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The Role of Team Effectiveness in Construction Project Teams and Project Performance

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The role of team effectiveness in construction project teams and project performance

by

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ABSTRACT

Increasingly, organizations in the construction sector use teams to meet today's global competition and customer expectations, but they need better ways of evaluating the effectiveness of the teams. To ensure that construction teams are successful and effective, construction companies must promote, measure, and evaluate their teams' effectiveness. It is believed that creating a highly effective project team will produce high-end project outcomes that exceed standards, and, therefore, enhance overall productivity. Moreover, it is imperative for construction teams to know the contributing factors of team effectiveness in construction projects. The purpose of the study is to determine the role of team effectiveness in construction project teams on the overall construction project performance. It examines different factors that associated with team effectiveness and the relationship between the team effectiveness factors and project performance aspects. Quantitative and qualitative research methods are used for this study, which are survey and semi-structured interview. A Team Effectiveness Survey and Project Performance Survey are developed to use for data collection. The data collected was analyzed using several statistical tests, including Analysis of Variance (ANOVA) and linear regression. The results obtained from the data analysis are validated using semi-structured interview. It was found that Team Leadership is the most important factor in Project Change Management. Additionally, definitions of team effectiveness in construction project teams are developed based on the perspectives of project team members and project owners. The surveys developed are intended for assessment and evaluation of the construction project team to maintain their effectiveness level throughout the project phases. The outcomes from this study are anticipated to provide construction project teams with the ideas on the factors that need to be focused in order to improve team effectiveness on project performance aspects. Furthermore, the definition on team effectiveness from the team members and owner's point of view are developed to provide better understanding on what team effectiveness really means to different parties on a construction project.

CHAPTER 1. INTRODUCTION

An evolution of teamwork and its concept started during the Industrial Revolution, where most work organizations shifted to the hierarchical approach and used scientific management to design organizations and jobs (Taylor 1911). According to Taylor (1911), scientific management methods call for optimizing the way tasks were performed by simplifying the jobs, so workers could be trained to perform their specialized sequence of motions in the "best" way. This resulted in more simplified jobs and provided benefits to skilled workers. However, during the 1920s and 1930s, the scientific management model was questioned, since it created issues with people's relationships to work, although the model functioned well. Workers became alienated and difficult to motivate. In addition to no task flexibility, changes were difficult to implement.

Later, the Hawthorn Studies (Mayo 1933) discovered social factors had some implications on performance. This substantial impact on productivity resulted in work groups able to effectively enforce norms—positive or negative to the organization. After World War II, more research was conducted with regards to work groups. According to Levi (2007), research indicated that organizing people into teams was one way to improve the operations of organizations and productivity. It was not until the 1960s and 1970s that the term “teams” was refined. Companies in the manufacturing industries were changing their operating methods, as Japanese companies successfully developed high-quality products with minimal cost. These changes adopted the team concept and later became the foundation for organizations in the late 1980s.

The use of work teams, a group of employees with interdependent interactions and mutually-shared responsibilities (Sundrom et al. 1990), has improved dramatically during the past decade. A study conducted by Ostermann (1994) indicated that over 50% of the 700 organizational units studied were using teams and over 40% had more than half of their employees working in teams. Lawler et al. (1995) proved the trend continues to gain momentum, where 60% of the 313 organizations studied stated increments in their use of teams over the next decade. Only 3% plan to discontinue the use of teams. Additionally, according to Cohan and Bailey (1997), 85% of companies with 100 or more employees use some type of work teams.

At present, more organizations use teamwork to meet today's global competitions and expand customer expectations. Mohrmar et al. (1995) indicated application of a team is an essential element in a company, where organizations restructuring were determined, based on teams. Teamwork is no longer applied only to manufacturing, but also to management, service, problem-solving, projects, and other work. Recent developments in teamwork and teams in organizations have heightened the need to determine better ways to utilize teams, especially in the construction sector. Highly effective teams have proven to establish good working relationships and potentially achieve greater outcomes, since conflicts within teams are minimized (Demkin 2008). Due to this, the concept of working together collaboratively as a team by pooling knowledge and experience ensures buildings meet the needs of today, let alone tomorrow.

The nature of the construction industry is fragmented. Traditionally, the design phase in a project is considered as a separate activity of the construction phase (Anumba et al. 2002). Construction teams are usually reorganized and formed for almost every new project. As indicated by Cornick and Mather (1999), the construction team is organized around specific trades and functions, with project team members selected on the basis of technical and financial soundness of design, and the competitiveness of the tender sum. Focusing on organizations' individual professional capabilities has resulted in construction teams working towards individually-defined objectives, often are in disagreement with other team members. Additionally, Evbuonwan and Anumba (1998) indicated that part of the reasons for poor performance of product delivery in the construction industry is due to the inability of project participants to work collaboratively.

According to Egan (2002), process and team integration are the key drivers of changes necessary for the construction industry to become more successful. However, simply bringing people together does not necessarily ensure they will function effectively as a team. Effective teamwork does not occur automatically. It may be challenged by various issues, such as lack of organization, misunderstandings, poor communications, and inadequate participation from team members. Therefore, it is crucial for construction project teams to find a solution to help their team members to integrate and work together effectively.

1.1. PROBLEM STATEMENT

Construction project teams are developed as soon as they enter into a new project. The goal is for a team to showcase its desirability of cooperative relationships through project performance. To ensure construction teams successfully complete their projects, it is necessary for construction companies to promote, measure, and evaluate their teams' effectiveness. By all means, it is a challenging task to perform, but there are underlying reasons why construction companies need an effective measurement system for teams. As stated by Mohrman (1995), measurement of individual performance is still the focus of most research, and many appraisal and reward systems, despite the increase in team usage.

According to Cantu (2007), some of the reasons for an effective measurement in teams are based on the probability that the more effectively a team functions, the more benefits they are likely to realize from the work team structure. Team structures alone are not sufficient to create successful developments in workplace efficacy, quality, productivity, and employee attitudes. In addition, cost related to supporting work team structure would help provide a return on investment (ROI) as viewed by the stakeholders.

Although there are numerous effectiveness measurements for teams, there is not one measurement tailored specifically for construction project teams. Since construction teams comprise individuals with diverse backgrounds, each possesses a unique set of requirements he/she wishes to achieve. Cohen and Bailey (1997) indicated it is often impossible for researchers and managers to compare teams in different functional areas, departments, or facilities. Therefore, it is crucial for team leaders to determine the best way to ensure all team players' expectations are aligned with the overall project's goals and objectives. Busseri et al. (2000) suggested it may be useful for team members to reflect on how well they are working together from time-to-time. This can be addressed by conducting assessment and evaluation among team members and by the project owner on what they think is working well, what is not working well, and how it can be improved.

By developing sound measurements, it is hoped team effectiveness can assist in quality improvements (Manz and Sims 1993), productivity (Ray and Bronstein 1995), safety, absenteeism, and employee attitudes (Beyerlein and Harris 1998) throughout the construction process.

1.2. PURPOSE OF THE STUDY

The purpose of this study is to determine the role of team effectiveness in construction project teams on the overall construction team and project performance. According to Gibson et al. (2003), an organization's team effectiveness is a key juncture of theory development. A recent report produced by the Lowe (2009) indicated team performance can be increased by keeping basic teamwork principles at the forefront. To expedite this matter, it is vital to examine different factors associated with team effectiveness and to what extent these factors can lead to create effective construction project teams. These factors examined are crucial to help comprehend the determinants of team effectiveness and to implement teams in construction projects.

Therefore, it is the aim of this study to help construction project leaders and construction companies' top management to develop highly effective project teams through identified factors that contribute towards a construction project's success, by means of conducting a series of evaluations and assessments using the new team effectiveness assessment tool. This study also seeks to provide an understanding on what team effectiveness means to people in the construction business.

To address this goal, this study is arranged as follows. First, a literature review is performed on different team effectiveness models, other team literatures, and on all types of team measurements to assist in developing a new assessment for team effectiveness. Once completed, a pilot study is conducted to determine the most important factors that drive team effectiveness from the perspective of different parties in the construction industry. Information obtained from this pilot study, as well as the literature review, will be included in the development of the assessment tool. Once a draft is developed, a validation process will take place, where the Capstone Class in the Construction Engineering undergraduate program will validate the assessment tool. Data from the validation process will be used to statistically evaluate the psychometric properties of the assessment tool, which contains a factor analysis to guide appropriate factor development, reliability of scales to demonstrate sufficient uniformity among individual items in a scale, construct validity to ensure the assessment is measuring its intended dimensions, and criterion validity to exhibit consistency

of measurement of the new team effectiveness assessment tool with other measures of a team's effectiveness.

Once these data have been collected using the new and improved team effectiveness assessment tool, a statistical analysis is performed on the collected data to determine the relationship between the team effectiveness factors and the project performance aspects on individual and team levels. Once the relationships are determined between the variables, further statistical testing is conducted to determine which factor is the most significant in predicting project performance. In addition, two definitions of team effectiveness are developed from this study by analyzing the open-ended questions included in the surveys using text analysis.

Once the findings of the study are obtained, a validation process is performed by conducting a semi-structured interview with an award-winning project team. A set of questions related to team effectiveness and project performance are designed to ensure relevant information is obtained from the interview conducted. Next, an interview transcription is produced and text analysis is performed on the rich data obtained.

1.3. SIGNIFICANCE OF THE STUDY

This study contributes to the body of knowledge relating to project management and organizations, specifically on teams and team practices. Besides focusing on the performance aspects of the construction project, it is also predicted this study will assist project managers and construction team leaders in understanding what factors contribute to create an effective project team.

The development of surveys to assess the level of team effectiveness in construction project teams adds significance to the available metrics for evaluating projects. The developed assessments tailored for construction teams can help identify the areas for improvement, as well as obtain valuable input from the owner on the overall team performance, based on the assessment of the project's performance aspects. On the other hand, this manuscript is anticipated to stimulate other researchers to continue investigations pertaining to team effectiveness in construction project teams.

From an academic viewpoint, this study will help balance group literature by examining team effectiveness and its role in contributing to team performance, and, thus, project success. From a managerial perspective, this study will help top management and project leaders to improve their understanding of the relationships among team effectiveness and team performance. Consequently, they will know how to develop an effective project team by targeting specific team effectiveness factors and motivate their colleagues to work together to become a highly effective team.

