant impact on a team's ability to complete the deliverables for each phase in a timely manner and to satisfactorily address the requirements and needs of their customer.

The role and importance of shared leadership cannot be stressed enough; this variable has influence and relationships with several other factors, such as change management and decision-making, which also have an effect on a team's environment and its ability to effectively complete the phases of the DMAIC model. The value of the shared leadership approach to any quality improvement team cannot be doubted. In order for organizations to be effective, they must rely on quality improvement projects to maximize both

efficiency and efficacy. An organization can gain an edge with quality. Many organizations use quality improvement projects as the mechanism to build quality into their products and services. Using the shared leadership approach is a proven method for driving results and increasing quality improvements within the NSLIJ Health System organization. Understanding the impact and relationship(s) that shared leadership has on quality improvement projects can provide an organization with several benefits, such as an improved ability to complete its quality improvement projects in an efficient and high quality manner.

The results of the study have contributed to several fields of research, such as leadership development, team dynamics, the Six Sigma and improvement science methodologies, change management, and shared decision-making. The results of this study have helped to build on knowledge from previous studies as well as validate findings from previous studies. Throughout this section, as I discuss the contributions from this research, I will also reference the specific previous studies that this study impacted.

6.1.1 Field of Leadership

From the leadership perspective, previous studies identified from the Gap Analysis (reference Chapter Two for Alavi et al., 2004; Carson et al., 2007; Avolio et al., 1996; Liu & Wei, 2005; Koschzeck, 2009; Mayo et al., 2002; Meyers, 1997, and Yang, 2010), have not focused on how shared leadership develops over the duration of a project. Note Avolio et al. and Meyers performed a longitudinal study on shared leadership but did not measure shared leadership throughout their studies. In addition, these previous studies have investigated leadership from a before and after perspective. These previous studies have investigated the relationships that shared leadership had with different input conditions, but only from a before and after perspective. These studies also investigated how shared leadership impacted performance metrics from a before and after perspective. The results of this study fill in the gaps from previous studies (and add to these studies) since my study investigated that shared leadership development and the relationships (impact) that shared leadership had on two input factors and two performance metrics over the duration of a whole project were examined. By studying these variables over the course of a project, this study provided a more robust view into how these variables

change over a project and how these changes impact the relationships that the variables have with each other at different points in a project. Some relationships only manifested themselves during the middle portions of a project; investigating these variables with a before and after study would have missed the relationships that were only present in the middle segments of a project. This study contributed to the body of knowledge by identifying the relationships that existed between the five variables at each phase of a project and mapping out how these relationships changed over the course of the phases of a project. The study also builds knowledge since my study was also identified the outcomes (team performance, team dynamic, organizational, etc) that were affected as a result of the development of these relationships. Reference Chapter Five for further information about these findings.

This study expands on the body of knowledge since the findings from this research open new avenues of future research into the field of leadership and the relationships between the other variables from this study. All of these findings can be utilized by future researchers who seek to perform more research in the field of leadership or the other variables from this study since my study identified several factors that affected the five variables as well as the outcomes that are affected by the five variables. A researcher could utilize my findings to build new research designs and study that investigate these variables in a more in-depth manner as well as design research studies that perform a more in-depth investigation into the factors that affected the five variables as well as the outcomes that are affected by the five variables. The findings from this research open new avenues of future research into the field of leadership and the relationships between the other variables from this study. Future researchers could utilize the knowledge identified from my study to future investigate the degree of impact that and how each factor had on the development of the five variables and the five relationships; in addition, future researchers could utilize my findings to study to what degree each relationship and variable impacted the "affected outcomes" outlined in my study.

This study fill in the gaps from these previous studies (and add to these studies) (reference Chapter Two for Goktepe & Schneider, 1983; Hackman, 1987; Kouzes & Posner, 2002; Pearce, 1997; Thompson, 2008; Wageman, 1997; 2001; and Ziegert, 2005) by identifying that a team's leadership approach typically changes over the course of a

project in order for a team effectively manage the deliverables and requirements of a phase of a project. The study found that specifically in order to satisfactorily complete the project deliverables and meet the needs of their customers at any phase of a project, if a phase required a high degree of change management as well as logistics to complete the phase's deliverables. The team would then typically rely on a shared leadership environment to properly accomplish the objectives of the phase. In phases of a project where a high degree of change management was not a critical aspect of the phase and the deliverables were not as complex, a team could satisfactorily complete the project deliverables and meet the needs of their customers by relying on a leadership environment that is centralized around one or two key team members instead of utilizing the shared leadership approach. This finding leads to the implication that engineering management practitioners need to be aware of the deliverables and change management needs of their projects at different points in a project in order to anticipate how the team needs to adjust its leadership approach to effectively meet the deliverables and demand of their projects.

In addition, this study builds knowledge in the field since the results highlight that the type of leadership approach and decision-making approach employed by a team are linked and both have critical impacts in several areas of team development as well as team performance. My study evolves previous research in the field of leadership (referenced in Chapter Two for Cannon-Bowers et al., 1993; Carson et al., 2007; Cervone, 2005; De Dreu et al., 2001; Gelzheiser et al., 2001; Jones & Roelofsma, 2000; Kocher et al., 2006; and Yang, 2010) since these studies have identified a potential relationship between the leadership approach and decision-making approach employed in a team environment. My study identified a direct relationship between decision-making and leadership in a team environment, and found that both the type of leadership approach and decision-making method usually changes over the course of a project in order for a team to effectively manage the deliverables and requirements of a phase of a project. At points in a project where teams had low degrees of shared leadership, they typically relied on a "single leader individual decision method" to make decisions related to their projects. In cases where the teams had moderate to high levels of shared leadership, the consensus decision-making approach was typically employed by the

teams. In addition, the results of the research highlight the belief that a team's level of effectiveness and success in decision-making is directly linked to the degrees to which team members are actively engaged in decision-making, which in turn implies that a team's level of effectiveness and success in decision-making is directly related to the type of decision-making approach being employed by the team. For engineering management practitioners, this implies that the type of leadership approach a team utilizes does make a difference in the execution of a project and that a team needs to choose their form of leadership to be appropriate to the needs of the project and team dynamics. Engineering management practitioners need to be aware of these relationships and understand that the leadership approach and decision-making approach utilized in their team environment has consequences on the effectiveness of the team as well as the team's performance. This finding also implies that engineering management practitioners need to be aware of the deliverables and change management needs of their projects at different points in a project in order to be able to anticipate how the team needs to adjust its leadership approach and decision-making strategy so that the team can still be effective in meeting the deliverables and demand of their projects.

6.1.2 Field of Team Dynamics

From the field of team dynamics, this study contributed to the knowledge by showing a direct relationship between shared leadership and internal team environment. The results of my study fill in the gaps from these previous studies (and add to these studies) (reference Chapter Two for Avolio et al., 1996; Carson et al., 2007; De Dreu et al., 2001; Johnston & Wheelan, 1996; LePine & Van Dyne, 1998; Seers, 1996; and Wageman, 1997) since my study shows that a primary driver behind this relationship was the presence of the three dimensions of the internal team environment condition. The study identified that shared purpose, social support, and voice had to be present in the team environment in order for the relationship between shared leadership and internal team environment variables to develop. In addition, the study found that the teams had to place equal and strong importance on developing each dimension. As these three dimensions became stronger, the study found that the relationship between the shared leadership and internal team environment variables also grew stronger. This finding implies that engineering management practitioners need to be aware of the three dimensions of the

internal team environment condition and place equal but strong importance on developing each dimension, which will result in the development of the relationship between shared leadership and internal team environment. The presence of this relationship impacts several outcomes (refer to Chapter Five) in the team environment.

This study also builds knowledge in the field from previous studies (reference Chapter Two for Hackman & Wageman, 2005; Johnston & Wheelan, 1996; Manz & Sims, 2000; Marks et al., 2000; Pearce & Ravlin, 1987; Thompson, 2008; Wageman, 1997; 2001) since the study found that a coach's level of involvement and style of coaching had an impact on the relationship between shared leadership and internal team environment. The level of involvement and style of coaching had impact on every variable studied in this research, but an external coach cannot rely on only one level of involvement and style of coaching. The level of involvement and style of coaching from the external coach has to be adjusted throughout a project in order to provide the degree of support that a team needs to achieve the deliverables and requirements of a phase of a project. This builds on the body of knowledge since for implies that in order to be an effective coach, engineering management practitioners need to be able to continuously gauge the performance of their team and as a result, the coach needs to be able to adjust their level of involvement and style of coaching in order to provide the team with the optimal level and style of coaching.

The study also expanded the body of knowledge since it identified specific traits that an external coach needs to possess in order to be an effective external coach. One of the most important traits was willingness to provide mentorship and help the team at any point in the project. A second trait was a coach's ability to provide a clear and consistent explanation about the requirements and expectations of a project as well as the deliverables for each phase. The study found that these impacted several areas of the team environment as well as a team's performance; the presence or absence of these traits impacted the effectiveness of team completing their project phases and how effective these teams' shared leadership environments were. If the external coach focused on developing and strengthening the critical traits, the external coach will strengthen the relationship between the external coaching and shared leadership variables and have an improved ability to assess the needs and status of their teams and adjust their level and

style of coaching. These findings lead to the implication that engineering management practitioners should utilize the findings in order to strengthen their ability to be effective coaches to their teams.

6.1.3 The Six Sigma and Improvement Science Methodology

The results of this study validate findings from these previous studies (and add to these studies) since previous research about project and work team environments (reference Chapter Two for Adams et al., 2009; Alavi et al., 2004; Bell & Kozlowski, 2003; Chatfield, 2011; Ensley et al., 2006; Hackett et al., 1999; Hackman, 1987; Kirkman and Rosen, 1997; Langfred, 2004; Pearce & Ravlin, 1987; and Wageman, 1997; 2001) has shown that effective communication and accurate commitment of time from team members are pivotal towards an effective execution of a project. The results of this study built on this body of knowledge since the findings confirmed that in Six Sigma project environment, communication and accurate commitment of time from resources were critical to effectively completing the deliverables of each phase of the Six Sigma projects. The study confirmed the belief that consistent internal and external communication is critical to establishing an effective shared leadership environment. Communication is pivotal to a shared leadership environment and a team's ability to effectively achieve the deliverables of each phase of their projects.

The accurate commitment of time from team members also impacted a team's degree of shared leadership. In cases when internal members could not remain committed to the team, the teams typically had lower degrees of shared leadership. In teams where all members were consistently present, the teams displayed high degrees of shared leadership. The findings from this research lead to the implication that engineering management practitioners need to establish proper mechanisms to establish and maintain effective communication throughout a project. In addition, these findings imply that engineering management practitioners need to properly assess the needs of a project in order to accurately assign resources to a project. The absence of these two factors will not only impact team performance of the project, but also impact a team's ability to form establish and maintain a shared leadership environment.

The study also contributes to building knowledge from previous research (reference Chapter Two for NSLIJ Health System research and American Society for Quality, 2011)

in the field of Six Sigma and improvement science methodologies by showing that the structure of the Six Sigma DMAIC structure has significant impact on the development of shared leadership and the relationships with the other four variables from the study. The study builds knowledge by showing that the deliverables and degree of change management associated with each phase impacted how the five variables developed in the course of the Six Sigma project. The studies also showed that the complexity of the deliverables and degree of change management associated with phases were the main drivers behind the type of leadership approach and decision-making method employed by the team.

The results of the study highlighted that in a Six Sigma environment, the teams adjusted their leadership approach and decision-making method based on the complexity of the deliverables and change management needs associated with a specific phase. The phases of the DMAIC structure were found to directly impact a team's degree of shared leadership, the degree of team cohesiveness, and the type and degree of external coaching that the external coach need to provide the team. From an improvement science perspective, these findings imply that at times when a project involves complex deliverables and high degrees of change management, the engineering management practitioners will tend to rely on specific forms of leadership and decision-making methods. These findings imply that engineering management practitioners that utilize the Six Sigma methodology and improvement science methodologies need to recognize the points in the projects where there are highly complex deliverables and high degrees of change management and provide the teams with the training and knowledge to properly adjust their leadership and decision-making approaches.

The study has shown that in a Six Sigma environment, a team's ability to meet the deadlines and deliverables of each phase as well as the quality requirements of their customers is impacted by several factors, but a team's performance is directly impacted by the shared leadership, internal team environment, and external coaching variables. These relationships are especially apparent at specific phases of the Six Sigma structure. The study has built knowledge in this field by showing that in order for a team to have a strong ability to meet deadlines and quality requirements of their customers, the teams

need to possess strong degrees of shared leadership, internal team environment, and external coaching.

This study builds knowledge in the field of Six Sigma and improvement science since the study showed that the improvement science training model utilized to train teams on the Six Sigma methodology and tools has an important influence on a team's ability to achieve an environment with a high degree of shared leadership. In addition, the study showed that the improvement science training model impacts the team members' ability to utilize to tools and concepts to effectively management the deadlines and quality requirements of each phase and the project as a whole. The quality and robustness of a training model has a direct impact on a team's ability to apply the knowledge to their project and to effectively manage the tasks and outcomes of their projects.

6.1.4 The Impact on Social Network Theory and the Leadership Field

The results of this study fill in the gaps from previous studies and expand on previous studies (reference Chapter Two for Andrews & Ibarra, 1993; Brass & Burkhardt, 1992; Carson et al., 2007; Dixon et al., 2006; Freeman, 1979; and Mayo et al., 2002). Overall, the use of social network theory in this study has affirmed that social network theory is a tool that can applied to longitudinal studies in order to study how leadership changes in project environments over the course of a whole project and not only the start and end of a project as well as applying social network theory to different research constructs in order to investigate how leadership develops in relation to other factors such as external coaching or customer satisfaction. This study has shown that social network theory has several applications in the field of leadership development and team dynamics. The use of social network theory adds a layer of complexity to a study, but it provides a researcher with a more robust view into leadership development and team dynamics.