1.4. ORGANIZATION OF THE DOCUMENT

Following this introduction chapter, the dissertation is organized into seven additional chapters. Chapter 2 focuses on the background of the study, which consists of a review of relevant literature from previous research. The next chapter (Chapter 3) provides the point of departure of this study, based on the literature review conducted earlier. The research methodology used in this study is explained in Chapter 4 and is laid out according to research questions. Chapter 5 consists of the methods and results obtained from the pilot study. The overall results and discussions on the statistical analysis and qualitative analysis are explained in Chapter 6. Chapter 7 presents information on the validation process utilized in this study. Finally, Chapter 8 focuses on outcomes and benefits associated with the outcomes, the significance of the findings found from the study, and how the outcomes can be applied to future practice, as well as suggestions for future research. Appendices are included at the end of this document to provide further detailed information on the surveys, interview protocol and questions, as well as output from statistical analyses.

CHAPTER 2. BACKGROUND/LITERATURE REVIEW

According to Robbins and Finley (2000), the concept of teams has existed a hundred thousand years ago, even before the time of Hammurabi. However, teams developed duringthat era are small-scaled teams. The Industrial Revolution in the 1700s saw changes in organizational structures and business models, which leads toward the beginning of scientific management. In the 1960s, organizations created functional teams, but the teams were still fragmented. After World War II, Japanese companies enhanced the team ethic, by making every worker, in every function, at every level, a part of the organization team. Many organizations experienced change by moving towards self-directed teams and team-based management processes starting in the 1980s. Later during this era, reengineering was prominent and lead to something called a high performing organization. Both incorporated teams as part of their core approach. By the 1990s, organizations across the world, particularly in the United States, saw the team model replace the old organization structure.

As time passed, there was a dramatic increase in the trend toward implementation of more teams to address various organizational issues. People started to realize the importance of collaborating and working together, as the end results were much better than working individually or as a centralized unit. According to Parker (2008), teams and teamwork are now widely recognized, and are here to stay and dominate the way work is performed. Both have gained importance as public and private entities saw the substantial benefits of such programs.

A team is no longer a group of people working in the same area, using the same equipment, dealing with the same clients within the same location. Nowadays, a team is comprised of people from different organizations, located around the globe with a high degree of interdependence geared toward the accomplishment of mutual goals. According to Bell (2004), teams are prevalent in organizations and stipulate imperative contributions to organizational productivity. This is supported by Cohen and Bailey (1997) and Sundstrom et al. (1990), who connoted there is a boundless acknowledgment that a lot of work can be accomplished in organizations as the result of team work.

The concept of team and teamwork has currently become a concern for management in all types of industries, including construction. Teamwork in construction and project management is nothing new (Albanese and Haggard 1993).Throughout history, people have worked together and collaborated as big groups on construction projects. Some of the earliest examples known to mankind are megaliths and the construction of the pyramids. During this particular time, teams, tasks, and individuals, some committed, some coerced, under leadership of one sort or another but mostly 'dictatorial', started to emerge very early in the evolution of civilized man in the context of the construction process (Cornick and Mather 1999).

Since these early times, teamwork in construction has undergone changes and started to evolve in different aspects. Most of the literature regarding teams has piqued great interest among researchers in management and the social sciences, as well as practitioners. However, according to Spatz (2000), the topic of teamwork and team building has received little attention in the construction literature. Fong & Lung (2007) indicated most of the research conducted only focused on factors necessary for team success, rather than teamwork issues. This chapter systematically reviews the literature applicable to this study. Since the study focuses on construction project teams and team effectiveness, the three major threads follow these themes. As part of this study, an in-depth literature review is conducted, which contains three main sections. The first section describes team concepts, in general, by providing an overview of a team and teamwork in organizations. This is followed by discussion on construction project teams and the concept of teamwork in the construction industry. The second section builds upon the literature on the team effectiveness aspects, which include the definition, factors, models and methods of measuring and evaluating team effectiveness. Finally, the third section describes construction project performance aspects, and how these aspects can be measured and evaluated. Based upon these bodies of literature, a team effectiveness survey and a project performance survey are developed to assess the effectiveness of construction project teams and the construction project performance.

2.1. TEAMS

2.1.1. Overview of Team

Team is a word and concept well-known to everyone. Each person has his/her own definition of what a team means. Therefore, it is imperative to clarify what team means, since it conveys different things to different people. Some people think any group working together can be called a team; some even think it is associated with sports; whereas, others perceive team as in its values, such as cooperating and helping each other. Regardless of what people perceive of teams, it exceeds individuals acting alone or in large organizational groupings, especially when performance requires numerous skills, judgments, and experiences. According to Katzenbach and Smith (2003, p.45), a team can be defined as:

> "A small number of people with complementary skills, who are committed to a common purpose, performance goals, and approach for which they hold themselves mutually accountable."

Almost all teams, either in small or large organizations, somehow fit into the above definition. This definition highlights some important elements that comprise a real team—complementary skills, commitment, common purpose and goals, common approach or strategy, and mutual accountability (Spatz 2000; Katzenbach and Smith 2003). Hackman (1987, 1990) defined team as two or more people with different tasks, who work adaptively together to achieve specified shared goals. As for Baker and Salas (1997), team can be considered as two or more individuals who have specified role assignments, perform specified tasks, and must interact and coordinate to achieve a common goal. Besides the term "team," other researchers use the nomenclature "work group" to describe teams in organizations.

According to Guzzo and Dickson (1996), work group insinuates a larger social system, such as organization. It consists of interdependent individuals, due to the tasks they perform, and view themselves and are viewed by others as a social entity. Consequently, work groups and teams constitute two or more individuals, who exist to perform organizationally relevant tasks, share goals and task interdependencies, interact socially, maintain and manage

boundaries, and exist within an organizational context (Kozlowski and Bell 2003, Cohen and Bailey 1997). Work groups and teams are also viewed as a socially intact identity embedded in a larger social context and manage relations across social boundaries.

As indicated by Cleland and King (1988), characteristics of an effective and productive project team are team spirit, trust, and quality of information exchange among team members. In addition, these characteristics contribute towards effective decision-making processes, enhancing commitment of team members, developing self-forcing and self-correcting project controls. According to Cannon-Bowers and Salas (1998), team members must possess certain team-related skills to perform effectively. Research has shown team members must be able to adapt to unpredictable situations, monitor each other's behavior, and provide constructive feedback to improve overall team performance.

Team members must have skills needed to maintain the team, such as exhibiting assertiveness in terms of sharing task-related information, ability to resolve conflicts, as well as providing motivational reinforcement, structure, and organization among themselves (Cannon-Bowers and Salas 1998). Additionally, problem-solving skills, technical specialty, and interpersonal skills are considered complementary skills that drive the success of the team. Moreover, the commitment of each team member towards a common purpose and goals of the team is crucial. Each team member must be dedicated to the whole team and be willing to act unselfishly. When challenges arise, the team needs to have the resources and commitment to deal with them in a constructive and positive manner. Team members hold themselves accountable to one another, besides deciding on a common approach to accomplish their purpose, such as decision-making, problem-solving, and means of communications. More importantly, all team members should evaluate overall team performance, as well as peer evaluation for individual performance.

Performance is the core of the substance for teams. It lays the fundamental basis of a team, where team and performance are inextricably related. Therefore, it is extremely important a team, regardless of its size, be the basic unit of performance for an organization. No team arises without a performance challenge meaningful to those concerned. A universal set of performance goals that a group considers significant to attain will lead most of the time to both performance and a team. To create a high performance team, there are several critical

steps that should be followed: (1) common interests, goals, and strategies, (2) shared values, (3) individual responsibilities, (4) highly effective collaborations, (5) agreed behaviors, (6) shared leadership, and (7) continual improvement (Spatz 1998).

The intrinsic distinction between teams and other forms of working groups turns on performance (Katzenbach and Smith 2005). Team strives for something greater than its members could achieve individually and depends on individual contributions of its members for shared performance. Every team member must understand his/her role and responsibilities to the team. It is essential during the preliminary phase of forming a team, the authority of teams and the role of team leader be defined and understood by team members. A dynamic team has players, who share common goals, common vision, and have some level of interdependence that requires both verbal and physical interaction, as well as recognizing and appreciating each team member's individual role. Combinations of team members' efforts may increase what the team can accomplish and will achieve peak performance to experience success.

2.1.2. Construction Project Teams

The construction industry is a project-based industry. Each project needs different people in accordance with their professionalism, knowledge, and experience, and requires them to work and coordinate with others from different companies. The construction industry has always dealt with the relationship between team, task, individual, and leadership (Adair 1983). It is sufficient to say that teamwork is dominant in construction's cultural tradition and at the foundation of successful construction projects. Teams and teamwork in construction have been impacted by diverse and exceptional features in the construction industry, as in the way it goes about its business. This can be seen more in the application of integrated project delivery method, where teams start to work as one unit, creating faster delivery times, minimizing costs, and creating an enjoyable working relationship for the entire project team. However, there are several barriers to teamwork in construction, such as disrespect and mistrust, among various project participants and professional rivalry that must be overcome towards developing and maintaining teamwork throughout the entire project's process (Uher and Loosemore 2004).

Cornick and Mather (1999) stated an overpowering need today for construction companies is to embrace teamwork in a broader sense than just individual work teams, due to the complexity of the construction business. As indicated by Alshawi and Faraj (2002), a typical construction project is a collaborative venture that involves a number of different organizations brought together to form ‘‘the construction project team.’’ This team is responsible for the design and construction of the project. Any parties involved in a construction project team, such as the project manager, site superintendent, and crews understand the importance of having effective teamwork. The project manager can be considered as the most important person for the success or failure of a project (Hendrickson and Au 1988). Project managers for the owner frequently work collaboratively with other parties, such as the architects and contractors, with each in charge of design and construction processes. Selecting a competent project manager has much at stake, since the project manager is assumed responsible at various stages of the project, regardless of the types of contractual agreements for implementing the project.

The construction project team comprises of a team of diverse people and cultural backgrounds. According to Emmit and Gorse (2007), construction project teams are a loose grouping of interested parties brought together for a specific construction project. People often portray a typical construction project team as a team that includes a project manager as an owner’s representative, architect, or engineer for the design team and the contractor. Additionally, there may be people under each of these categories, i.e., construction workers, superintendent, etc. Construction stakeholders are regularly viewed as closely associated with the construction project’s team, in which their responsibility and authority range from occasional contributions in surveys and focus groups to full project sponsorship, such as providing financial and political support.