As explained in Chapter Two, social network theory can enable a researcher to study a team environment and learn about the leadership interactions that each member has with each of their team members and how they change from time period to time period and at any point in a project. In addition, the centralization metric, part of social network theory, is composed of individual centrality values (for each value) as well as a team-level metric; this unique feature can enable a researcher to measure the individual leadership value for each team member as well as the team-level metric. From this point,

by utilizing the individual and team leadership values in a longitudinal study, one can study how leadership changes at the individual and team level as the team(s) progresses through a project. These are two features that are unique to social network theory, but the issue identified from the gap analysis was that social network theory has been utilized to its fullest extent by researchers. Previous studies that utilize social network theory to study leadership development in project teams, only gathered data at the start and end points (before and after) of projects.

This study employed social network across each phase of Six Sigma projects, and the success of this study validates that social network theory is a valid approach to not only study how leadership changes from the start and end points of a project, but in a longitudinal manner across the entire duration of a project. The results of this study highlight that social network theory produces valid data that enables a researcher to learn about the leadership interactions that take place throughout a project (i.e. longitudinal study) and not just the start and end points. The application of social network theory to longitudinal studies provides a researcher with a more robust view into how leadership changes in project environment since it not only enables a researcher to see the development from a before and after perspective, but also from a continuous perspective by investigating the variable at each point of a project.

A second major implication, which helps to build knowledge into the field of social network theory and leadership development, is that this study shows that social network theory can be employed with different research constructs to formulate an effective mixed method design, which can be utilized to study how leadership changes in relation to other variables such as internal team environment or project completion. For example, social network theory was utilized to measure the shared leadership variable on a specific scale (based on a specific formula), but the other input and output variables investigated in this study were measured and analyzed on a different type of scale (Likert scale in the opposite direction of the shared leadership variable). The different forms of measurement and definition for the variables added another layer of complexity to the study, especially in terms of analysis and data collection aspects. This type of complexity requires proper planning on the part of the researcher since a mixed method design can impact the analysis methods and data collection methods utilized in a study. But the successful

execution of this study demonstrates that with proper planning, social network theory can be utilized in conjunction with other research constructs (measurement tools and designs) to produce a robust set of data and conclusions for a study.

6.1.5 The Impact of Change Management on Shared Leadership and Six Sigma Teams

The findings from the study lead to the identification of two key implications for engineering management practitioners. The first implication revolved around the need for internal members and external coaches to have the ability to identify and understand the relationship between change management and leadership. The second implication was that a Six Sigma training program needed to include educational modules on the topics of change management and leadership.

In order to successfully complete the deliverables and tasks and manage the varying degrees of change management at each phase of the DMAIC structure, a Six Sigma quality improvement team and external coaches need to identify the relationship between the two factors investigated in this study, and understand the effects that degree of change management complexity has on a team's ability to select an appropriate leadership approach at each phase of their project(s), in order to achieve the objectives of each phase of their projects. From the perspective of the Six Sigma quality improvement team, being able to identify the effect that change management has on a team's degree of leadership will enable the team to select the appropriate leadership structure, which will empower the team to effectively respond to the dynamic demands of the degree of change management complexity observed at each phase of the DMAIC structure. This in turn will enable the team to effectively achieve the deadlines for each deliverable of the improvement project as well as achieve the quality requirements of their customers.

The data showed that in a Six Sigma project, the change management demands and the complexity of the deliverables are two factors that must be considered when a team selected its appropriate leadership structure. The study found that due to each phase having different needs in terms of complexity of change management and deliverables, there was not only one leadership approach that was applicable to complete the objectives of each phase. At each phase, the type of leadership approach selected and employed by a team had a statistically significant impact on a team's ability to effectively achieve the

objectives and goals of each phase of their projects. Therefore, this highlights the implication that engineering management practitioners need to identify and understand the relationship between change management and leadership in each phase of their projects because it impacts the team's ability to select the appropriate leadership approach and achieve the objectives of each phase.

From the external coaching perspective, the coaches need to identify and understand the effect that change management has on their team's leadership approach at each phase, since this impacts the type and degree of coaching and support that the external coaches need to provide. An external coach cannot rely on one type of coaching style and one level of involvement while mentoring a quality improvement project. Based on the demands of the phases, the degree of change management, and the type of leadership approach being employed by the team, the external coach needs to adjust their coaching style and their degree of involvement in the project. These findings implied that the external coaches need to gauge the type of leadership displayed by their teams throughout a project in order to properly select the level of involvement and type of coaching style that they utilize in each phase of the projects. Therefore, this implication signifies engineering management practitioners need to be aware that a coach's style of coaching and degree of involvement must be fluid throughout the execution of a project and is directly related to the type of leadership being employed by their team at each phase of the project. An external coach must be able to continuously gauge the performance of their team(s) in order to assess if a team's leadership approach is being effective in achieving the objectives of the phases. By continuously monitoring the progress of a team's performance, the external coach will be able to identify points where the team's leadership approach is not working properly, and it may signify that the coach needs to adjust their coaching style and become more involved.

The findings from the study also lead to the implication that engineering management practitioners need to be educated on handling the demands of change management as well as education on the different types of leadership approaches. The study found that the degree of change management complexity has a relationship with the type of leadership approach that a quality improvement team might employ in the various points of their projects. These factors impact the effectiveness of a team in completing the

deliverables at each phase as well as meeting the quality requirements of their customers at each phase of their projects. If a team can assess the demands of a project, the team can select the change management tools and leadership approach that will enable the team to achieve the maximum potential of team effectiveness for that phase or the project as a whole.

Therefore, a Six Sigma training program must include educational modules that focus on change management tools that teams can employ throughout a Six Sigma project in order to properly manage the dynamic demands of this factor. In addition, a Six Sigma training program must include educational modules that focus on the different approaches to leadership as well as the applications of each leadership approach. This type of training will enable a team to assess the needs of a project or phase of a project and select the appropriate leadership structure that would enable the team to achieve an optimal level of team effectiveness. Education in the areas of leadership and change management would enable the teams to manage the "people piece" of a quality improvement project. The effectiveness of any quality improvement project is based on the quality of the solutions and deliverables and the acceptance of the solutions by the stakeholders and customers. The acceptance piece is the segment that requires an effective change management methodology, and the change management task was a responsibility of the internal team members of each team and in some cases the external coach as well.

6.1.6 Proposed Shared Leadership Decision-Making Structure

Recall that this research has also shown that as a team becomes more involved in the shared leadership model, the methods utilized to make decisions also change in such a way that the decision-making power is more distributed among members; the team moves away from single individual decision models and it moves towards a shared decision model. Based on the research presented and the relationship that exists between that shared leadership conditions and team decision-making, a continuum for decision-making in shared leadership environments has been developed and is presented in Figure 60.

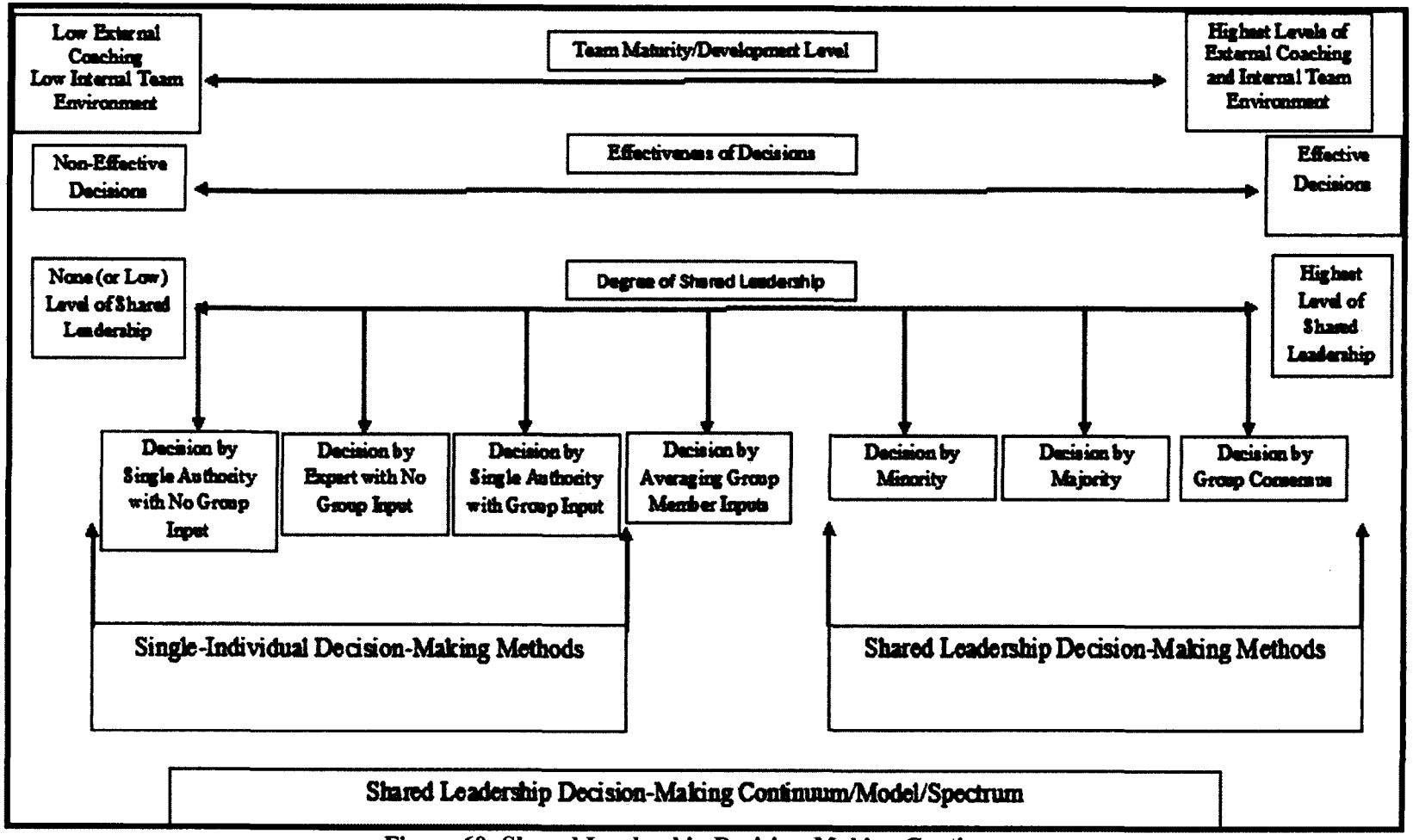

Figure 60: Shared Leadership Decision-Making Continuum

This figure demonstrates that as a team develops and evolves its sense of shared leadership, the team progresses through the seven different methods of decision-making. When the shared leadership environment is in its infancy, the most common and effective method is the "decision by single authority with no group input." As the shared leadership environment is developed, through the internal and external conditions of shared leadership, it was found that the team evolves to a consensus decision method, which was determined to be the decision-making method that is most closely related to the maximum potential level of a team's degree of shared leadership. When a team is at its fullest potential of shared leadership, the most effective decision method is the consensus decision method. As the team evolves from the single individual decision-making method to the consensus decision-making method, the team's approach to decision-making morphs through a progression of decision-making methods, which properly reflects the level of distributed decision-making power and influence in the team.

When the level of shared leadership is nonexistent (or very low), the team progresses through the continuum by using the decision by single authority with no group input. The next step in the team's progression is the "decision by expert with no group input." As a team evolves from this decision-making method, it moves towards the "decision by single authority with group input" method. This method is located at this point in the continuum since the leader is beginning to involve the members more in the decision-making process but the decision is still made by a single individual or authority. This shows that shared leadership is developing in the team since the members' input are being collected by single authority, but the final decision still lies with the single authority. The first three methods have been determined to represent the "single individual decision-making methods" in this model since the final decision is being made a single individual/authority, despite some input from team members. The relationship (from left to right) of these first three methods shows that as a team gains more experience in shared leadership, the decision-making methods change in order to reflect the increased level of influence of the members.

The fourth progression and mid-point is the "decision by averaging group member inputs," since this decision-making method displays that the decision-making power and

influence are moving towards a more distributed focus. The next three methods have been determined to represent the "shared leadership decision-making methods," since the power and influence for making a decision are now in the hands of the team instead of a single authority. In the final segments of a team's progression through the methods, the team evolves from the mid-point method into the decision by minority method, which is followed by the decision by majority method. This progression shows that as the team becomes more developed in shared leadership, influence is spread to more members, until the consensus method is reached and decision-making influence is distributed among all members. In this final area, as a team develops its level of shared leadership, more team members gain the ability to have decision-making power and influence. The end point of the continuum is the point where all members have influence. At this point, the decision-making power is given to all members and all members' input is valued and used in the decision.

Another important aspect of this model is that as a team develops its level of shared leadership, the effectiveness of a team's decisions also directly improves. The Shared Leadership Decision-Making Continuum has been developed to reflect the understanding that, in a shared leadership setting, as a team progresses through the seven methods of rational decision-making and develops its level of shared leadership, the effectiveness of the team's decisions increases. The model represents that in a shared leadership setting, decisions made through the use of shared leadership methods are more effective than decisions made by using single individual methods. In a shared leadership setting, the consensus method produces much more effective decisions than decisions made by the "single individual decision method without group" technique.

The last portion of this model presents how a team's level of maturity and development changes as its degree of shared leadership increases. As a team evolves its level of shared leadership, the team's level of maturity and overall team development also increase. This relationship has been reflected in the top portion of Figure 60, which shows that when a team begins its development of shared leadership, there are low levels of external coaching and internal team environment. Since the members are "new" to this type of team environment, there will be some confusion and chaos especially in terms of members and the external leader not understanding their roles and responsibilities. Thus,

the team's level of development and maturity is reflected in low levels of external coaching and internal team environment at the left end of the spectrum, which is related to a team's low degree of shared leadership. As a team increases its degree of shared leadership, its level of maturity and development are also increasing. A team's highest degree of maturity and development will come as a result of a team advancing to the highest degree of shared leadership, which means that the team will have the highest potential levels of external coaching and internal team environment conditions.