Uher and Loosemore (2004) listed the participants of a typical construction project team as the following:

- Client
- Project Manager
- Financier
- Legal Consultant

- Design Leader (Architect or Structural Engineer)
- Other Design Consultants
- Main Contractor
- Subcontractors
- Cost Consultant
- Other Consultants (depending on project needs)
- An end user of the completed project (where appropriate)

However, the above list is subjected to the size and types of project, as well the project delivery method chosen. Different types of delivery methods require a different project team composition. Common project team members include owner, project manager, architect, and engineers, as well as contractors and subcontractors.

The owner or client of a construction project can either be a public or private entity. Typically, it is the owner who is responsible for providing the project's scope and requirements, as well as funding for the project. The design team is comprised of architects, engineers, and consultants, who generate the construction documents for the owner. The contractor typically builds a unique project in a viable setting and relies heavily on subcontracted and sub-subcontracted labor. Additionally, other participants, such as city planners, zoning authorities, union officials, safety specialists, health specialists, government engineers, vendors, users, subcontractors, special issue groups, and many others, also influence a construction project team.

The basic functional of a construction's project phases is significant for forming a construction team, and defining its roles and responsibilities, not essentially according to contractual roles. A construction project typically consists of six main phases, namely project briefing, designing, specifying, tendering, constructing, and maintaining. Cornick and Mather (1999) mentioned the functions for each construction project phase are always accomplished on any project, regardless of whether the delivery route is design-bid-build, design-build, construction management, or any hybrid of all three. The delivery method only changes the context and relationship in the time these functions are achieved.

According to Uher and Loosemore (2004), a unique feature of construction teams is their composition varies from stage-to-stage of a project's lifecycle. This is true as the construction project team moves collectively over the life of the project with the function of the same team member changing as each phase comes into being. In addition, the membership of the construction project team may vary according to size, type, and complexity of the project. The owner and project manager are always involved from the beginning to the end of the project throughout all six phases. Other important team members, such as designers, contractor, and subcontractors, join the construction team when their expertise is required. They leave the project site upon completion of their specific task(s). Even if they are currently in the construction phase, the owner or project managers, designers, construction managers, and subcontractors may all continue part of their work in their own work places.

As previously mentioned, the delivery method adopted for a construction project only changes the context and relationship in time. According to Figure 2.1, the whole diagram can span across all delivery methods and team members may come into play, but not always. Additionally, the diagram set-up would best fit the contractual roles of a construction management method for project delivery. For a traditional design-bid-build, the construction manager would be replaced with a general contractor with subcontractors still there. As for the design-build project delivery approach, the construction manager would have the role of design/build contractor and designer, if not 'in-house', the role of subcontractor designer (Cornick and Mather 1999).

Regardless of the project delivery method, each team member has very different roles and responsibilities to fulfill. The project manager, throughout the construction phase, continues the same tasks; whereas, the designer would either be a consultant architect or engineer, or a team of both. It is common for a construction project team to be led by a project manager, since he/she has the utmost knowledge of the entire project. As far as the leadership of the construction project is concerned, the function that dominates at any particular time should lead for convenience and practical reasons.

Figure 2.1 illustrates the construction phases and its functions that act as the basis for the general setup of a construction project team; whereas, Figure 2.2 demonstrates the breakdown of a construction project team in each phase, according to its basic functions.

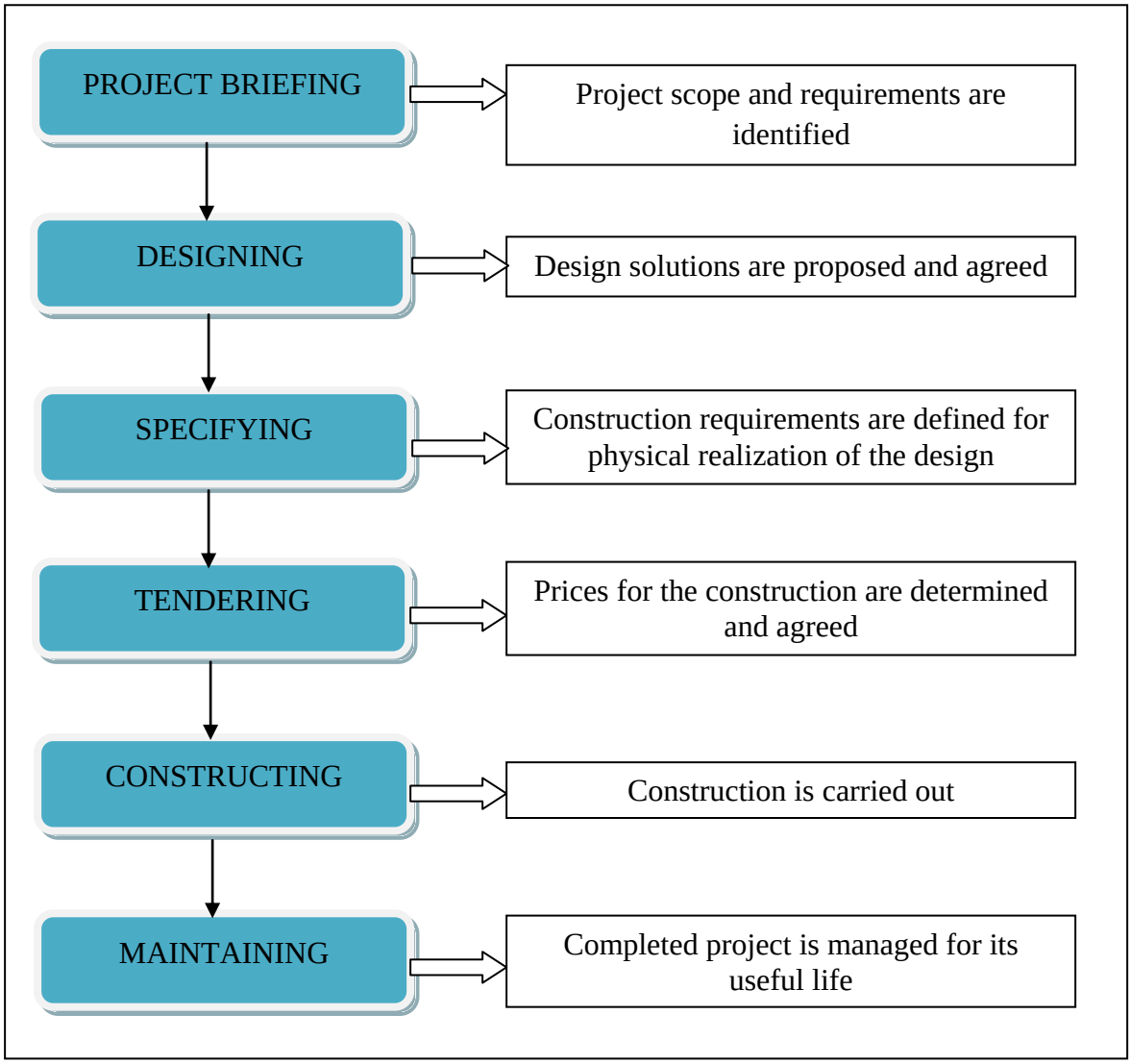

Figure 2.1. Generic phases in a construction project
(Adapted from Cornick and Mather, 1999)

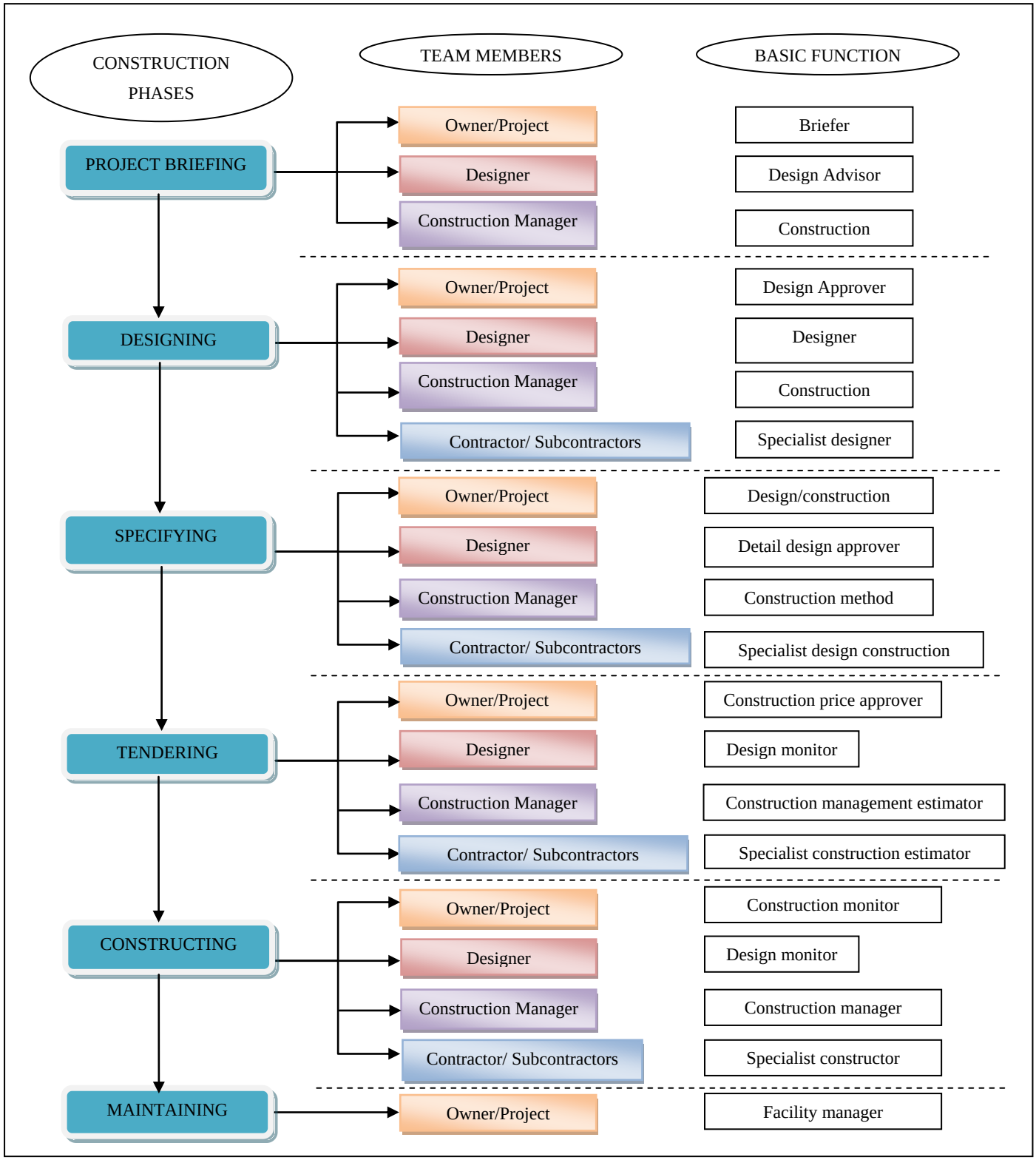

Figure 2.2. Construction project team and its basic functions (Adapted from Cornick and Mather 1999)

Construction projects are often associated with constraints, such as time and cost control. It is essential for a team to fully understand the whole project setup and how critical it is to develop an effective team. Construction team members are selected, based on the abilities of each team member, namely particular discipline skill, expertise, and experience, they have to offer to perform the technical contribution in an efficient and profitable way. In addition, some are chosen according to the project's needs, such as social, political, and economic requirements. Team members are alike — they share the common general experience of construction project activity, and its implications and impact. However, according to Cornick and Mather (1999), they are also very different, as each and every one possesses:

- Unique and often complex company culture characteristics to make them behave in a particular way as a group, which can apply equally to the firms of designers and constructors as to the owner.
- Unique personal characteristics make them think either holistic or focused, design or production way about the project, and behave in a specific way towards other team members.
- They have a discipline group history, which has traditionally set them in particular roles and relationships, including owners, through traditional contractual arrangements.