This model has many applications throughout the research fields and for the general business world. As a basis, this model can be used by managers and leaders in order to enable them to gauge the proper level of external coaching and support that they will need to provide in order for the team in a shared leadership environment. It can provide a leader with the ability to know how to guide a team through the shared leadership development process. A leader can also use this model to aid them in focusing the team on the right direction and generating a shared sense of purpose and support for the team. From the external leader point of view, the model can be utilized as a tracking tool, in which the external leader has the ability to track a team's development of shared leadership and how a team is making decisions, as well as how effective the team's decisions are. From an organizational point of view, the model can be used to develop training programs aimed at shared leadership and decision-making in teams and teaching managers how to guide shared leadership environments.

A team that is new to shared leadership can utilize this model as a guide to how to develop shared leadership as well as the methods that it should employ as it develops a higher degree of shared leadership. A team can utilize this model as a tracking tool as it develops shared leadership in order to ensure that the team is progressing in the proper direction. The academic world can utilize this model in order to study the various theories of shared leadership and decision-making. The academic world can use this continuum to advance the fields of shared decision-making since the field currently lacks substantial decision-making continuums that limit researchers from drawing accurate conclusions. This model can also be used as a guide to design leadership and decision-making curricula, in which students learn the proper methods of decision-making in shared

leadership environments and how the internal and external factors contribute to the shared decision-making process.

6.3 Contributions to NSLIJ Health System

As a result of the research study, in order to improve the organizational model in the NSLIJ Health System and the five variables, a number of strategies were identified. The improvement strategies were developed through the collaborative effort of the external coaches and me from the NSLIJ Health System, who oversees all of the Six Sigma projects that are performed at NSLIJ. The improvement strategies identified were classified into three categories of improvement: educational model, internal and external communication, and the role of the external coach.

The first of the improvement strategies centers on modifying and updating the educational model in order to improve upon the deviations and areas of concern relating to the internal team members. The following suggestions make up the overall improvement strategy for the educational model:

- The Six Sigma content for the Measure, Analyze, and Improve phases should be modified in order to reduce the degree of difficulty of the Six Sigma material specifically related to the following tools: measurement systems analysis (Measure phase), the hypothesis testing (Analyze phase), and the design of experiments (Improve phase). This would also help to improve the internal team members' competency of the Six Sigma material associated with these phases.
- Alternatively, the organization can modify the delivery of the material related to these phases. Currently, the training model teaches the theory and application of these tools to real-world projects. The organization should consider only teaching the application portion of these tools and not include the theory behind the tools and concepts. This would also help to improve the internal team members' competency of the Six Sigma material associated with these phases.
- Add change acceleration process (CAP) or change management material and discussions with case studies and real-world examples to the Measure, Analyze, and Improve phases to help improve the internal members' ability to manage the complexity of change and overcome resistance to change throughout the phases of Six Sigma.

- Build an abbreviated Fast Track Decision-Making (FTD) course into the training module for the Define phase in order to educate the internal team members on the tools and concepts to effectively achieve the following: develop and stick to meeting agendas, establish action plans, establish timelines and workloads, manage deadlines, and make effective decisions in a timely manner. The FTD tools and material should be delivered in the Define phase since teaching these skills will enable the teams to begin the projects in the proper direction.
- At the end of each training module, require all teams to take part in "team time," which involves the team planning for the coming phase and working on the deliverables for the project. If the teams are required to hold "team time" meetings for each training module, it will help to monitor the teams' progress and ensure they are moving in the proper direction. This would enable the teams and external coaches to proactively complete the deliverables and ensure that the team is completing the tasks in the proper timelines and remaining on task.
- For the required "team time," the external coaches should set the agenda for the "team time" session in order to ensure that all of the teams are working toward the same set of expectations and completing the same set of deliverables. The agenda should outline the specific deliverables and tasks that the teams must complete and/or discuss by the end of the "team time" session. Even though the teams have different project objectives, this improvement enables the teams to share lessons learned and to work in collaboration to complete the same deliverables and tasks. If an issue or obstacle is identified and resolved for one team, those solutions may be applicable to other teams working on the same or similar deliverables.
- Include the skill development of active listening at the training modules for each phase in order to enable the internal members to effectively listen and value the input of their fellow team members.
- Include the skill development of conflict resolution at the training modules for each phase in order to enable the internal members to identify conflicts and resolve them in a timely manner. This will minimize the involvement of their external coaches with respect to resolving the conflict. To effectively build this skill, the training material should include the use of simulation and case studies to provide real-life applications.

- Team-building exercise at the start of the training modules for each phase since this will enable the team to build cohesiveness and trust among the team members throughout the phases of the projects, helping to ensure that all members have valued input and equal responsibility in the team environment.
- Have the internal team members perform a pre and post assessment to evaluate the internal members' competency of active listening, conflict resolution, and change management tools. Currently, the pre and post assessments only evaluate internal team members' competency with respect to the Six Sigma content. By including the "people skills" and change management tools, the external coaches will be able to clearly assess the effectiveness of the improved training model and identify any additional areas of the training model that need to be further improved (or modified).

The second category for improvement strategies involves making improvements around the communication that occurs between the internal members and the communication that occurs between the external coach and the internal members. The following suggestions make up the overall improvement strategy for internal and external communication:

- Require the teams to send a weekly action plans to their external coach, outlining the teams' progress for the current phase and the intended steps and actions for the coming week. This will help to monitor the teams' progress and ensure they are moving in the proper direction.
- More frequent coaching visits and calls between the external coaches and the internal members. It is suggested that each phase includes two coaching visits and three coaching calls. This will help to proactively monitor the teams' progress and ensure that they are moving in the proper direction.
- Within 24 hours of receipt, coaches should review the weekly submitted action plans and provide feedback to help the team remain focused on the deliverables and objectives. The external coach should review the action plans to ensure that the work is being evenly distributed. Recommendations should be provided to the team if this is not occurring. This will help to monitor the teams' progress and ensure that they are moving in the proper direction.

- At the start of the project, the internal team members and the external coaches must establish a team communication plan for both internal and external communication. The communication plan must outline the proper form of communication, the frequency of the communication, the sender of the communication, the receivers of the communication, and the content of the message. This will ensure that all parties receive the same consistent message in the proper timeframe.
- External coaches should also develop a uniform set of instructions and scripting that can be delivered to the internal members, which can be utilized to outline and clarify the expectations and requirements for the project deliverables for each phase. This will help to sure that the teams are receiving the same set of instructions from their external coaches, which should help to reduce variation of the message and the consistent need for the external coaches to clarify the expectations of the project phases.
- The external coaches should develop model timelines for the deliverables associated with each phase of the process and provide these to the teams. These could serve as templates that the teams could use to establish and manage their action plans and timeline schedules. These timeline templates will help to clarify the expectations and deliverables of the project phases, and ensure that the requirements and deliverables are defined clearly and uniformly for each team.
- Establish a policy that within 24 hours of identification any issue or obstacle, the internal team members notify their external coaches and request any support the team needs to overcome the issue. This will help the teams and coaches to proactively identify and resolve issues with the projects instead of responding in a reactive manner and allowing the magnitude of the issues to increase.
- At the start of the project, the external coaches should spend time with their internal teams in order to clearly define and outline the roles and responsibilities of the external coach and the internal team members. This will help to ensure that everyone in the team environment understands the role and responsibilities of their fellow members and external coach, which in turn should help to reduce team members' confusion with respect to understanding each person's role and responsibilities.

The third category for improvement strategies involves the role of the external coach. The following suggestions make up the overall improvement strategy for the role of the external coach:

- Weekly meetings between all external coaches who are mentoring projects so that they can discuss the progress of the active projects and any issues. This will help to act as a mechanism among the external coaches to touch base and maintain contact with each other throughout the phases of the project.
- Include the skill development of conflict resolution in order to enable the external coaches to identify conflicts and resolve them in a timely manner. To effectively build this skill, the training material should include the use of simulation and case studies to provide real-life applications.
- When selecting the internal team members for future projects, implement a mechanism to ensure that the members can dedicate the time and resources required for their role in the project, which is 20%-25% of their time. Implement a mechanism in which the supervisors of the internal team members acknowledge and agree to the time and resource commitment that their employees will need to display for the duration of the projects. This will help to ensure that the projects are being staffed with internal team members who have the ability to commit the required time and resource for the duration of the project.
- Implement a checklist or similar tool that the external coaches can utilize to monitor the competency and learning of each of their internal team members. The training modules for each phase are designed to teach the internal team members on key tools and concepts that will help them to complete the deliverables for each phase. The implementation of a checklist that gauges the competency for each internal member will enable the external coaches to identify training deficits for the individual members and the team as a whole. The external coaches can then take the proper action to address these knowledge issues, which will help improve the individuals' and teams' performance on the project.
- For the supervisory staff that oversees and mentors the external coaches, implement a checklist or similar tool to gauge the coaching skills of the external coaches. The role of the external coach is one where the person has coaching and instructor

responsibilities; they provide the continuous coaching to the teams but also deliver the training modules for each phase to the internal team members. The external coaches are expected to have the ability to provide instruction for every tool and concept that is taught to the internal team members. The use of a checklist can help the supervisory staff gauge the coaching skills and instructional competencies for each external coach. This will help to identify deficits in competency and coaching skills for the external coaches, which will enable the supervisory staff to take the proper action to address these knowledge issues.

- Implement a mechanism to monitor the level of involvement for each internal team member throughout each phase of the projects. Have a response plan for situations when internal members are not actively taking part in project activities. This will ensure that workloads are equally distributed and that all members are continuously involved throughout each phase of the projects.

6.4 Summary of Results from Hypothesis Testing

The results and findings from this research have shown that while shared leadership did not positively increase from the Define phase to the Improve phase of the DMAIC process, shared leadership had unique relationships with the four other variables studied in the research. Table 22 summarizes the unique relationships that existed between shared leadership and the four other variables at each of the four phases of the DMAIC structure:

	Shared Leadership Variable			
Variable	**Define**	**Measure**	**Improve**	**Analyze**
Internal Team Environment	√	√	√	√
External Coaching		√	√	√
Project Completion		√		√
Customer Satisfaction		√		√

Table 22: Summary of the Presence of the Relationships

The analysis of data and the five hypotheses identified that from a statistical perspective, shared leadership did not have a direct relationship with the phases of the

DMAIC process. Although Hypothesis #1 was not statistically significant, from the individual team level, one could see how the complexity of the deliverables as well as the need for varying degrees of change management from each phase impacted the degrees of shared leadership that were present for each team as the teams progressed through the DMAIC process.

The study also found that shared leadership had unique relationships with the four variables investigated in the study. It was found that a direct relationship exists between the internal team environment and shared leadership variables throughout each phase of the DMAIC process. The relationship between these two variables developed throughout the project since the internal team members placed almost equal significance on all three dimensions of the internal team environment variable. The analyses found that a team's degree of internal team environment and its relationship with the shared leadership value had a significant impact on how effectively and successfully a team completed the deliverables and tasks for each phase of a DMAIC project, especially in the following areas: making decisions and completing tasks in a timely manner, establishing a clear and consistent team direction, and establishing an environment where each member had an equal voice and unwavering team support. The relationship between these two factors had significant impacts on several aspects of a team's performance as well as a team's overall environment.

The research found that no relationship existed between the external coaching and shared leadership variables in the Define phase, but that a relationship did exist between the external coaching and shared leadership variables at the Measure, Analyze, and Improve phases of the Six Sigma DMAIC process. In the Define phase, the internal teams relied on the external coaching variable to help them accomplish their deliverables, but due to the complexity of the Measure, Analyze, and Improve phases, the teams needed to rely on both high degrees of shared leadership as well as the external coaching variable. The study highlighted that there were critical traits that the external coaches had to possess in order for the external coaching variable to be high. The presence of these traits impacted the effectiveness of team when it came to completing their project phases and how effective these teams' shared leadership environments were. The research identified that the relationship between these two factors had significant impacts on several aspects

of a team's performance, a team's overall environment, and the relationship that a team had with their external coach.

The statistical analysis supported the conclusion that no relationship existed between the project completion and shared leadership variables or the customer satisfaction and shared leadership variables in the Define or Analyze phases. A relationship did exist between the project completion and shared leadership variables and customer satisfaction and shared leadership variables at the Measure and Improve phases of the Six Sigma DMAIC process. The analyses supported the conclusion that in phases where a lot of change management was required, the shared leadership approach should be used by the internal team. If a phase did not require a lot of change management, then the shared leadership approach could be used but it would not add much value to the team's ability to have high degree of project completion and customer satisfaction. The research identified that the external coaching variable had a significant impact on the customer satisfaction and project completion variables throughout each phase of the DMAIC process. The qualitative data also indicated that the high degrees of external coaching contributed to the direct relationships that were identified for the project completion and shared leadership variables as well as for the customer satisfaction and shared leadership variables at both the Measure and Improve phases.

The research highlighted that there were several areas in which the teams and external coaches could improve, leading towards improvements in the five variables. The areas that required improvement from the teams and external coaches included: the complexity of change management, delegating responsibilities, team members being open-minded in the team environment, confidence and assertive of team members, setting deadlines and establishing action plans, establishing clear expectations, and internal and external communication. Additionally, the study identified several general components of the DMAIC structure that affected the five variables from the study as well as the teams' general ability to be successful in their projects, including: the training and educational model utilized by the NSLIJ Health System, the complexity of change management in the team environment, time and resource commitment of the internal team members, external coaches' methods used to explain expectations and deliverables for each phase, and the mechanism of communication between the external coaches and the teams. By focusing

on improving these general issues, the teams would be able to improve the five variables throughout the phases of the project as well as their ability to be successful in their projects. The improvement of these general issues would help the organization in terms of how the DMAIC process is executed on future projects and how the educational model for Six Sigma projects is delivered to future teams.

6.5 Research Limitations

It is important to discuss the potential limitations of this research study since they may have contributed to the conclusions drawn from the study. The following limitations were identified and addressed in this study in order to minimize their effect on the outcomes of the study:

- Exclusion of the Control phase of the Six Sigma process from the research design
- Sample size
- Non-normal data
- Assumption of an association (relationship) for the variables in hypotheses #2, #3, #4, and #5
- Bias from the respondents by utilizing surveys as the data collection method
- Bias from the researcher by having only one researcher record the data, analyze the data, interpret the data, and develop conclusions/findings for the hypotheses and goals of the research study.