It is significant to observe how the construction project team is setup and the characteristics it possesses. By nature, it is the most fluid in terms of people, where team members seldom train together, have unclear 'leadership', and come and go on a project-by-project basis. Therefore, it is sufficient to mention the construction project team has unique characteristics compared to other ordinary teams in various industries. Cornick and Mather (1999) listed how the construction project team differs from an ordinary team:

- Each team member has his/her own objectives and may or may not be the same as the project team's objectives unless shared goals are agreed and accepted.
- The team leader of a construction project team is unnoticed, since the team leader may vary over the life of the project.

- The project manager does not play a part in the design or construction process. However, project manager understands both and supervises the overall project process from the beginning to the end.
- Construction project team usually trains together for a specific project due to the time, cost, and convention constraints. Team members will only understand and plan how all their individual contributions can come together as a whole team effort in a very ad hoc manner as the project progresses.

Additionally, the uniqueness can be seen when the construction team consists of individuals, who are engaged by diverse firms that run different businesses. The team is usually formed for just one project, where team members have never worked together before and no guarantee of ever doing so again. Jefferies et al. (1999) indicated most construction project teams comprise participants from different organizations that come together to form temporary organizations aimed at achieving the common objective of delivering a project. To complete the construction project, people and firms may experience changes along the construction process. Along the construction process, different trades and subcontractors will come and go according to the project's schedule, and if the duration of a project is long, there might be a possibility in a change of key team members (Cornick and Mather 1999).

Furthermore, working collaboratively brings out improvement for everyone in a construction project (Cornick and Mather 1999). All team members are brought to the table through contractual relations from various organizations. Therefore, it is common knowledge that each and every team member has an interest in making a profit for the companies. It is the responsibility of the team leader to ensure the entire team's members focuses are directed towards attaining project goals outlined by the owner.

Since the construction project team is assembled from different divisions of the same organization or even from different organizations, other members of the project team must learn to work together. A construction project team comprises of team members, who are flexible in the way they perform their tasks and are easy to adapt to their work environment and new situations. In addition, they work well to deliver a unique set of very specific project requirements, according to the owner's needs. However, working together with people who come from different working cultures and environments may result in different working

conventions that might not be suitable for a project and prove difficult in working with other people they have never worked with previously. Some problems of interaction may begin initially when the team members are unfamiliar with their own roles in the project team, predominantly for a large and complex project. These problems must be resolved quickly to develop an effective, functioning team (Hendrickson and Au 1988).One way of doing this is by having an established work method beginning with the inception phase until the completion phase. In addition, providing a real team process accomplished throughout an organization, team members will be able to work together effectively and efficiently.

2.2. TEAM EFFECTIVENESS

The search for an improved, more inclusive perception of team effectiveness has continued for decades. Since the beginning of the 20th century, globalization, technology, and the intricacy of work have resulted in more organizations becoming aware of the importance of understanding team effectiveness within such environments. Once the concept of team and teamwork are established, it is important for the team to know how to work together effectively. An effective team requires continuous monitoring of team conditions to ensure team members can adjust their tasks with respect to one another and the intended goal.

2.2.1. Definitions of Team Effectiveness

It is imperative to define team effectiveness beforehand to enhance the understanding of its concept. Various researchers have defined team effectiveness. Some prominent definitions are:

- Cohen et al. (1996) define team effectiveness in terms of both high performance and employee quality of work life. This idea draws from socio-technical theory, which states both social and technical systems must be maximized for optimally effective teams.
- Tannenbaum et al. (1996) define effectiveness as a combination of performance in terms of outputs, and the team's ability to grow and regenerate itself.
- Mohrman et al. (1995) define team effectiveness, based on three aspects. First, team performance is the extent to which the groups' productive output meets the approval

of its customers. Second, interdependent functioning is the extent to which the team is inter-reliant on one another. Third, team satisfaction is the extent to which the team is satisfied with team membership.

These definitions of team effectiveness and many others include team performance as an important element. However, the terms *team effectiveness* and *team performance* are not clearly defined. Often, when teams achieve their goals, they are considered effective. However, concluding teams are effective based only on goal accomplishment fails to consider other factors. For example, Essens et al. (2005) suggest achieving a project's objectives can be a deceptive measure of team effectiveness.

A successful team should be evaluated for both performance and effectiveness because teams are effective in certain situations or conditions. Nevertheless, this does not mean a team will always be effective in different settings. For example, a team that achieves certain goals may fail to consider the best interests of other parties. Furthermore, an effective team may fail to reach its goals because they were unrealistic.

According to Henderson and Walkinshaw (2002), team performance can be viewed as the execution of an action, something accomplished, or what is going on inside the team; whereas, effectiveness is the accomplishment of a desired result, especially as viewed after the fact. An effective team is believed to produce high-end project outcomes that exceed standards and, therefore, enhance overall productivity.

2.2.2. Characteristics of Effective Teams

The idea behind team effectiveness is a group of people working together systematically can achieve more than if the individuals of the team are working on his/her own. A study conducted by Henderson and Walkinshaw (2002) proved effectiveness is relevant to the achievement of the project's goals, milestones, and objectives, as defined by the project's requirements outlined by the owner; whereas, performance is closely associated with how sound the task work and teamwork are completed. Team performance is evaluated in terms of inter-team productivity and intra-team productivity (Harris 2008). Another study performed by Kezsbom et al. (1989) identified essential elements that lead towards successful team performance as:

- A mission or a reason for working together.
- A sense of ownership, commitment, and interdependence of each team member.
- Commitment to the benefits of group problem-solving and group decision-making.
- Accountability as a functioning unit.

By having teams apply the elements identified by Kezsbom et al. (1989), high performing teams will be achieved and, thus, contribute towards an effective team. In addition, numerous studies were conducted to determine the elements that make a team successful and effective. According to Cleland (1996), the characteristic of an effective team includes focus, cohesion, trust, communications, and interdependence. To achieve project success, each team needs to possess focus, recognition, structure, empowerment, and good communications (Peters1988; Katzenbach and Smith 2003; Forsberg et al. 2005 and Sundstrom et al.1990).

A simple sequence of events required in achieving effective teamwork and team synergy was discovered by Covey (1989) as follows:

RESPECT → TRUST → OPENNESS → SYNERGY = TEAMWORK

When team members establish respect among each other, trust will soon develop. Open communications result from trust and will, and, therefore, produce genuine teamwork. Additionally, Parker (2008) lists twelve characteristics of effective teams, which come alive when team members act as high performing team players. The characteristics are listed in Table 2.1.

Table 2.1. Characteristics of an effective team (Parker 2008)

Characteristic	Description
Clear purpose	The vision, mission, goal, or task of the team has been defined and is now accepted by everyone. There is an action plan.
Informality	The climate tends to be informal, comfortable and relaxed. There are no obvious tensions or signs of boredom.
Participation	There is much discussion and everyone is encouraged to participate.
Listening	The members use effective listening techniques, such as questioning, paraphrasing, and summarizing to discuss ideas.
Civilized Disagreement	There is a disagreement, but the team is comfortable with this and shows no sign of avoiding, smoothing over, or surpressing conflict.

Characteristic	Description
Consensus Decision	For important decisions, the goal is substantial but not necessarily unanimous agreement through open discussion of everyone's ideas and avoidance of formal voting or easy compromises.
Open Communication and Trust	Team members feel free to express their opinions on the tasks as well as on the group's operation, coupled with a high level of trust. Communication also takes place outside of meetings.
Clear roles and work assignments	There are clear expectations about the roles played by each team member. When action is taken, clear assignments are made, accepted and carried out. Work is fairly distributed among team members.
Shared leadership	Although the team has a formal leader, leadership functions shift from time-to-time, depending upon the circumstances, the needs of the group, and the skills of the members. The formal leader models the appropriate behavior and helps establish positive norms.
External relations	The team spends time developing key outside relationships, mobilizing resources, and building credibility with important players in other parts of the organization.
Style Diversity	The team has a broad spectrum of team player types, including members, who emphasize attention to task, goal setting, focus on process, and questions about how the team functions.
Self-assessment	Periodically, the team stops to examine how well it is functioning and what may be interfering with its effectiveness.

The twelve characteristics in Table 2.1 can be utilized in a variety of forms, such as to assess its current state, to identify strengths and weaknesses of team members, and at the end of a project to analyze the project and develop further action plans to improve overall team effectiveness.

2.2.3. Team Effectiveness Models

Various team effectiveness studies have resulted in team effectiveness models. Team effectiveness models included in this section looked specifically on teams, in general, as there is not much literature on the team effectiveness model in construction teams. Several

studies identified sets of variables or constructs used to determine team effectiveness (Guzzo 1986; Hackman 1987; Bettenhausen 1991; Campion et al. 1993; Guzzo and Dickson 1996; Cohen and Bailey 1997; Milosevic and Tugrul 1997; Werner and Lester 2001; English et al. 2004; Kirkman et al. 2004; Mannix and Neale 2005). Therefore, it is relevant for this study to examine various team effectiveness models to determine team effectiveness factors that can be use to develop assessment tools for this study.