The Six Sigma DMAIC methodology involves five phases, but recall that this research study only studied the first four. The Control phase of the DMAIC process was not included in this study since by the completion of the Improve phase, teams have typically completed at least 90% of the project by the time they reach the Control phase. The incremental development of shared leadership after the "report-out" at the Improve phase is negligible. The Control phase was dedicated primarily to the implementation of control measures and attaining sustainability for the project improvements and solutions. Additionally, by the time the Improve phase is completed, research from the NSLIJ Health System has shown that shared leadership in Six Sigma team environments is very high at this phase and review of previous research has shown that it should remain the same level as the team completes the final phase of the DMAIC process. Therefore, it was justifiable to only study the first four phases of the DMAIC structure.

Sample size also posed a limitation into the research study. There was a population of sixteen Six Sigma projects that were performed during the data collection period, but only eight of the sixteen teams were selected to take part in the study, due to the time constraints of the data collection period and the resource constraints of the research team. The sample size of eight teams limited the types of statistical analysis methods that were available to evaluate the five hypotheses. This limitation was accounted for by using a power analysis to determine the ideal sample size; the power analysis determined that studying eight teams in the study would provide a similar degree of information as studying sixteen teams.

Another limitation was that the data for the five variables in the study was found to be non-normal and therefore, it limited the statistical analysis methods that could be employed to evaluate the five hypotheses. In order to statistically evaluate the five hypotheses, the study utilized non-parametric statistical methods, which do not assume any statistical distribution. This concern was accounted for by performing extensive research into non-parametric statistical methods as well as reviewing the available non-parametric statistical methods with Biostatisticians and Epidemiologists that specialize in non-parametric statistical methods. The selection of the appropriate non-parametric methods enabled valid evaluation of the five hypotheses and minimized the risk that the assumptions from the non-parametric test would affect the integrity of the research design.

Another limitation that was identified involved the assumption made about the association (relationship) that existed between the each of the variables that comprised hypotheses #2, #3, #4, and #5. This assumption impacted the approach used to analyze the data sets associated with each of these hypotheses. Based on the assumption of association, each of these hypotheses was evaluated on the basis of the "difference" between the two variables at each time period. The assumption of association for the variables of these hypotheses was developed as a direct result of the extensive research that was performed on the variables, which identified associations between these variables but in the context of previous research studies. It was concluded that the assumption of association and using the "difference" technique in the analysis of these hypotheses were valid.

Since the data collection method for the research study involved surveys completed by the participants, the issue of bias from the respondents was introduced as a limitation into the study. Surveys as a primary means of data collection has been found to be most effective in capturing the desired level of data and has historically been proven to be a very robust and reliable method. The concern of bias from the respondents was addressed in the research protocol by designing the surveys in a manner such that all of the participants were given the same necessary information such as definitions of terms and each question was designed to be specific and clear, which helped to reduce the participants' need to interpret the questions or terms. Prior to the main study being executed, a pilot study was executed in order to assess the bias of the surveys. The use of the pilot study helped to ensure that the surveys were designed such that the questions and terms required minimal interpretation by the participants and that all of the participants were given the same necessary information.

Bias on behalf of the researcher was also introduced as a limitation into the study since there was only one researcher that was responsible for recording the data, analyzing and interpreting the data, and developing conclusions/findings for the hypotheses and goals of the research study. This concern was accounted for by designing the surveys such that they required minimal interpretation by the researcher when the researcher was reviewing and recording the data from the surveys. The pilot study also helped to verify that both the quantitative and qualitative questions on the surveys resulted in data that required minimal interpretation on behalf of the researcher. In addition, prior to executing the study, the analysis methods were pre-selected by the researcher and other subject matter experts, which helped to limit how the researcher analyzed data. The researcher had limited options for the statistical methods, and the available options depended on the normality of the data sets. The researcher was also limited with how they could interpret the data for developing the conclusions for the study since the study had five hypotheses that guided how the researcher interpreted the analysis findings and how he developed conclusions.

All of the limitations discussed in this section have been addressed and accounted for in order to control or limit their influence on the outcomes of the research study.

6.6 Future Research

The purpose of this research was to serve as the first step in studying how shared leadership and organizational development relates to quality improvement in the healthcare field. This form of social science research has not been performed in the past in the healthcare field and has only been investigated on a limited basis in other social science fields and other industries, such as defense, manufacturing, and business academia. Since this study design served as a first step in studying leadership and organizational development within the healthcare field and the social science field, this section discusses suggestions that should be considered for future areas of research.

One such avenue of future research would be to study the proposed shared leadership decision-making model discussed in Chapter Six. The decision-making structure developed from this research is theoretical and based on the conclusions and finding from this study. Further research needs to be done on this proposed structure in order to validate the accuracy of the model as well as refine the model in order to handle diverse team environments as well as diverse industries. Another such future research work could involve studying how leadership and organizational development relate to the entire Six Sigma DMAIC process. As explained in the limitation section, the study only included the first four phases of the Six Sigma DMAIC process. Future research that would expand this original study to include all five phases would prove insightful to the study of the five variables and hypotheses. It would provide a robust view into how the five variables and hypotheses relate to the full Six Sigma DMAIC process.

This study focused on Six Sigma project teams from the NSLIJ Health System, but future research could involve healthcare providers and environments beyond the NSLIJ Health System. By executing the design of the original study but with healthcare providers and environments beyond the NSLIJ Health System, the findings and conclusions could be more generalizable and applicable to Six Sigma projects from across the healthcare business sector. The inclusion of more healthcare providers and environments would help to improve the overall Six Sigma DMAIC methodology as well as training models that are employed by healthcare providers across the healthcare business sector.

Since this research design focused on only one improvement science methodology (the Six Sigma DMAIC process), one suggestion for future research would be to perform this study in other improvement science methodologies. In addition, another interesting study could involve executing a study as designed for this research effort, but with a diverse set of improvement science methodologies. Executing the study with a mixture of teams that are using different improvement science methodologies could also prove insightful into how leadership and organizational development relates to quality improvement teams in the healthcare industries; it would also enable researchers to generalize findings and conclusions beyond the baseline Six Sigma methodology.

The study of how leadership and organizational development relates to quality improvement teams is a relatively new field of study, and limited research has been performed in other industries, such as defense, manufacturing, and business academia. Future research into other industries, beyond these and the healthcare business sector, would provide findings and conclusions that can be generalized for Six Sigma projects and other improvement sciences. By studying how leadership and organizational development relates to quality improvement teams in a diverse set of industries, a robust organizational and training structure or model could be developed and deployed throughout a variety of business sectors.

Further study into the relationships that additional input and output variables have with shared leadership would be another milestone for research in the field of leadership and quality improvement teams. Examples of additional input variables that would add value to this field include: change management, organizational culture, organizational structure, leadership experience of participants, support from executive leadership, and retention of project participants during a quality improvement project. Examples of additional output variables that would add value to this field include: staff and clinician satisfaction, patient satisfaction, effect on clinical quality, degree of sustainability for the improvement initiative, and amount of cost savings from the improvement initiative. This type of research would provide insight into the specific relationships that exist between leadership and how these relationships impact the performance of quality improvement teams. The diverse research that could be performed by studying different sets of input and output variables would provide researchers with a more robust picture of how

leadership impacts quality improvement teams and how these relationships change over the course of an improvement science structure. By studying different sets of input and output variables, researchers would also be able to develop new areas of social science research, which will add more richness and robustness to field of social science research as a whole.

Recall that the internal team environment variable was composed of three dimensions: shared purpose, social support, and voice. The original research design identified that a relationship existed between the internal team environment variable and the shared leadership variable. Further research in the dimensions of the internal team environment variable would provide insight into which dimension contributes the most influence to the relationship that the internal team environment variable has with the shared leadership variable.

Another interesting focus of future research could include executing the original research design but with an increased sample size. If future research could account for the time and resource requirements associated with a larger a sample size, it would aid in improving the validity and robustness of the research findings and conclusions. This type of research study would also help to improve the degree of belief among the organization as well as improve the generalizability of the research conclusions and findings. By utilizing a larger sample size, the research findings and improved DMAIC organizational model could be deployed to a more diverse array of business units and divisions across the NSLIJ Health System as well as additional healthcare providers and environments.

The original research design focused on the shared leadership style and the relationship it has with quality improvement teams, but future research that investigates how additional leadership styles relate to quality improvement teams would prove to be insightful by providing researchers with the ability to identify the similarities and differences that each leadership style has in relation to quality improvement teams. Leadership styles such as situational leadership, path-goal theory, leader-member exchange theory, and transformational leadership are additional styles that could be studied in relation to quality improvement teams. The execution of the original research design with a focus on different leadership styles could form a set of findings that could be generalized across the field of leadership development.

By studying how each of these leadership styles relates to quality improvement teams, improvements could be identified that could be deployed across the diverse set of improvement science methodologies as well as improve the organizational and training structures employed for each of the improvement science methodologies. In addition, future research that studies how these additional leadership styles relate to various input and output variables would enable researchers to clearly understand how the relationships that exist between leadership and the input or output variables change based on the leadership style. All of the findings from these studies would be important because these findings can help an organization select the appropriate leadership style for a particular type of quality improvement project. The matching of the appropriate leadership style to type quality of improvement project as well as to the set of input and output variables would help ensure that each quality improvement project is set up by the organization to work to its maximum effectiveness and ensure that the project has the best opportunity for success.

All of the recommendations for future areas of research work highlight the importance of expanding research in the field of how leadership develops, especially with regard to quality improvement teams. The research performed in this dissertation provided a solid foundation and a research design template that could be used for future studies. The suggestions discussed in this section will help to take this field of research to the next level. In order to execute any of these suggestions, the proper time and resources would need to be allocated for these studies since the complexity and scale of these initiatives would be large and difficult to manage with limited time and resources.

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APPENDICES

APPENDIX A: SURVEYS FOR INTERNAL PARTICIPANTS

Data Collected from Internal Team Members

Survey "A" (Internal Team Environmental Condition)

Directions: At each time point, each team member will be required to rate their team in terms of these ten items on the following scale: 1 (Strongly Disagree) to 5 (Strongly Agree). In addition, at each time point, each team member will be required to provide their opinion or feelings on key mixed (open and closed) questions.

Quantitative Questions

Rating Scale: 1 = Strongly Disagree; 2 = Somewhat Disagree; 3 = Neither Disagree nor Agree; 4 = Somewhat Agree, 5 = Strongly Agree.

Definition of Internal Team Environment: Internal team environment consists of three dimensions: shared purpose, social support, and voice. The three dimensions work together to develop a team context that supports (and encourages) team members' willingness to offer leadership influence as well as to rely on the leadership influence of other team members.

Shared Purpose (exists when team members have similar understandings of their team's primary objectives and take steps to ensure a focus on collective goals)

The members of my team . . .

1. Spent time discussing our team's purpose and goals for the project.
   1 2 3 4 5

2. Discuss our team's main tasks to ensure that we have a shared understanding.
   1 2 3 4 5

3. Devise action plans (WWW) that allow for meeting our team's goals.
   1 2 3 4 5

Social Support (team members' efforts to provide emotional and psychological strength to one another)

The members of my team . . .

4. Talk enthusiastically about our team's progress.
   1 2 3 4 5

5. Recognize each other's accomplishments and hard work.
   1 2 3 4 5

6. Give encouragement to team members who seem frustrated.
   1 2 3 4 5

7. We are checking the validity of this survey, for this purpose please leave this question blank.
   1 2 3 4 5

Voice (the degree to which a team's members have input into how the team carries out its purpose)

The members of my team . . .

8. Are encouraged to speak up to test assumptions about issues under discussion.
   1 2 3 4 5

9. As a member of this team, I have a real say in how this team carries out its work.
   1 2 3 4 5

10. Everyone on this team has a chance to participate and provide input.
    1 2 3 4 5

11. My team supports everyone actively participating in decision making.
    1 2 3 4 5

Mixed (Open and Closed) Questions: For each question, please select only the 1 response you believe to be the most significant (i.e. only check 1 box). For any question, if you select the "other" box, please elaborate in the space provided (next to the "other" box).

5. What do you think of your current team environment?

Response:

□ Team environment needs much improvement.
□ The team works well together but needs improvement.
□ Team is cohesive and works very well together.
□ Other, Please Specify: _____

6. What is the most significant factor in your current team environment?

Response:

□ The level of shared vision among the team members.
□ The level of social support that the team members display.
□ The level of voice that each member is given.
□ Other, Please Specify: _____

7. What do you think needs to change or improve in terms of your current team environment?

Response:

□ The level of shared vision among the team members.
□ The level of social support that the team members display.
□ The level of voice that each member is given.
□ Other, Please Specify: _____

8. In what area has your team's internal team environment had the most significant impact on the team's ability to complete this phase of the project (up to this point)?

Response:
□ Making decisions and completing tasks in a timely manner.
□ Establishing a clear and consistent team direction.
□ Establishing an environment where each member has an equal voice and has unwavering team support.
□ Other, Please Specify: _____

Survey "B" (External Coaching Environmental Condition)

Directions: At each time point, each team member will be required to rate their external leader/coach in terms of these three items on the following scale: 1 (Strongly Disagree) to 5 (Strongly Agree). In addition, at each time point, each team member will be required to provide their opinion or feelings on key mixed (open and closed) questions.

Quantitative Questions

Rating Scale: 1 = Strongly Disagree; 2 = Somewhat Disagree; 3 = Neither Disagree nor Agree; 4 = Somewhat Agree, 5 = Strongly Agree.

Definition of External Coaching: External coaching is defined as a direct interaction with a team intended to help team members make coordinated and task-appropriate use of their collective resources in accomplishing the team's task.

The external coach....

1. Expresses his/her confidence in the capabilities of our team.
   1 2 3 4 5

2. Effectively motivates and guides our team toward accomplishing challenging goals for this project.
   1 2 3 4 5

3. We are checking the validity of this survey, for this purpose please leave this question blank.
   1 2 3 4 5

4. Is aware of the needs of our team and help the team however he/she can.
   1 2 3 4 5

Mixed (Open and Closed) Questions: For each question, please select only the 1 response you believe to be the most significant (i.e. only check 1 box). For any question, if you select the "other" box, please elaborate in the space provided (next to the "other" box).

5. What do you think of the level of support and guidance from your External Coach?

Response:
□ External coach does not display any level of support or guidance.
□ External coach provides some guidance and support, but improvement is needed.
□ External coach provides a consistent level of guidance and support.

□ Other, Please Specify: _____

6. What are the positive aspects of your External Coach?

Response:
□ Level of support, guidance, and presence.
□ Willingness to provide mentorship and help at any point in the project.
□ Consistency of communication.
□ Other, Please Specify: _____

7. What do you think needs to change or improve in terms of the guidance/support given by your External Coach?

Response:
□ Level of support, guidance, and presence.
□ Willingness to provide mentorship and help at any point in the project.
□ Consistency of communication.
□ Other, Please Specify: _____

8. In what area has the coach's external coaching had the most significant impact on the team's ability to complete this phase of the project (up to this point)?

Response:
□ Ensuring that the team stays focused.
□ Removal of obstacles and barriers that are in the team's way.
□ Providing clear direction on deliverables and providing advice to the team as needed.
□ Other, Please Specify: _____

Survey "C" (Shared Leadership Condition)

Directions: At each time point, each team member will be required to rate each of their fellow team members for each criterion on the following scale: 1 (not at all) to 5 (to a very great extent). Note that since the teams will consist of 4 members, a member will only complete this survey for their fellow team members (i.e. a team member will not rate themselves). In addition, at each time point, each team member will be required to provide their opinion or feelings on key mixed (open and closed) questions.

Quantitative Questions

Rating Scale: 1 = Not At All; 2 = To A Very Little Extent; 3 = To Some Extent; 4 = To Some Good Extent, 5 = To A Very Great Extent.

Definition of Shared Leadership: An emergent team property that results from the distribution of leadership influence across multiple team members. Leadership is a process whereby an individual influences a group of individuals to achieve a common goal. Leadership has four main components: involves influence; is a process; involves goal attainment; occurs in a group context.

Team Member Name: _____

1. To what degree does your team rely on this individual for leadership?
   1 2 3 4 5

Team Member Name: _____
1. To what degree does your team rely on this individual for leadership?
   1 2 3 4 5

Team Member Name: _____
1. We are checking the validity of this survey, for this purpose please leave this question blank.
   1 2 3 4 5

Team Member Name: _____
1. To what degree does your team rely on this individual for leadership?
   1 2 3 4 5

Mixed (Open and Closed) Questions: For each question, please select only the 1 response (for each team member) you believe to be the most significant (i.e. only check 1 box). For any question, if you select the "other" box, please elaborate in the space provided (next to the "other" box).

5. What do you think of the level of leadership displayed by:
   Response:
   a. Team Member Name:_____
      □ Need to show leadership in the team setting.
      □ Shows leadership but needs much improvement.
      □ Provides consistent leadership; he/she only needs to maintain this level.
      □ Other, Please Specify: _____

   b. Team Member Name:_____
      □ Need to show leadership in the team setting.
      □ Shows leadership but needs much improvement.
      □ Provides consistent leadership; he/she only needs to maintain this level.
      □ Other, Please Specify: _____

   c. Team Member Name:_____
      □ Need to show leadership in the team setting.
      □ Shows leadership but needs much improvement.
      □ Provides consistent leadership; he/she only needs to maintain this level.
      □ Other, Please Specify: _____

6. What do you think needs to change or improve with the leadership of:
   Response:
   a. Team Member Name:_____
      □ Delegate more tasks and responsibilities to the team members.
      □ Be more open-minded to hearing the thoughts and opinions of all members.
      □ Be more assertive and follow the procedures of the project (i.e. timelines and deadlines).
      □ Other, Please Specify: _____

b. Team Member Name:_____
□ Delegate more tasks and responsibilities to the team members.
□ Be more open-minded to hearing the thoughts and opinions of all members.
□ Be more assertive and follow the procedures of the project (i.e. timelines and deadlines).
□ Other, Please Specify: _____

c. Team Member Name:_____
□ Delegate more tasks and responsibilities to the team members.
□ Be more open-minded to hearing the thoughts and opinions of all members.
□ Be more assertive and follow the procedures of the project (i.e. timelines and deadlines).
□ Other, Please Specify: _____

7. What recommendations do you have for improvement or change for:
Response:
   a. Team Member Name:_____
   □ Delegate more to the team members.
   □ Set deadlines and enforce policies/deadlines for the team.
   □ Be more confident and assertive with your role in the team.
   □ Other, Please Specify: _____

   b. Team Member Name:_____
   □ Delegate more to the team members.
   □ Set deadlines and enforce policies/deadlines for the team.
   □ Be more confident and assertive with your role in the team.
   □ Other, Please Specify: _____

   c. Team Member Name:_____
   □ Delegate more to the team members.
   □ Set deadlines and enforce policies/deadlines for the team.
   □ Be more confident and assertive with your role in the team.
   □ Other, Please Specify: _____

8. In what area has the level of internal team leadership had the most significant impact on the team's ability to complete this phase of the project as well as meet the expectations/requirements of the project (up to this point)?

Response:
□ Ability to create an environment where all members share responsibilities of the leadership role.
□ Ability to resolve conflicts and issues in a timely and effective manner.
□ Ability to provide clear direction on deliverables and providing an outlet for all members to openly speak their minds.
□ Other, Please Specify: _____

APPENDIX B: SURVEYS FOR EXTERNAL PARTICIPANTS

Data Collected From External Coaches (Coach/Sponsor)

Survey "D/E" (Project Completion Team Performance Metric)

Directions: At each time point, each external coach/leader will be required to rate the team in terms of the following eleven items. The first four items will be utilized to gauge the degree of project completion present in the subject team and the remaining seven items will be utilize to gauge the degree of customer satisfaction in the subject team. Each external coach or customer will be required to rate the team on each dimension with a single item using a 5-point scale (1= extremely ineffective to 5= extremely effective). In addition, at each time point, each external coach/leader will be required to provide their opinion or feelings on key mixed (open and closed) questions.

Quantitative Questions

Definition of Project Completion: Project Completion is defined as a team's final outcome that involves tangible and intangible one. This variable includes a team's ability to complete the tangible and intangible deliverables at each milestone in a project.

Project Completion Metric (4 Items)

Rating Scale: 1 = Extremely Ineffective; 2 = Somewhat Ineffective; 3 = Neither Ineffective Nor Effective; 4 = Somewhat Effective; 5 = Extremely Effective.

How effective was this team along the following dimensions?

1. Meeting specified project deadlines in a timely manner (i.e. by the completion of the Six Sigma phase) as defined by the project sponsor and Master Blackbelt.
   1 2 3 4 5

2. Meeting project requirements (i.e. as defined by the project charter, project sponsor, and Master Blackbelt) in a timely manner (i.e. by the completion of the Six Sigma phase).
   1 2 3 4 5

3. Providing project deliverables (i.e. phase by phase deliverables such as report out presentations, analyses, charters, etc) in a timely manner (i.e. by the completion of the Six Sigma phase).
   1 2 3 4 5

4. We are checking the validity of this survey, for this purpose please leave this question blank.
   1 2 3 4 5

5. Providing consistent support and responsiveness (i.e. status updates) to the project sponsor and Master Blackbelt in a timely manner (i.e. by the completion of the Six Sigma phase).
   1 2 3 4 5

Quantitative Questions

Definition of Customer Satisfaction: Customer Satisfaction is defined as a team's ability to satisfy the customer's demands and requirements by providing high quality deliverables in an efficient and timely manner at each milestone in a project.

Customer Satisfaction Metric (7 Items)

Rating Scale: 1 = Extremely Ineffective; 2 = Somewhat Ineffective; 3 = Neither Ineffective Nor Effective; 4 = Somewhat Effective; 5 = Extremely Effective.

How effective was this team along the following dimensions?

1. Meeting your expectations in terms of the contents included in the deliverable(s) (i.e. the tools, concepts or analyses such as stakeholder's analysis or process map, that are included in deliverables such as in a report out presentation or project charter).
   1 2 3 4 5

2. Meeting your expectations in terms of the quality of the deliverable(s) and its contents (i.e. how well the quality of the contents of the deliverables, such as the analysis or tools utilized, meets the expectations of the Master Blackbelt).
   1 2 3 4 5

3. Meeting your expectations in terms of the level of collaboration and teamwork amongst the team members as well as with the extended team members (stakeholders) (i.e. how well the team able to collaborate amongst itself as well as with the stakeholders).
   1 2 3 4 5

4. Meeting your expectations in terms of how project responsibilities and project tasks are delegated and shared amongst the team members (i.e. how well the core team members delegate and share the project responsibilities and project tasks).
   1 2 3 4 5

5. We are checking the validity of this survey, for this purpose please leave this question blank.
   1 2 3 4 5

6. Meeting your expectations in terms of the requirements (needs) and goals for the project at this time period (in terms of the phase by phase deliverables required to be completed by the project team).
   1 2 3 4 5

7. Meeting your expectations in terms of providing conclusions and findings for each phase (i.e. analysis, recommendations or solutions) that are thorough, feasible, and data-driven (i.e. can realistically be implemented based on the constraints that were defined by the project sponsor).
   1 2 3 4 5

8. Meeting your expectations in terms of providing a quality report out (i.e. report out presentation) of the status of the team progress and deliverables (i.e. how well did the team present its report out presentation and how well did the team convey its deliverables and status).
   1 2 3 4 5

Mixed (Open and Closed) Questions: For each question, please select only the 1 response you believe to be the most significant (i.e. only check 1 box). For any question, if you select the "other" box, please elaborate in the space provided (next to the "other" box).

Project Completion Metric

4. In what area has your level of support or guidance had the most significant impact on the team's ability to complete the project on time (up to this point)?

Response:
□ Establishing a clear direction and staying on task.
□ Establishing a collaborative team environment.
□ Removing barriers or resolving conflict that the team is faced with.
□ Other, Please Specify: _____

5. In what area has your level of support or guidance had the most significant impact on the team's ability to complete the project deliverables (up to this point)?

Response:
□ Identification of project requirements and project tasks.
□ Staying focused on the objective of the phase and the project as a whole.
□ How to apply concepts and tools to the team's project (process).
□ Other, Please Specify: _____

6. What recommendations do you have for improvement or change for the team's ability to complete project requirements and deliverables (up to this point)?

Response:
□ Ability to stay on task and stay focused on the objective of the phase.
□ Working collaboratively as a team and delegating tasks to each member.
□ Setting deadlines and schedules for each project tasks and ensuring that the team sticks (works) to the specific deadlines and schedules.
□ Other, Please Specify: _____

Customer Satisfaction Metric

4. In what area has your level of support or guidance had the most significant impact on the team's ability to satisfy the customer (up to this point)?

Response:
□ Identification of customer requirements and identification of customer's expectations of the project.
□ Obtaining the support and buy-in from the customer and stakeholders.
□ Establishing a clear direction and focus that aligns with the expectations and requirements of the customers.
□ Other, Please Specify: _____

5. In what area has your level of support or guidance had the most significant impact on the team's level of quality for solutions and deliverables to the customer (up to this point)?

Response:

□ Alignment of team's deliverables and solutions with the expectations and requirements of the customers.

□ Obtaining the support and buy-in from the customer and stakeholders.

□ Removing barriers or resolving conflict that the team is faced with

□ Other, Please Specify: _____

6. What recommendations do you have for improvement or change for the team's ability to meet the expectations of the customer and satisfy the customer's needs (up to this point)?

Response:

□ Ability to stay on task and stay focused on the objective of the phase.

□ Obtain and maintain the support and buy-in from the customer and stakeholders.

□ Align the team's focus and direction (i.e. the tasks and steps the team takes) with the expectations and requirements of the customers.

□ Other, Please Specify: _____

<u>General Questions</u>

3. What do you think needs to change or improve with the team environment (internally)?

Response:

□ The ability to set priorities and keep all members actively participating in the project.

□ The ability to stay on task and adhere to schedules and deadlines.

□ The ability to consistently communicate with the team and delegate project tasks and responsibilities to each team members.

□ Other, Please Specify: _____

4. What recommendations do you have for improvement or change for the team Environment (internally)?

Response:

□ Need to set priorities as well as balance workloads and project responsibilities.

□ Need to establish methods to stay on task as well as set schedules and deadlines and adhere to schedules and deadlines.

□ Need to establish a clear communication plan for the team and outline how tasks and responsibilities will be delegated to the team members.

□ Other, Please Specify: _____

APPENDIX C: SAMPLE INFORMED CONSENT FORM (MAIN STUDY)
North Shore-Long Island Jewish Health System
Consent for Participation in a Research Study

PROJECT TITLE: Shared Leadership in Six Sigma Teams from the NSLIJ Health System – Main Study

Principal Investigator: Brian Galli

INTRODUCTION

You are being asked to join a research study. The purpose of a research study is to answer specific questions.

This consent form will explain:

- the purpose of the study
- what you will be asked to do
- the potential risks and benefits

It will also explain that you do not have to be in this study if you do not want to. You should ask questions before you decide if you want to participate. You can also ask questions at any time during the study.

The research study will be performed in the Six Sigma team project environments in the North Shore LIJ Health System, under the coaching/mentorship of the Operational Performance Solutions department from the Center for Learning and Innovation at the North Shore LIJ Health System.

You are asked to participate in a research study conducted by Brian J. Galli, MS, from the Engineering Management and Systems Engineering Department at Old Dominion University. The results of your participation in this study will contribute to research being performed for a dissertation.

DESCRIPTION OF RESEARCH STUDY

Several studies have been conducted looking into the subject of shared leadership (or team leadership) and team performance; shared leadership has begun to be researched more at both the academic and industrial levels since organizations have begun to see the high level of influence and impact that it can have on a team.