Normative models of team effectiveness (Hackman 1987) emerged in the late 1980s and emphasized points of leverage that practitioners and researchers could employ to influence team effectiveness. According to (Salas et al. 2009), input-process-output (IPO) theory was fundamental in the early development of team effectiveness models. IPO theory predicts input factors, such as team and individual characteristics, function through mediators or moderators to influence outputs, such as team satisfaction and performance (Salas et al. 2009). This section describes several important team effectiveness models in chronological order.

2.2.3.1. Driskell et al. (1987)

The team effectiveness model developed by Driskell et al. (1987) in Figure 2.3 depicts the IPO framework. On the Input factors side, there are three levels of factors—namely Individual Level Factors, Group Level Factors, and Environmental Level Factors. All three Input Factors are considered as potential to the team's productivity, but do not guarantee team effectiveness (Driskell, 1987). The Input factors then undergoes the group interaction process, where Hill (1982) indicated group interaction may produce performance as the outcome beyond that expected on the basis of group input factors when the team capitalizes on the opportunity to pool resources and correct errors, and outperforms even its cost component member. The team effectiveness model, outlined by Driskell et al. (1987), takes into consideration how the environment has effects on team processes and outcomes. It is sufficient to conclude that effectiveness emerged from interactions within the team.

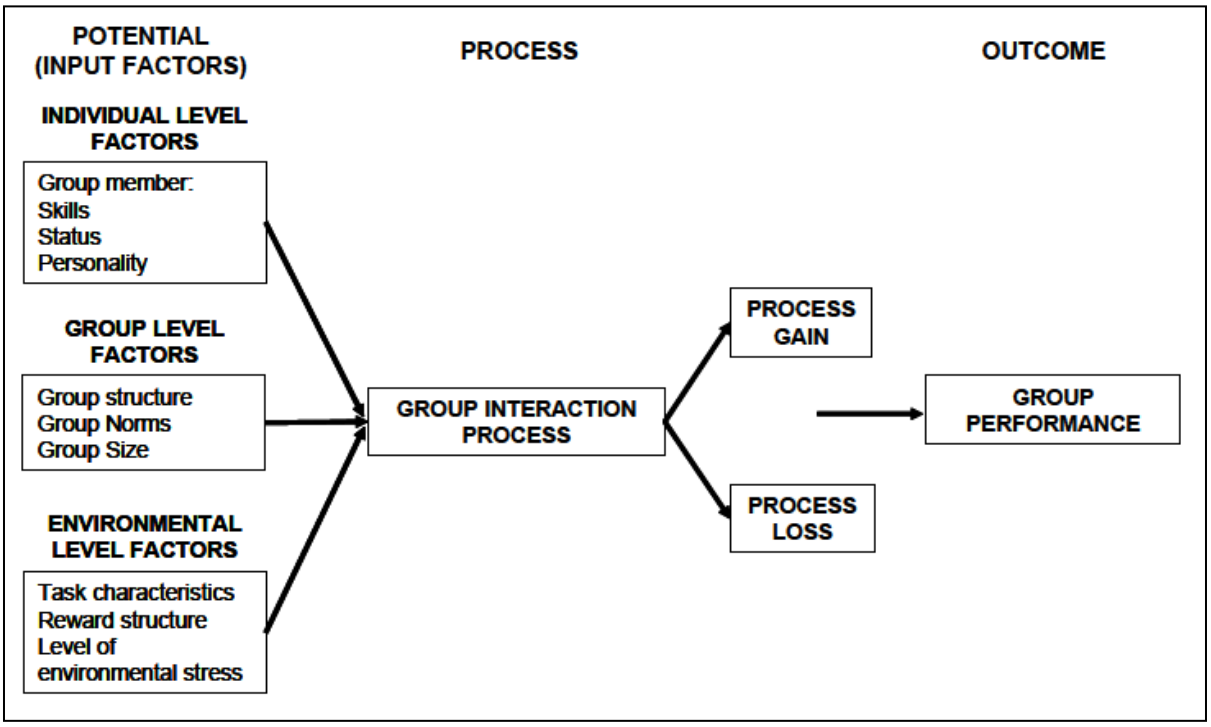

Figure 2.3. Team effectiveness model by Driskell et al. (1987)

2.2.3.2. Salas et al. (1992)

The team effectiveness model by Salas et al. (1992) in Figure 2.4 suggests organizational context and team design affect the team's communication process, which, in the end, affects the quality of the team's performance. Team synergy helps develop the process criteria of effectiveness, namely through interactions among team members, knowledge, and skills the team members apply to task work and the strategies used for task performance. In addition, Salas et al. (1992) indicate the resources allocated to the team also influence effectiveness; such appropriate tools, equipment, etc. are all factors that enhance a team's performance. This team effectiveness model emphasizes organizational context, team synergy, materials resources, and differentiates team and task outcomes in terms of group effectiveness. However, the model does not mention the importance of leadership in team effectiveness.

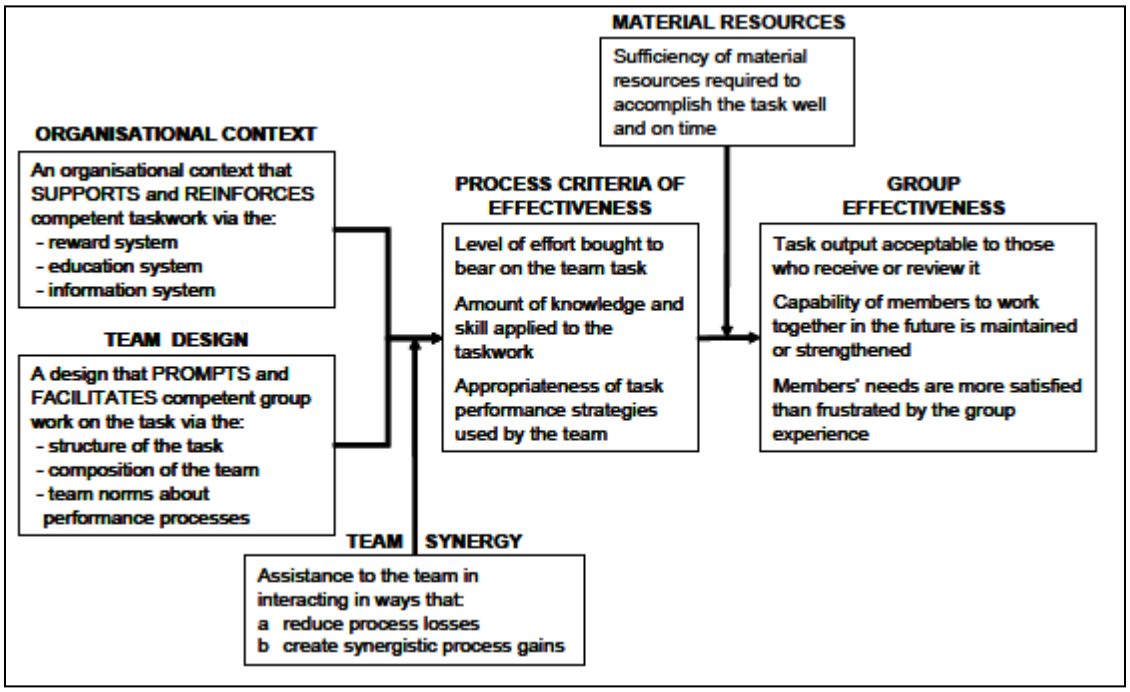

Figure 2.4. Team effectiveness model by Salas et al. (1992)

2.2.3.3. Tannenbaum et al. (1992)

The team effectiveness model in Figure 2.5 by Tannenbaum et al. (1992) adopts the IPO structure, while acknowledging the significance of the organizational and situational context throughout the entire process, as well as incorporating feedback loops. The input consists of four variables—task characteristics, work structure, individual characteristics, and team characteristics. According to Gladstein (1984) and Tannenbaum et al. (1990, 1992), a team that performs better has better individual task proficiency, abilities, and skills. This process incorporates both team interventions and input variables—the end influence is the overall team's performance. Changes within the team and individual changes will occur as a result of the team's processes. Once the team's performance is assessed, it will serve as feedback on team members' characteristics, work structure, or other team inputs and processes. Besides, an ongoing evaluation of team performance may affect team processes and team performance. This model highlights team functioning, and distinguishes between teamwork and task work on both an individual level and a team level.

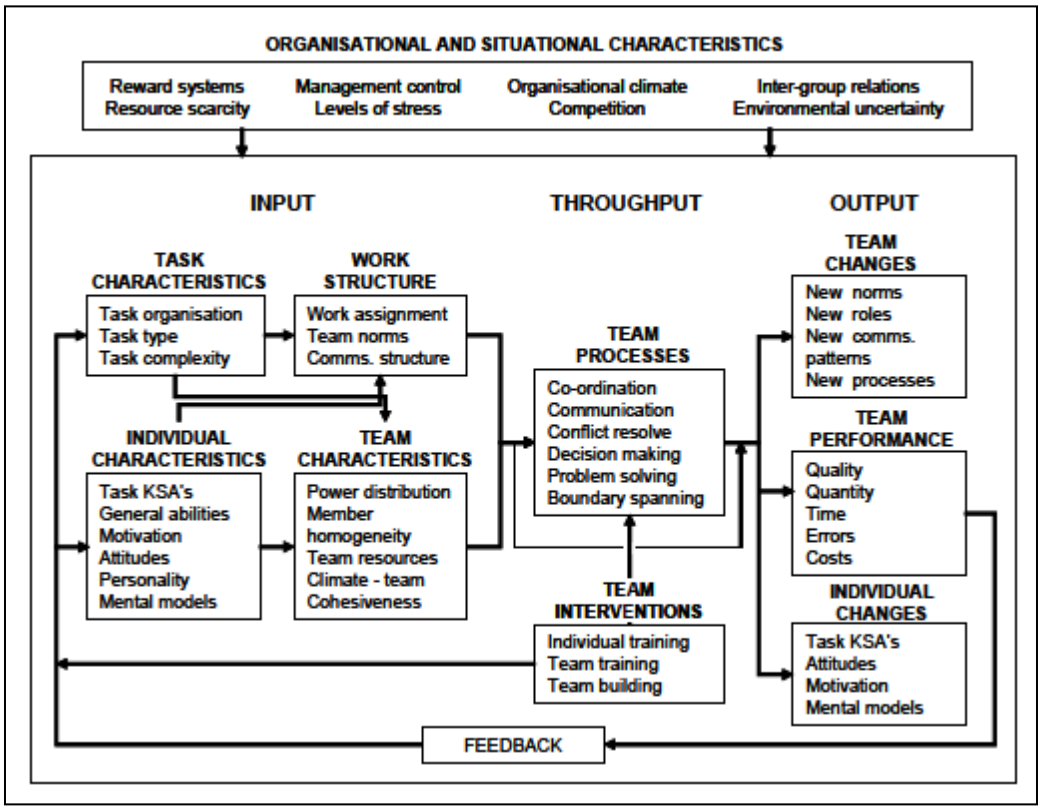

Figure 2.5. Model of team effectiveness from Tannenbaum et al. (1992)

2.2.3.4. Cannon-Bowers et al.(1995)

Cannon-Bowers et al. (1995) adapted a structure similar to the one presented by Tannenbaum et al. (1992). Organizational and situational characteristics are considered important to the overall team's performance. Cannon-Bowers et al. (1995) suggest that task and work characteristics help identify individual and team competencies that affect team performance. Similar to the previous model, this model highlights the importance of team and task competencies in team training and performance. (Figure 2.6)

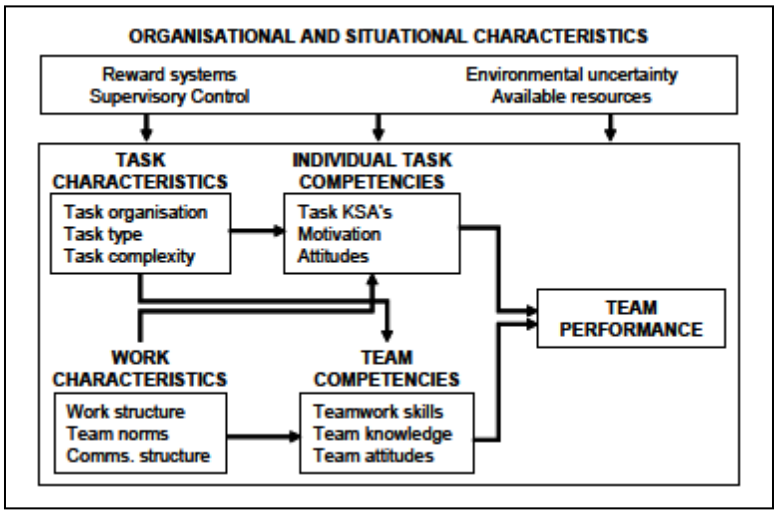

Figure 2.6. Model of team effectiveness from Cannon-Bowers et al. (1995)

2.2.3.5. Klimoski and Jones (1995)

The model developed by Klimoski and Jones (1995) as in Figure 2.7 emphasized environmental demands and resources as the most important aspects emphasized throughout the team. The input variables comprise of organization and team norms, composition of Knowledge, Skills and Attitudes (KSAs), size of the team as well as leadership, since both formal and emerging leadership roles have leadership consequences on the team's performance. For process variables, Klimoski and Jones (1995) emphasize effective teams depend upon several factors, namely interpersonal dynamics of the team, the level of hostility or distrust in the team, and levels of compatibility between team members. The outcome variables listed are a separation between task-based and team/social-based. The turnover of a team can also be predisposed by team members' levels of satisfaction and emotional tones, such as pleasant environment and encouragement (O'Reilly et al. 1989).

2.2.3.6. Shanahan (2001)

Figure 2.8a illustrates the level model comprised of four elements—inputs, process, structure, and output. Demand and resources are the important elements that begin the whole team effectiveness process. Once the demand and resources are identified, the inputs will go through the process to produce a set of outputs that determine team performance and team effectiveness as outlined by the project's objectives. The process is divided into task work,

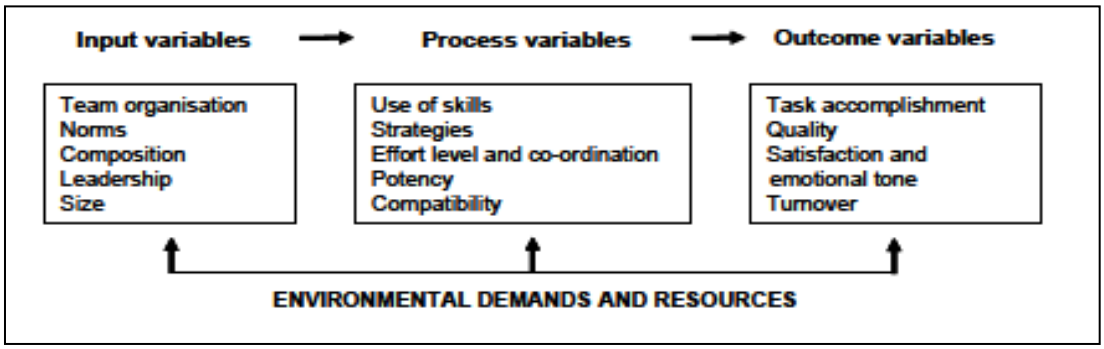

Figure 2.7. Model of team effectiveness proposed by Klimoski and Jones (1995).

teamwork, and leadership. The main function of task work is turning the resources and demand (inputs) into team performance (outputs). According to Shanahan (2001), teamwork and leadership influence the overall task work function. Thus, it is essential to ensure team members perform their tasks well and have a good team leader. A good leader should be able to demonstrate great leadership. This function may be exercised by having either a formal team leader or a team member, who considers him/her to be best placed to exercise leadership in the team. The overall team process is influenced by structural factors; some may be in the form of physical resources, such as equipment and buildings, as well as training and career planning. These factors can be usefully considered under the traditional task work-oriented headings of 'fitting the man to the job' and 'fitting the job to the man,' suitably extended to cover the teamwork and leadership dimensions (Essens et al. 2005). A detailed model has been expanded by Shanahan (2001) to illustrate the leadership, task work, and teamwork factors, together with the relationships that exist between each element (Figure 2.8b).

2.2.3.7. Rasker et al. (2001)

The team effectiveness model proposed by Rasker et al. (2001) is a theoretical framework that comprises five different factors resulting in effective teamwork. Situational factors, such as uncertainty, dynamism, and time stress, are factors that come from outside the team and are affected by the environment. Organizational factors are determined from outside the team, such as organization, which offer social support and reward system, as well as outlining the overall mission, objectives, and goals of a project's team. To ensure the team's

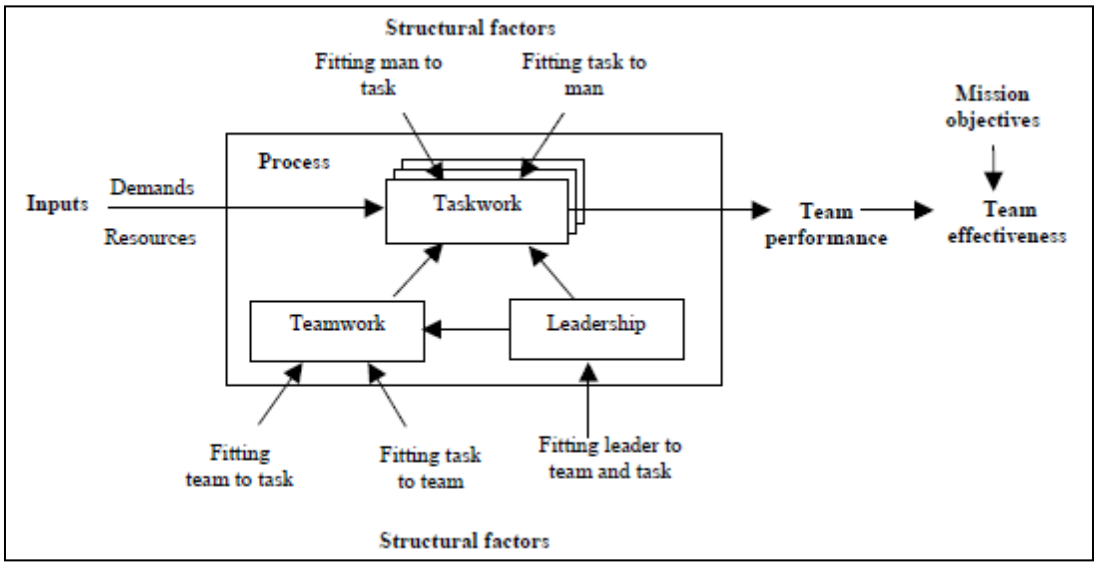

Figure 2.8a. Level model of team effectiveness from Shanahan (2001)

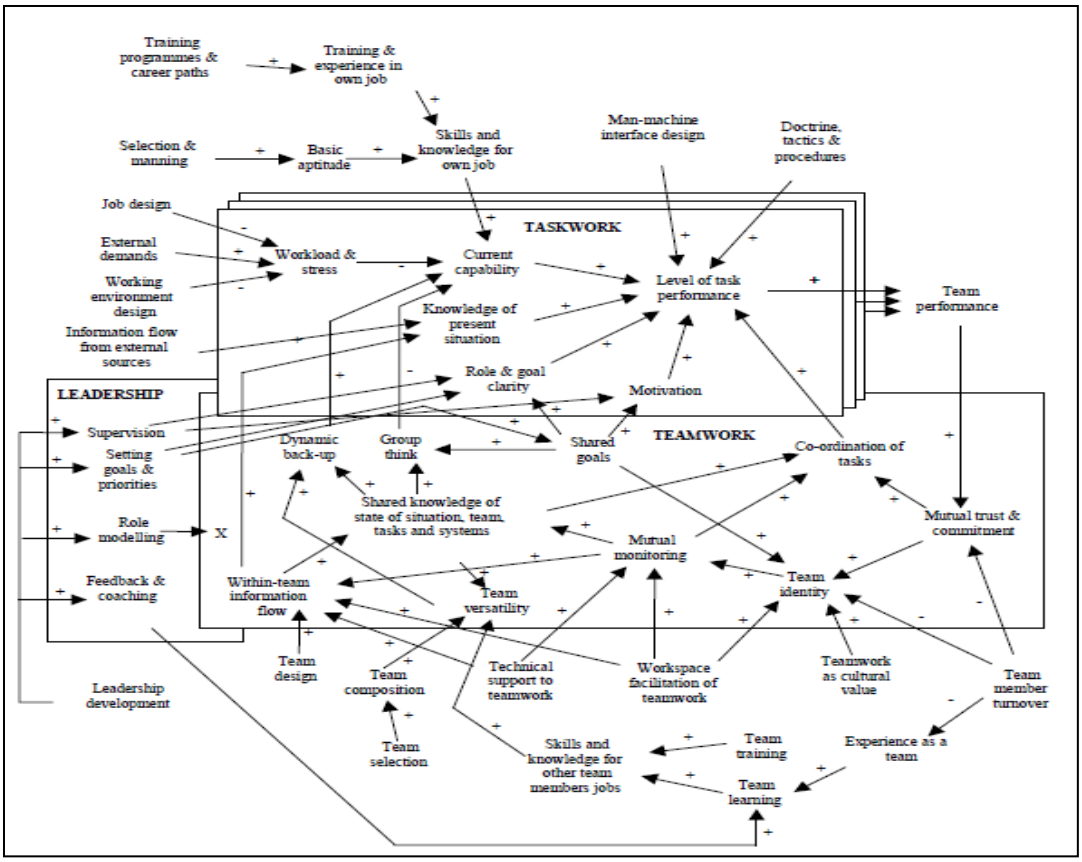

Figure 2.8b. Detailed model of team effectiveness from Shanahan (2001)

missions are achieved, the team should possess good structure and cohesion among its team members, as well as providing a good leadership function throughout the entire project. Moreover, each team member should possess Knowledge, Skills, and Attitudes (KSA) to ensure all tasks and activities are completed successfully and efficiently. Finally, this model imposes different task factors, such as complexity, structure, interdependency, and load, for teams to achieve their goals. In addition, teamwork is the important factor that ties-in all factors. It is comprised of two kinds of behavioral activities—task-related activities and team-related activities—where task activities include all of those individual behaviors directly related to the job at hand and team activities include communication and coordination (Rasker et al. 2001).