Research has not yet investigated the relationship(s) that internal and external environmental conditions have with the shared leadership dynamic in real-world Six Sigma projects teams as well as the relationship(s) that shared leadership has with two team performance metrics in these Six Sigma project environments. More specifically, research has yet to be performed in the field of shared leadership in relation to Six Sigma project teams in the healthcare delivery industry.

If you decide to participate, then you will join a study involving research of the relationship(s) that shared leadership has with different internal and external environmental conditions in Six Sigma project environments from the NSLIJ Health

System. In conjunction with studying these relationships, this study will examine shared leadership and its relationship(s) with two performance metrics, project completion and customer satisfaction, in Six Sigma projects from the NSLIJ Health System. In total there will be eight (8) Six Sigma project teams participating in this research study.

In order to execute this study, you will be asked to complete a survey/questionnaire at four different points throughout the execution of your Six Sigma project. More specifically, since all of the Six Sigma projects overseen by the Operational Performance Solutions department from the Center for Learning and Innovation utilize a specific DMAIC Six Sigma timeline, you will be asked to complete a survey/questionnaire at the "report outs" (i.e. conclusion) of the Define, Measure, Analyze, and Improve phases of the health system's defined DMAIC Six Sigma methodology timeline.

If you say YES, then your participation will require the completion of a survey/questionnaire at four different points throughout the health system's defined DMAIC Six Sigma methodology timeline. All surveys/questionnaires will be completed via hard copy after each of the pre-specified "report out" sessions in the Define, Measure, Analyze, and Improve phases of the health system's defined DMAIC Six Sigma methodology timeline. If you say YES, then your participation in this study will require duration of 4-6 months (dependent on the adherence to the health system's defined DMAIC Six Sigma methodology timeline).

SELECTION CRITERIA

You were selected as a possible participant in this study because you are a member of the North Shore LIJ Health System and you are currently scheduled to participate in a Six Sigma project (i.e. Six Sigma, Lean) that will take place in the North Shore LIJ Health System.

RISKS AND BENEFITS

RISKS: Due to the subject of this research, if survey responses collected from participants were to become known, there could be subsequent effects to participant employment or reputation. Surveys do ask you to report on team members, in an identifiable way. Steps and measures have been taken to maintain the security, confidentiality and privacy of the participants in this study; therefore, this potential risk has been mitigated. None of the data/information gathered by participating teams will be shared with anyone in the supervisory role; the only person from the health system that will have access to the survey data and information will be myself.

As with any research, there is some possibility that you may be subject to risks that have not yet been identified.

BENEFITS: The main benefit to each participating team is that the results from this study can help to provide guidance and recommendations, which in turn can help the participating teams to improve their performance and outputs for the Six Sigma projects. In addition, we hope that the information learned will benefit the Health System, in being

able to improve its approach to Six Sigma projects and how it approaches the team leadership (shared leadership) concept.

COSTS AND PAYMENTS
The researchers are unable to give you any payment for participating in this study.

NEW INFORMATION
If the researchers find new information during this study that would reasonably change your decision about participating, then they will give it to you.

CONFIDENTIALITY
Any information that is obtained in connection with this study and that can identify you will remain confidential and will be disclosed only with your permission or as required by law. The researcher will take reasonable steps to keep private information, such as questionnaires, confidential. The researcher will remove identifiers from the information and store information electronically, which will be password protected.

The results of this study may be used in reports, presentations, and publications; but the researcher will not identify you. Of course, your records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE
It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. The researchers reserve the right to withdraw your participation in this study, at any time, if they observe potential problems with your continued participation.

RESEARCH PARTICIPANT RIGHTS
Your participation in this project is voluntary. If you choose to not join the study, your employment and participation in the Six Sigma Program will not be affected. If you join the study you may withdraw at any time without prejudice to your employment at the North Shore-LIJ Health System.

VOLUNTARY CONSENT
By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them:

Brian J. Galli, Phone (Mobile): 631-662-0743 & Phone (Home): 631-683-4744
Email: bgalli@nshs.edu, bgall006@odu.edu or brianj.galli@gmail.com

If you have questions about your rights as a research participant, or concerns about being in the study, you may contact the Office of the Institutional Review Board (the committee

that oversees research at this institution) at (516) 562-3101. A signed copy of this consent form will be given to you.

And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form.

_____ _____

Signature of Participant Date

_____

Printed Name of Participant

_____ _____

Signature of witness Date

(Note: A witness can be a member of the research team, but cannot be the same person signing consent as the investigator)

INVESTIGATOR'S STATEMENT

I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.

_____ _____

Investigator's signature **Date**

_____

Investigator's printed name

APPENDIX D: SAMPLE INFORMED CONSENT FORM (PILOT STUDY)

North Shore-Long Island Jewish Health System

Consent for Participation in a Research Study

PROJECT TITLE: Shared Leadership in Six Sigma Teams from the NSLIJ Health System

Principal Investigator: Brian Galli

INTRODUCTION

You are being asked to join a research study. The purpose of a research study is to answer specific questions.

This consent form will explain:

- the purpose of the study
- what you will be asked to do
- the potential risks and benefits

It will also explain that you do not have to be in this study if you do not want to. You should ask questions before you decide if you want to participate. You can also ask questions at any time during the study.

The research study will be performed in the Six Sigma team project environments in the North Shore LIJ Health System, under the coaching/mentorship of the Operational Performance Solutions department from the Center for Learning and Innovation at the North Shore LIJ Health System.

You are asked to participate in a research study conducted by Brian J. Galli, MS, from the Engineering Management and Systems Engineering Department at Old Dominion University. The results of your participation in this study will contribute to research being performed for a dissertation.

DESCRIPTION OF RESEARCH STUDY

Several studies have been conducted looking into the subject of shared leadership (or team leadership) and team performance; shared leadership has begun to be researched more at both the academic and industrial levels since organizations have begun to see the high level of influence and impact that it can have on a team.

Research has not yet investigated the relationship(s) that internal and external environmental conditions have with the shared leadership dynamic in real-world Six Sigma projects teams as well as the relationship(s) that shared leadership has with two team performance metrics in these Six Sigma project environments. More specifically, research has yet to be performed in the field of shared leadership in relation to Six Sigma project teams in the healthcare delivery industry.

The main study for this research will involve researching the relationship(s) that shared leadership has with different internal and external environmental conditions in Six Sigma project environments from the NSLIJ Health System. In conjunction with studying these

relationships, the main study will examine shared leadership and its relationship(s) with two performance metrics, project completion and customer satisfaction, in Six Sigma projects from the NSLIJ Health System.

If you decide to participate, then you will join a pilot study, that will take place prior to the main study, which seeks to valid the effectiveness and quality of the research as well as the data collection tool (i.e. survey). Your participation in this pilot study will provide the opportunity to validate the design of the research methodology as well as the design of the data collection tool. In total there will be two (2) Six Sigma project teams participating in this research study.

In order to execute the pilot study, you will be asked to complete a survey/questionnaire at two (2) different points throughout the execution of your Six Sigma project. More specifically, since all of the Six Sigma projects overseen by the Operational Performance Solutions department from the Center for Learning and Innovation utilize a specific DMAIC Six Sigma timeline, you will be asked to complete a survey/questionnaire at the "report outs" (i.e. conclusion) of the Analyze and Improve phases of the health system's defined DMAIC Six Sigma methodology timeline.

If you say YES, then your participation will require the completion of a survey/questionnaire at two different points throughout the health system's defined DMAIC Six Sigma methodology timeline. All surveys/questionnaires will be completed via hard copy after each of the pre-specified "report out" sessions in the Analyze and Improve phases of the health system's defined DMAIC Six Sigma methodology timeline. If you say YES, then your participation in this pilot study will require duration of 4-6 months (dependent on the adherence to the health system's defined DMAIC Six Sigma methodology timeline).

SELECTION CRITERIA

You were selected as a possible participant in this study because you are a member of the North Shore LIJ Health System and you are currently participating in a Six Sigma project (i.e. Six Sigma, Lean) that is taking place in the North Shore LIJ Health System.

RISKS AND BENEFITS

RISKS: Due to the subject of this research, if survey responses collected from participants were to become known, there could be subsequent effects to participant employment or reputation. Surveys do ask you to report on team members, in an identifiable way. Steps and measures have been taken to maintain the security, confidentiality and privacy of the participants in this study; therefore, this potential risk has been mitigated. None of the data/information gathered by participating teams will be shared with anyone in the supervisory role; the only person from the health system that will have access to the survey data and information will be myself.

As with any research, there is some possibility that you may be subject to risks that have not yet been identified.

BENEFITS: The main benefit to each participating team is that the results from this study can help to provide guidance and recommendations, which in turn can help the participating teams to improve their performance and outputs for the Six Sigma projects. In addition, we hope that the information learned will benefit the Health System, in being able to improve its approach to Six Sigma projects and how it approaches the team leadership (shared leadership) concept.

COSTS AND PAYMENTS
The researchers are unable to give you any payment for participating in this study.

NEW INFORMATION
If the researchers find new information during this study that would reasonably change your decision about participating, then they will give it to you.

CONFIDENTIALITY
Any information that is obtained in connection with this study and that can identify you will remain confidential and will be disclosed only with your permission or as required by law. The researcher will take reasonable steps to keep private information, such as questionnaires, confidential. The researcher will remove identifiers from the information and store information electronically, which will be password protected.

The results of this study may be used in reports, presentations, and publications; but the researcher will not identify you. Of course, your records may be subpoenaed by court order or inspected by government bodies with oversight authority.

WITHDRAWAL PRIVILEGE
It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. The researchers reserve the right to withdraw your participation in this study, at any time, if they observe potential problems with your continued participation.

RESEARCH PARTICIPANT RIGHTS
Your participation in this project is voluntary. If you choose to not join the study, your employment and participation in the Six Sigma Program will not be affected. If you join the study you may withdraw at any time without prejudice to your employment at the North Shore-LIJ Health System.

VOLUNTARY CONSENT
By signing this form, you are saying several things. You are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them:

Brian J. Galli, Phone (Mobile): 631-662-0743 & Phone (Home): 631-683-4744
Email: bgalli@nshs.edu, bgall006@odu.edu or brianj.galli@gmail.com

If you have questions about your rights as a research participant, or concerns about being in the study, you may contact the Office of the Institutional Review Board (the committee that oversees research at this institution) at (516) 562-3101. A signed copy of this consent form will be given to you.

And importantly, by signing below, you are telling the researcher YES, that you agree to participate in this study. The researcher should give you a copy of this form.

_____ _____

Signature of Participant Date

_____

Printed Name of Participant

_____ _____

Signature of witness Date

(Note: A witness can be a member of the research team, but cannot be the same person signing consent as the investigator)

INVESTIGATOR'S STATEMENT

I certify that I have explained to this subject the nature and purpose of this research, including benefits, risks, costs, and any experimental procedures. I have described the rights and protections afforded to human subjects and have done nothing to pressure, coerce, or falsely entice this subject into participating. I am aware of my obligations under state and federal laws, and promise compliance. I have answered the subject's questions and have encouraged him/her to ask additional questions at any time during the course of this study. I have witnessed the above signature(s) on this consent form.

_____ _____

Investigator's signature **Date**

_____

Investigator's printed name

APPENDIX E: LEADERSHIP NETWORKS (PILOT STUDY)

Figure E1 - Team #1, Time Period #1 (Analyze Phase)

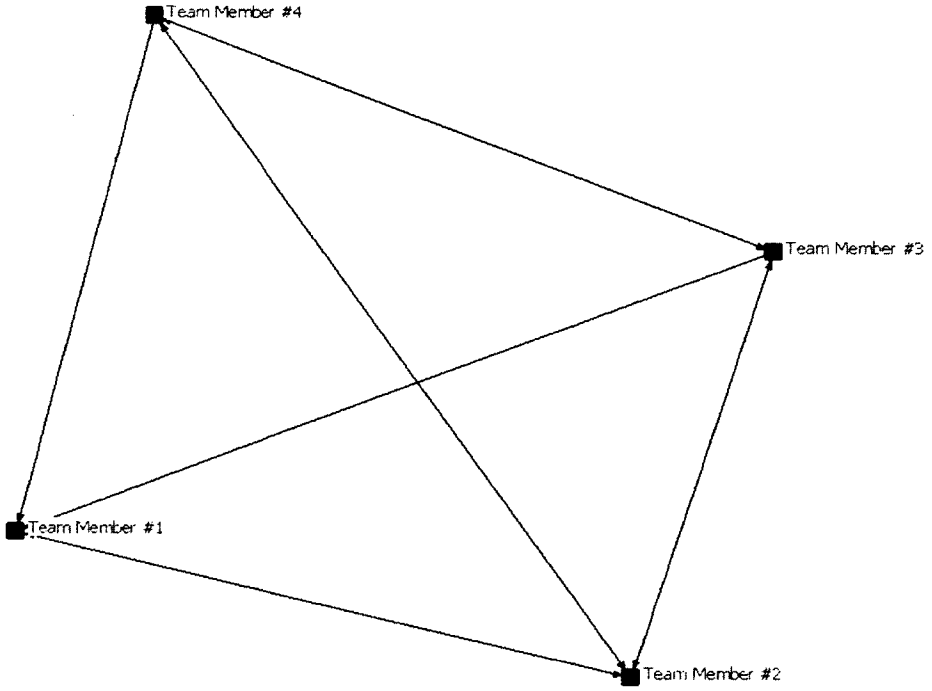


Figure E2 - Team #1, Time Period #2 (Improve Phase)