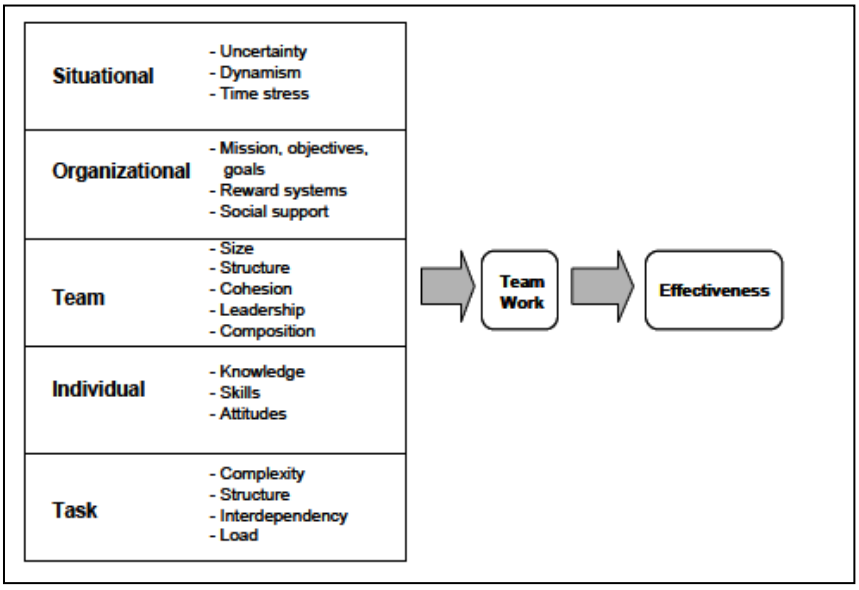

Figure 2.9. Team process model from Rasker et al. (2001)

2.2.3.8. Blendell et al. (2001)

As shown in Figure 2.10, the Blendell et al. (2001) model is setup according to the IPO structure, where each factor (input, process, and output) comprises several different functions. There are six functions considered important as input factors for overall team effectiveness—leadership style, experience, team composition, degree of distribution, aptitude and personality, and operating and procedures. The input factors, combined with

knowledge, leadership, behaviors, and attitudes from the process stage, will produce outcome factors, which are timely, accurate, and fulfill overall team satisfaction. This model illustrates clearly the different functions under each of the factors and does not take into consideration other factors, such as environment and individual characteristics.

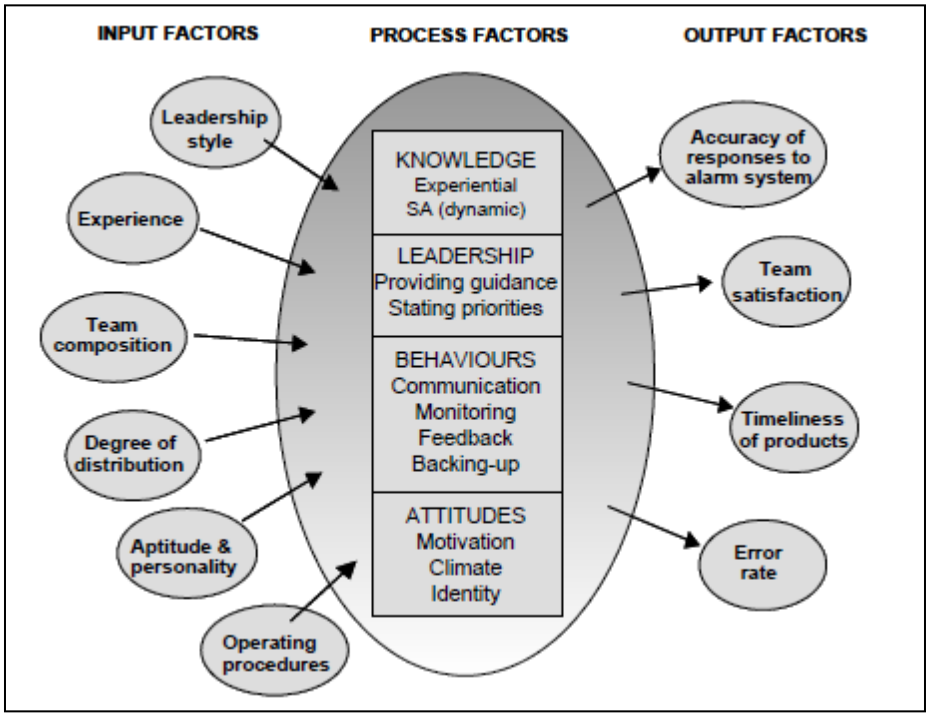

Figure 2.10. Team effectiveness model from Blendell et al. (2001)

Most of the team effectiveness models discussed earlier in this section follow a fundamental structure—IPO. All of the models examined possess a similar IPO structure as discussed previously. Beginning with Driskell et al. (1987), the effectiveness model is more defined chronologically and, therefore, improves the models. Some of the crucial pieces discovered to the puzzle of developing effective teams are shared understanding, facilitative functioning, proper goal setting, and decision-making. In addition, team effectiveness is clearly impacted by knowledge, skills, and attitudes of team members, as well as the leadership aspect of the team.

2.2.4 Measurement and Evaluation

High-performing teams are always portrayed as teams that have excellent communication, proper planning, and a good working relationship. To maintain the effectiveness level of a project team, it is crucial for the team to gauge its progress on different aspects. According to Busseri et al. (2000), teams seeking to improve their performance might also benefit from finding ways to measure team effectiveness, which would allow them to assess how well they are working on a given project.

Team measurements are developed to provide information on the performance of the team, and the efficiency and effectiveness of the services delivered. Additionally, measurements help delineate the components for specific tasks (Dickinson & McIntyre 1997). Measuring team performance on different aspects allows the team to focus on what is essential and if the activities performed by the team members are in accordance to the objectives specified. Good measures provide feedback and information from the team members to the team leader and upper management on their effectiveness level. Through appropriate measures, team members are able to be evaluated and learn on the nuances of teamwork.

Assessment and evaluation are considered as mechanisms to recognize and acknowledge performance on a team. There are extensive assessment tools developed to examine factors that lead to team effectiveness, such as the use of Team Effectiveness Critique to develop the Team Effectiveness Survey (Alexander 1985), Team Diagnostic Survey (Wageman et al. nd.), and Team Effectiveness Audit Tool (Bateman et al. 2002). By performing a periodic review and evaluation, the differences and priorities among team members regarding the project progress or the services provided can be determined. Moreover, the team will know the areas that need improvement; thus, helping them stay on focus to complete the project and be effective as a team.

2.3. CONSTRUCTION PROJECT PERFORMANCE

A typical construction project undergoes three stages—preconstruction, construction and post construction stages. Along these stages, there are numerous activities performed to achieve the output and objectives specified by the owner. Therefore, it is crucial for the

construction project team, at some extent, to measure its performance on the activities or sub-processes performed throughout the construction project. Performance of a project can be considered as a result of the process as well as the presence of the process (Bai and Yang 2011).For a project team to be effective, it is important for team members to understand and accept the performance measurement or indicators identified for the project.

2.3.1. Measures

Study on project performance measures have been extensively conducted by numerous researchers throughout the last decade. Different project performance measures have been identified since then, which include project cost, schedule, and quality (Ashley et al. 1987; Navarre and Schaan 1990; Barkley and Saylor 1994; Walker 1995 and 1996; Belassi and Tukel 1996; Hatush and Skitmore 1997;Atkinson 1999). According to Freeman and Beale (1992) and Riggs et al. (1992), these three performance measures are also known as tangible aspects in construction projects. Additionally, there are other aspects that should be included to measure project performance. Pinto and Pinto (1991) and Ashley et al. (1987) suggested soft measures are included as part of measuring project performance. Examples of soft measures or non-tangible aspects include customer satisfaction and team members' performance. Chan and Tam (2000) added several more aspects used to measure project performance, such as safety and health, functionality, user expectation and environmental performance. Moreover, another aspect relevant to measure project performance is project change management (Construction Users Roundtable 2005). The way a project team handles change orders, services related to changes and monitors cost, schedules, and quality associated with changes are determined crucial on a construction project.

2.3.1.1. Project Cost

Project cost is one of the most common measures used to gauge project performance. Construction teams are always looking for ways to complete the project within the budget specified. The ability of a project team to complete within the cost is challenging, as there are always uncertainties and changes occurring throughout a construction project. According to Bubshait and Almohawis (1994), cost can be defined as the degree to which the general conditions promote the completion of a project within the estimated budget. Cost can be

measured, based on cost variation calculated by the variance between the actual cost and the budgeted cost of a project.

2.3.1.2. Project Schedule

Project schedule or project duration is constantly used to measure project performance. According to Lim and Mohamed (1999), owners and stakeholders view duration of a project as their first criterion for project success. A project that fails to complete within the timeframe given for the project was not running as smoothly as it should. The duration of a construction project can be viewed as the timeframe from the start of site work (preconstruction stage) to the project's closeout (post construction stage).