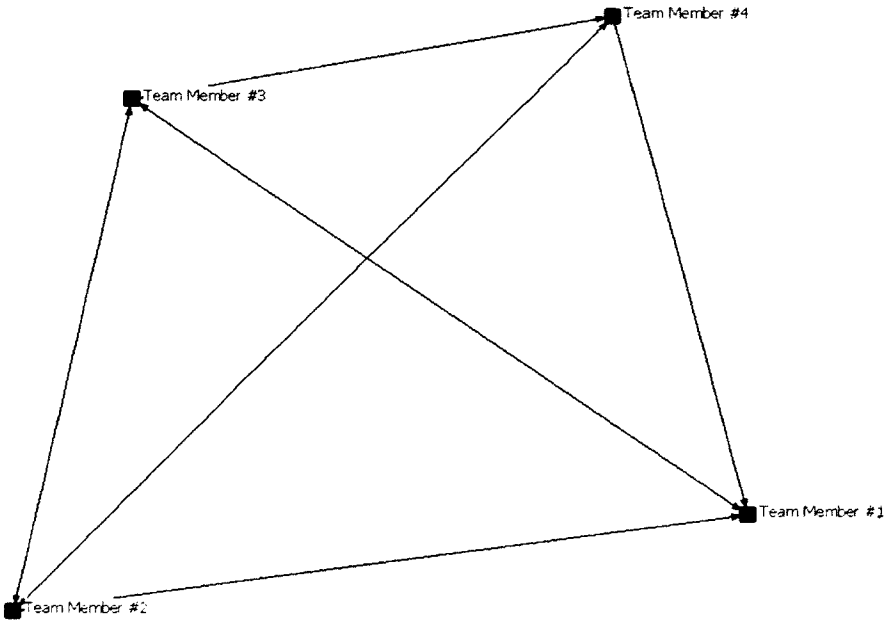


Figure E3 - Team #2, Time Period #1 (Analyze Phase)

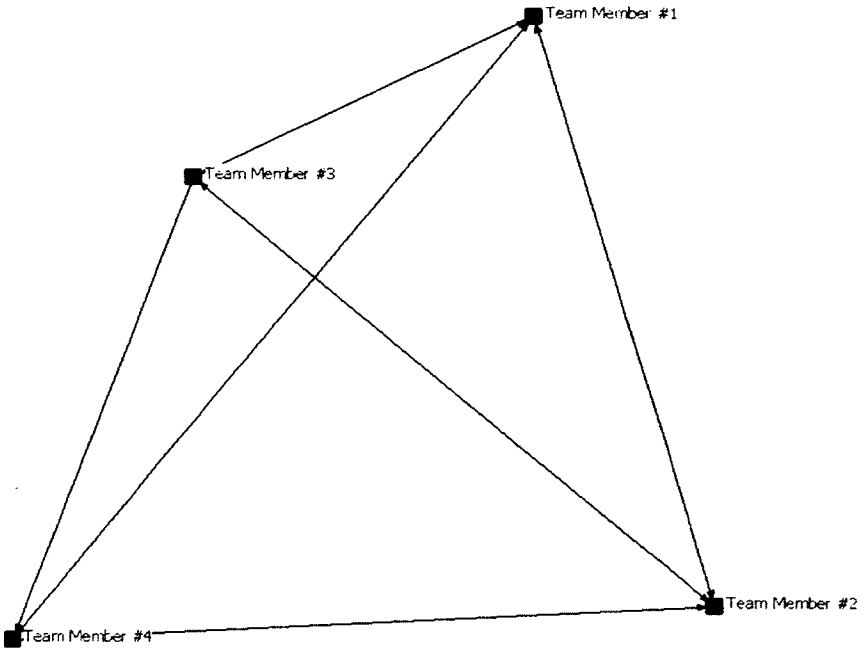
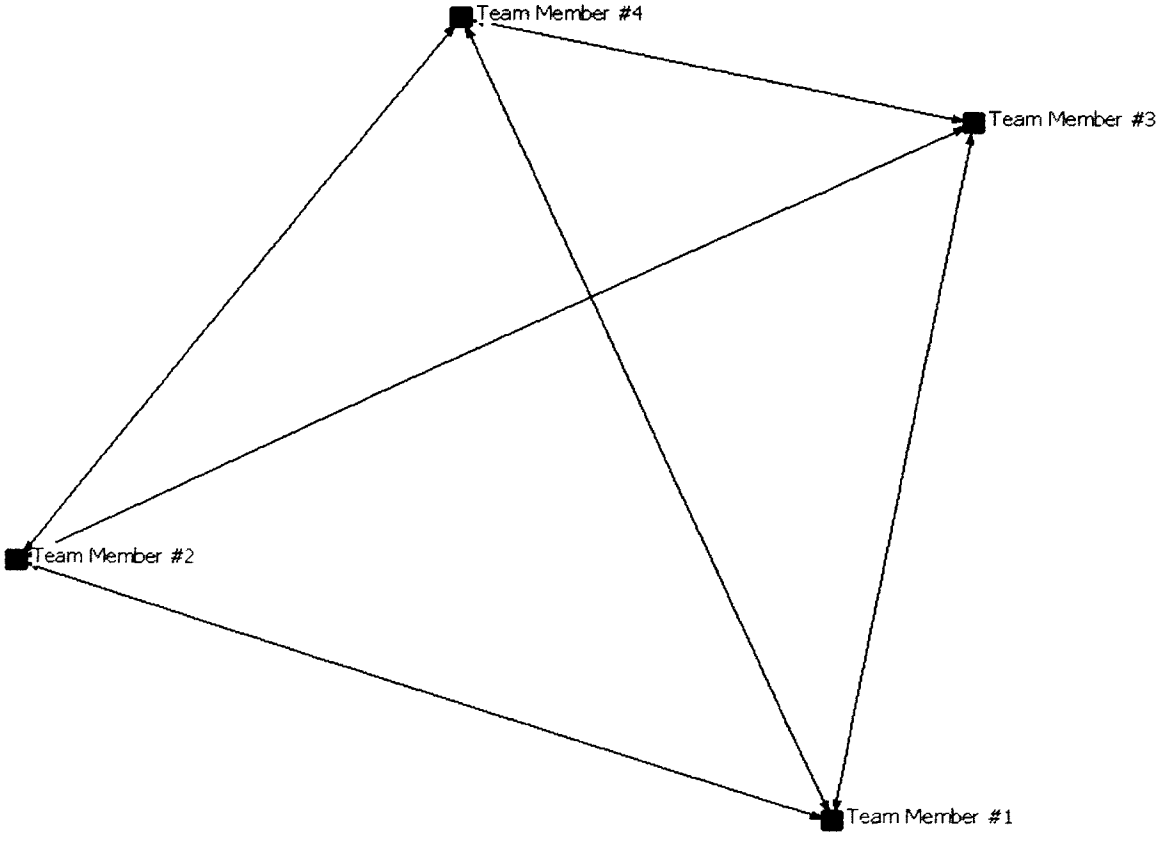
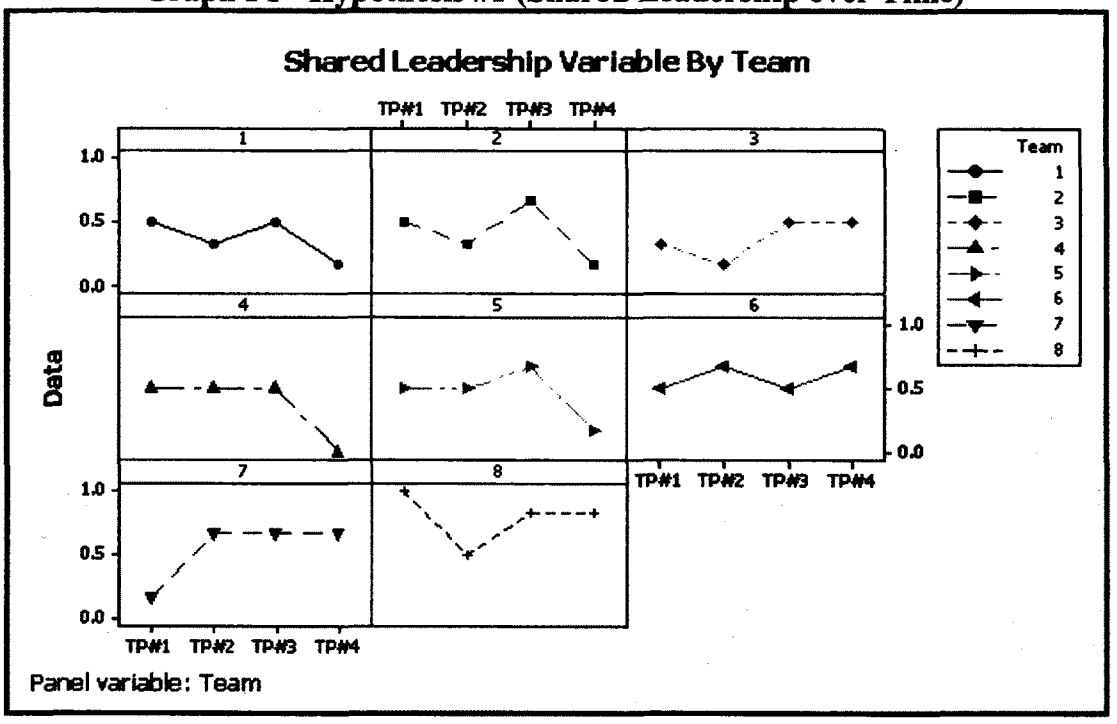


Figure E4 - Team #2, Time Period #2 (Improve Phase)

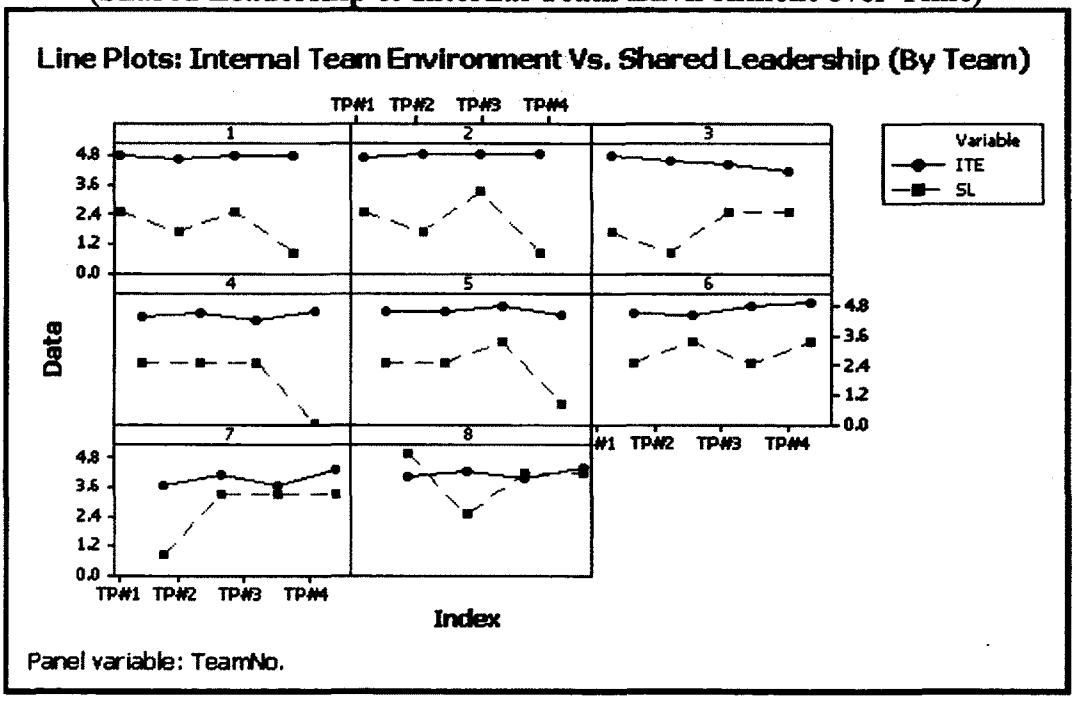


APPENDIX F: LINE PLOTS OF EACH HYPOTHESIS BY TEAM

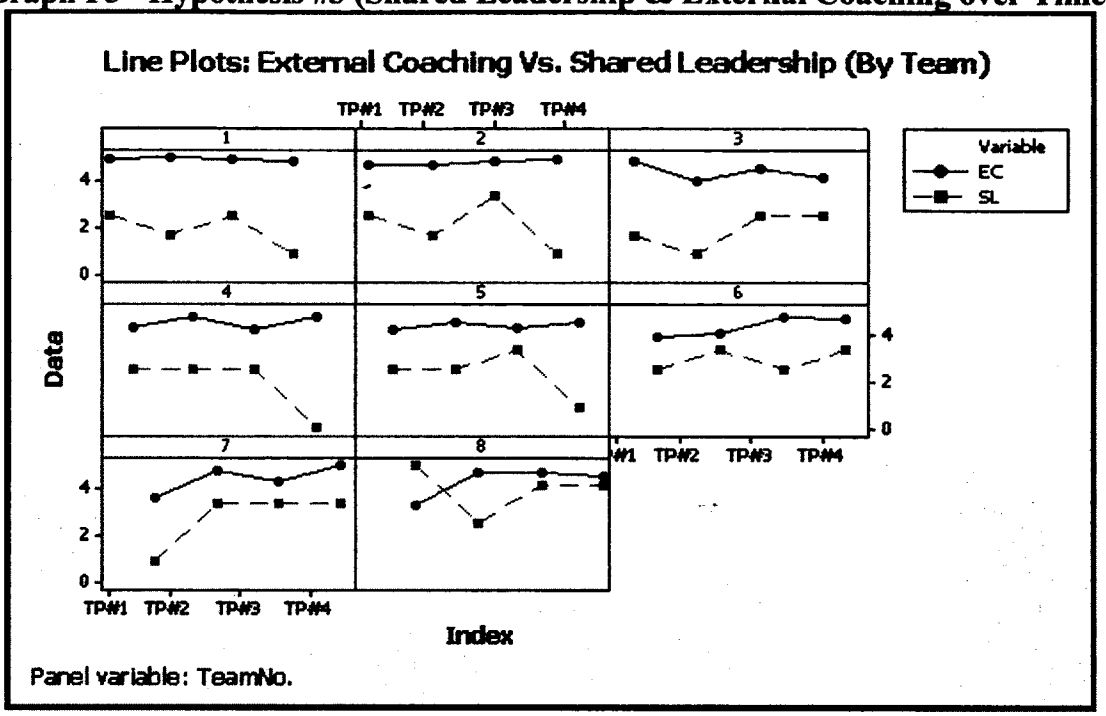
Graph F1 - Hypothesis #1 (Shared Leadership over Time)



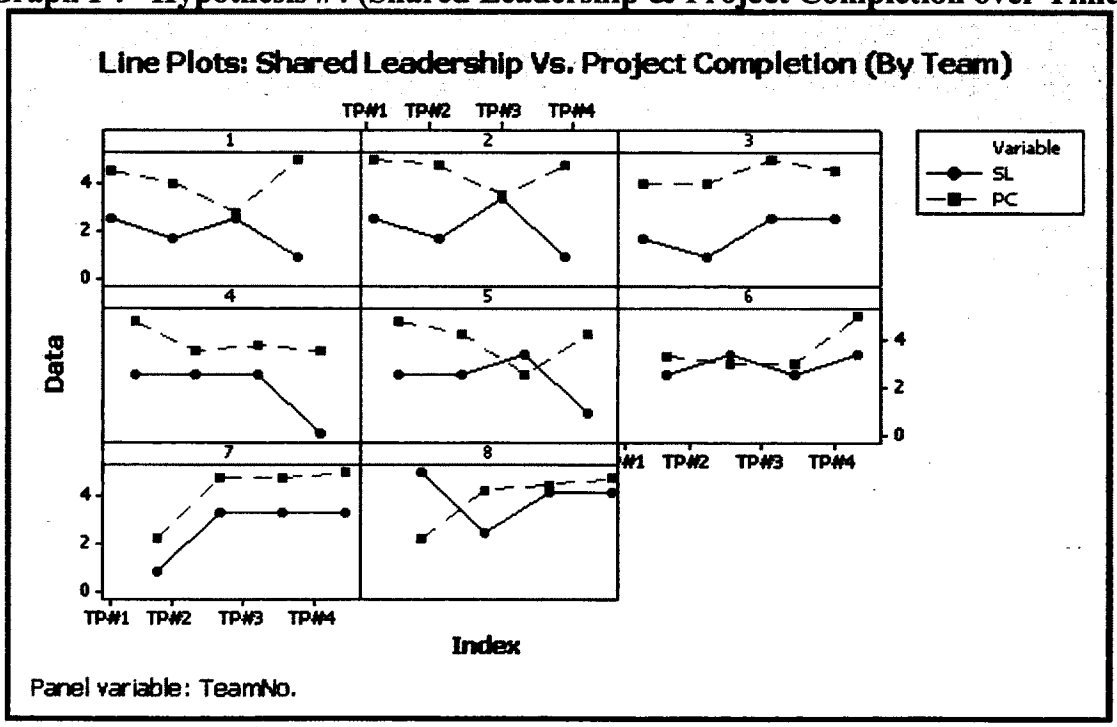
Graph F2 - Hypothesis #2
(Shared Leadership & Internal Team Environment over Time)



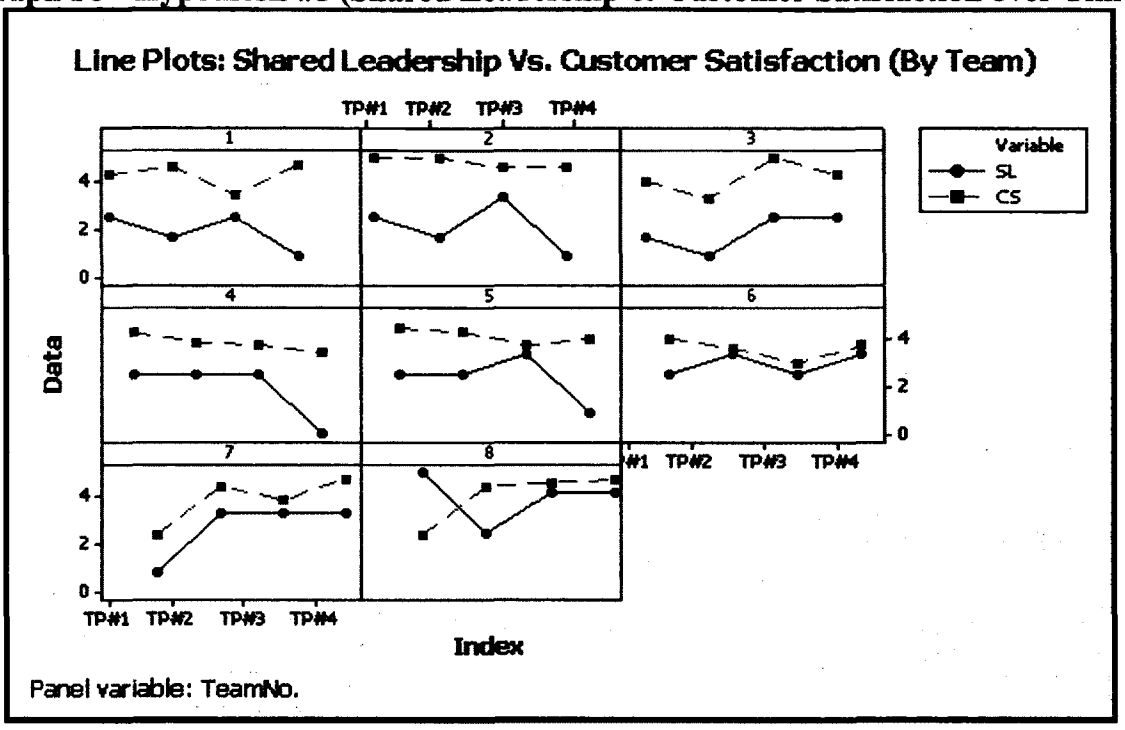
Graph F3 - Hypothesis #3 (Shared Leadership & External Coaching over Time)



Graph F4 - Hypothesis #4 (Shared Leadership & Project Completion over Time)



Graph F5 - Hypothesis #5 (Shared Leadership & Customer Satisfaction over Time)



APPENDIX G: SPEARMAN CORRELATION COEFFICIENT ANALYSIS

General Information

- Correlation Coefficient denoted as r.
- Since the shared leadership variable is defined on an opposite scale (0 implies maximum shared leadership, 5 implies no shared leadership) as compared to the internal team environment, external coaching, project completion, and customer satisfaction (1 implying the minimum value, and 5 implying the maximum value).
- Since the variables have opposite scales, in order to identify a direct relationship, I needed an r value of -1. An r value of -1 implies that there is a strong direct relationship between the two variables. For example, if r = -1, then as the shared leadership increases (improves), the internal team environment variable also increases (improves) (and vice versa).
- Since the variables have opposite scales, in order to identify an indirect relationship, I needed an r value of +1. An r value of +1 implies there is a strong direct relationship between the two variables. For example, if r = +1, then as the shared leadership increases (improves), the internal team environment variable decreases (gets worse) (and vice versa).
- A correlation coefficient with a value of 0 would imply no relationship exists between shared leadership and the second variable.

Hypothesis #2

H_0 = Internal Team Environment Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, $r = 0$

H_A = Internal Team Environment Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, $r < 0$

Note: H_A is set to have $r < 0$ since as outlined in the general information above, a negative value for r would imply a direct relationship between the two variables since they are defined on opposite scales.

Evaluated at alpha = 0.05. If p-value is < 0.05, accept H_A and reject H_0.
Test performed at each of the four phases.

Table G1 presents the r values and p-values for each phase.

Table G1: Results of Correlation Analysis on Hypothesis #2

Time Period	Correlation Coefficient (r)	P-Value
Define (1)	-0.795	P value < 0.05
Measure (2)	-0.855	P value < 0.05
Analyze (3)	-0.798	P value < 0.05
Improve (4)	-0.822	P value < 0.05

Conclusion: Shared Leadership and Internal Team Environment have a statistically significant and strongly direct relationship at all phases (highlighted in yellow in the table) of the DMAIC structure. These results match the conclusions identified for the Wilcoxon Matched-Pairs Signed-Rank Test performed on hypothesis #2 in Chapter Four.

Hypothesis #3

H_0 = External Coaching Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, r = 0

H_A = External Coaching Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, r < 0

Note: H_A is set to have r < 0 since as outlined in the general information above, a negative value for r would imply a direct relationship between the two variables since they are defined on opposite scales.

Evaluated at alpha = 0.05. If p-value is < 0.05, accept H_A and reject H_0.
Test performed at each of the four phases.

Table G2 presents the r values and p-values for each phase.

Table G2: Results of Correlation Analysis on Hypothesis #3

Time Period	Correlation Coefficient (r)	P-Value
Define (1)	0.025	P value > 0.05
Measure (2)	-0.780	P value < 0.05
Analyze (3)	-0.853	P value < 0.05
Improve (4)	-0.867	P value < 0.05

Conclusion: Shared Leadership and External Coaching have a statistically significant and strongly direct relationship at only the Measure, Analyze, and Improve phases (highlighted in yellow in the table) of the DMAIC structure. These results match the conclusions identified for the Wilcoxon Matched-Pairs Signed-Rank Test performed on hypothesis #3 in Chapter Four.

Hypothesis #4

H_0 = Project Completion Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, r = 0

H_A = Project Completion Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, r < 0

Note: H_A is set to have r < 0 since as outlined in the general information above, a negative value for r would imply a direct relationship between the two variables since they are defined on opposite scales.

Evaluated at alpha = 0.05. If p-value is < 0.05, accept H_A and reject H_0.
Test performed at each of the four phases.

Table G3 presents the r values and p-values for each phase.

Table G3: Results of Correlation Analysis on Hypothesis #4

Time Period	Correlation Coefficient (r)	P-Value
Define (1)	0.035	P value > 0.05
Measure (2)	-0.854	P value < 0.05
Analyze (3)	-0.012	P value > 0.05
Improve (4)	-0.940	P value < 0.05

Conclusion: Shared Leadership and Project Completion have a statistically significant and strongly direct relationship at only the Measure and Improve phases (highlighted in yellow in the table) of the DMAIC structure. These results match the conclusions identified for the Wilcoxon Matched-Pairs Signed-Rank Test performed on hypothesis #4 in Chapter Four.

Hypothesis #5

H_0 = Customer Satisfaction Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, $r = 0$

H_A = Customer Satisfaction Value$_i$ and Shared Leadership Value$_i$ Correlation Coefficient, $r < 0$

Note: H_A is set to have $r < 0$ since as outlined in the general information above, a negative value for r would imply a direct relationship between the two variables since they are defined on opposite scales.

Evaluated at alpha = 0.05. If p-value is < 0.05, accept H_A and reject H_0.
Test performed at each of the four phases.

Table G4 presents the r values and p-values for each phase.

Table G3: Results of Correlation Analysis on Hypothesis #5

Time Period	Correlation Coefficient (r)	P-Value
Define (1)	-0.048	P value > 0.05
Measure (2)	-0.985	P value < 0.05
Analyze (3)	0.043	P value > 0.05
Improve (4)	-0.912	P value < 0.05

Conclusion: Shared Leadership and Customer Satisfaction have a statistically significant and strongly direct relationship at only the Measure and Improve phases (highlighted in yellow in the table) of the DMAIC structure. These results match the conclusions identified for the Wilcoxon Matched-Pairs Signed-Rank Test performed on hypothesis #5 in Chapter Four.

General Conclusion

For the four hypotheses (#2, #3, #4, and #5) examined in this analysis, the correlation coefficient analysis identified the same relationships identified through the Wilcoxon Matched-Pairs Signed-Rank Test that was utilized as the main statistical analysis method presented in Chapter Four. The execution of the Spearman correlation coefficient analysis helped to enhance the credibility and validity (triangulation of research for social science) for the Wilcoxon Matched-Pairs Signed-Rank statistical test that was utilized to evaluate four hypotheses (#2, #3, #4, and #5). Since the results of the Spearman correlation coefficient analysis are equivalent to the findings from the Wilcoxon Matched-Pairs Signed-Rank statistical test, it can be concluded that the results identified for hypotheses #2, #3, #4, and #5 are credible and valid, which strengthens the triangulation of research surrounding these four hypotheses.

VITA

Brian J. Galli
Department Background
Department of Engineering Management & Systems Engineering
Old Dominion University, Norfolk, Virginia, USA
Email: bgall06@odu.edu

Education
Bachelors of Science, Industrial & Systems Engineering, May 2007, Binghamton University, Binghamton, New York
Masters of Science, Engineering Management, July 2009, Missouri University of Science & Technology, Rolla, Missouri
Doctor of Philosophy, Engineering Management, Expected Fall 2013, Old Dominion University, Norfolk, Virginia

Licenses/Certifications
Six Sigma Greenbelt, Completed Spring 2008
Lean Brownbelt, Dartmouth University, Completed Spring 2011
Lean Blackbelt, Dartmouth University, Completed Summer 2011
New York State Professional Engineering License (Industrial Engineering), June 2013
Improvement Advisor Professional Development Program – IHI, August 2013.

Professional Experience
After completing my Bachelors of Science in 2007, I began my career as a Reliability Engineer for Telephonics Corporation, based in Farmingdale, New York. In September 2011, I began employment as a Six Sigma Blackbelt Industrial Engineer at the North Shore LIJ Health System (in the Center for Learning and Innovation, Division of Improvement Sciences) based in Great Neck, New York.

Teaching Experience (Adjunct/Part-Time Status)
- New York Institute of Technology (NYIT), Old Westbury, New York (Fall 2010 – Present): Instruction in the following areas: Project Engineering/Management, Operations Management, Operations Research I and II, Engineering Economics System Simulation, Statistical Design I and II, and Technology and Global Issues.
- American Public University System (APUS), Charles Town, West Virginia (Fall 2011 – Present): Instruction in the following areas: Transportation Management, Transportation Economics, Logistics Management, Fundamentals of Intermodal Transportation, Advanced Business Logistics, and Supply Chain Management.
- Stonybrook University (SUNY Stonybrook), Stonybrook, New York (Spring 2011 – 2012): Instruction in the following areas: Program/Project Management.

Research Interests
Organizational Development, Leadership Development, Team Dynamics and Team Development, Team Decision-Making, Continuous Improvement, Six Sigma, Lean Methodology, and Engineering Management/Industrial Engineering Topics.