2.3.1.3. Project Phases & Task

A construction project comprises preconstruction, construction, and post construction phases. During these phases, there are various tasks performed, from site works to handing over a completed project to the owner. It is important the tasks performed throughout the project are according to specification and owner's expectations. The quality element is essential in every component of construction activities that acts as a guarantee to ensure the project achieves the highest standard specified by the owner. Parfitt and Sandivo (1993) define quality within the construction industry as the totality of features required by a product or services to satisfy a given need, as well as fitness for purpose. The measure of quality is subjective; however, Freeman and Beale (1992) include meeting technical requirements as one of the quality elements. Additionally, a completed project should be functional and this is best measured with the quality and technical requirements achieved (Chan and Ho 2001).

2.3.1.4. Owner Satisfaction

According to Liu and Walker (1998), satisfaction is one of the attributes of project success. This is an element on the soft side of project performance measures, or also known as intangible factors. It is essential for the owner to be satisfied with the completed project, as it acts as an indicator on the team's performance. Owners usually are satisfied, if the quality of service provided exceeds or at least meets their expectations. The ability of a project team

to complete the project to the owner's expectation may increase a team's reputation and result in more working relationships in the long run.

2.3.1.5. Project Change Management

Change is inevitable and often desirable. It may direct cost and time overruns. According to Senaratne and Sexton (2011), effect of changes occurring on construction project may take any of these forms; changed communication, changed project information, rescheduled work methods, interrupted cash flows, accelerated measures, extended time and costs, increase waste and decrease worker's morale. Therefore, the implementation of effective project change management practices can elevate the performance of the project team.

The project team should have an effective project change management system to ensure project success. All variations from the contract drawings and specifications should be identified and documented for technical approval and project authorization. Consequently, change orders should include other aspects, such as schedule, quality and safety consideration besides the cost impact of the change.

2.3.1.6. Project Team

Human factor is another aspect important to determine the outcome of a project. According to Takim et al. (2003), the quality of a project depends to a large extent on the skills and experience of project team leaders; managerial system (decision-making, choosing the correct strategy, setting-up specific objectives, selecting people, delegating responsibilities, and evaluating results); and the procedures adopted during the construction process. Ashley et al. (1987) indicated project teams' participation, motivation, capabilities, consistency, and adaptability help elevate the effectiveness of a team and are found to be a major contributor to project success. The owner generally selects team reputable members; possess knowledge and technical skills related to performing construction tasks; and a good track record in the construction business. Therefore, it is important for the team to establish good work ethics and a great working relationship within the team.

2.3.1.7. Project Safety

The issue on safety and health within a construction project is extremely important and cannot be overlooked. It is common within the project team's best interests to ensure the construction project has zero accidents. The focus of safety on jobsites is more towards the construction stage, since most accidents occur during this phase. Bubshait and Almohawis, (1994) indicate health and safety are defined as the degrees to which the general conditions promote completion of a project without major accidents or injuries. Safety is often measured by the number of incidents or accidents occurred on a jobsite. A project that has zero accidents usually performs good safety management practices and proper documentation on safety records.

2.3.2. Assessment and Evaluation

As discussed earlier, there are several performance measures utilized to gauge the level of project success. Team members or top management normally assess these measures to maintain a level of effectiveness within the project team. The project performance assessment is evaluated and the results obtained are communicated back to the team members for improvisation. Assessment and evaluation can be performed several times during the entire project's progress to ensure team members identify which aspects need improvement to ensure success of the project. The evaluation of process performance can help find questions in the enforcement of construction projects, determining the reasons for the questions and correcting the errors in the practice in time to improve management's performance of construction project (Bai and Yang 2011).

2.4. SUMMARY

Although much research about teams and team effectiveness has been performed, more research into the effectiveness of construction project teams is needed. Three components are examined in this literature review—team, team effectiveness, and project performance. The section on overview of the team provides a discussion on generic and construction teams. Based on the literature, construction project team members bring together various skills and knowledge to fill common roles, but the people who fill these roles vary from project-to-

project. The teams are not necessarily successful unless they improve the effective and efficient delivery of the project, such as by removing the traditional barriers between team members (e.g., designers and construction managers).

The team's effectiveness section begins with definition, followed by a discussion on team effectiveness characteristics, and examination of several team effectiveness models. Numerous studies from manufacturing and service sectors have identified characteristics (e.g., focus, empowerment, structure, recognition, interdependence and communication) and proposed models for team effectiveness.

Next, measurement and evaluation of team effectiveness factors are provided. In this section, assessment tools are mostly developed for generic teams, and not specifically geared towards construction teams. Therefore, it is one of the aims of this study to develop an assessment tool to evaluate the team effectiveness level within construction teams.

The following chapter provides a point of departure for this study and looks into the team effectiveness factors from various researchers. These factors are used to conduct a pilot study (Chapter 5) and aid into the development of a team effectiveness survey (Chapter 4).

CHAPTER 3. POINT OF DEPARTURE

A detailed literature review examination conducted on effective and high performing teams resulted in several findings, Chapter 2. There are several important elements or factors discovered to create effective and high performing teams. These factors were identified through a table of comparison between different team effectiveness models and other relevant literature. Table 3.1 illustrates the various team effectiveness factors gathered from the literature and the different authors' perspectives on the factors a team should possess to be effective and fully functional. The first column in Table 3.1 covers six different categories—individual factors, team factors, tasks, processes, situational factors, and others. Under these categories, there are a number of elements listed deemed relevant to this research.

The researchers listed in Table 3.1 had either proposed a team effectiveness model or determined research findings about effective teams. Under the individual factors, almost all researchers agreed knowledge, skills, and attitude (KSAs) are important factors to create a highly effective and functional team. KSAs are identified as individual factors, since it is crucial for team members to possess basic skills and knowledge, along with a positive mind-set or attitude. Team members, who possess KSAs, are likely able to perform their tasks effectively and efficiently. Additionally, team members will have a greater understanding on how to attain project objectives and commit to tasks completion within the required time frame.

Team structure and norm were found equally important by these researchers as part of an effective team. Other team factors include team composition and leadership. The researchers agreed an effective team should have proper structure and established norms when performing team tasks and processes. Leadership started to show as an important element in developing high performing teams only towards the end of the 20th century. This is true nowadays, where organizations' emphasis on the importance of leadership is increasing.

Task and processes were part of the IPO structure as discussed in Chapter 2. If performed efficiently and effectively, both act as keys to producing a high quality and an error-free outcome. Therefore, team objectives will be attainable. The elements under task factors identified by the researchers are scattered, from task strategies to task characteristics.

However, communication and collaboration are shown as vital factors, where both have been mentioned frequently by researchers over the years. Objectives and goals were deemed important to team's effectiveness only in the beginning of the 21st century. On the other hand, audit and monitoring teams have been conducted since 1983. Since this time, audit and monitoring have been viewed as frequent factors determined from these studies. Finally, teams could not be effective and high performing without the support of its organizations. Many organizations provide a reward structure as a method to help teams become more effective to achieve the organization and team's goals and missions.

All of the factors listed in Table 3.1 were gathered from preceding studies of teams, in general, not specifically construction teams. To determine factors that impact the effectiveness of construction teams, a pilot study was conducted by using the factors most frequently found by the researchers in Table 3.1, namely:

- Team goals and objectives
- Team leadership
- Company/ top management support
- Audit and monitoring
- Roles and responsibility
- Creativity and innovation
- Team/task processes
- Team relationship
- Communication

Additionally, assessment elements act as the point of departure for this study to identify the top-ranked factors that drive a construction team to be effective and high performing. Once identified, the research design can be developed for this study to answer the following main research questions:

1. How can team effectiveness in construction teams be evaluated and measured?
2. How can team effectiveness act as an indicator of construction project performance?
3. How to model team effectiveness for construction teams?

Table 3.1. Comparison of elements of effective/high performing team from different researchers

Authors / Elements of effective/ high performing team	Hackman (1983)	Driskell et al. (1987)	Salas et al. (1992)	Tannenbaum et al. (1992)	Cannon-Bowers et al. (1995)	Klimoski& Jones (1995)	Spatz (1998)	Shanahan (2001)	Rasker et al. (2001)	Blendel et al. (2001)	Adam et al. (2002)	Parker (2008)	Ross et al. (2008)
Individual factors:													
a) Skills	x	x	x	x	x	x		x	x				
b) Personality		x		x						x			
c) Status		x											
d) Knowledge	x		x	x	x	x		x	x	x			
e) Abilities				x									
f) Attitudes				x	x	x		x	x			x	x
g) Mental Model				x									x
h) Training				x				x					
i) Experience										x			
Team factors:													
a) Structure	x	x	x	x	x			x	x			x	
b) Norm/procedure		x	x	x	x	x		x		x			
c) Size		x				x			x				
d) Effort on task			x			x							
e) Composition	x			x		x		x	x	x		x	
f) Homogeneity				x									
g) Climate				x						x	x	x	
h) Cohesiveness				x			x		x				
i) Organization						x						x	
j) Leadership						x	x	x	x	x		x	
k) Team Building				x				x					
l) Team training				x				x					

Table 3.1. Comparison of elements of effective/high performing team from different researchers (cont'd)

Authors / Elements of effective/ high performing team	Hackman (1983)	Driskell et al. (1987)	Salas et al. (1992)	Tannenbaum et al. (1992)	Cannon-Bowers et al. (1995)	Klimoski& Jones (1995)	Spatz (1998)	Shanahan (2001)	Rasker et al. (2001)	Blendel et al. (2001)	Adam et al. (2002)	Parker (2008)	Ross et al. (2008)
Task:													
a) Strategies	x		x			x							
b) Performance	x			x									x
c) Organization/ structure				x	x				x			x	
d) Complexity				x	x				x				
e) Type					x								
f) Accomplishment						x							
g) Work/load								x	x				
h) Interdependency									x				
i) Synergy			x					x					
j) Characteristics		x											
Process:													
a) Coordination/ collaboration				x	x		x	x			x		
b) Communication				x	x	x	x			x	x	x	x
c) Conflict Solving				x							x	x	x
d) Decision making				x								x	
e) Problem solving				x							x	x	
f) Boundary spanning				x									
g) Compatibility						x	x	x					
h) Quality and satisfaction				x		x				x			

Table 3.1. Comparison of elements of effective/high performing team from different researchers (cont'd)

Authors / Elements of effective/ high performing team	Hackman (1983)	Driskell et al. (1987)	Salas et al. (1992)	Tannenbaum et al. (1992)	Cannon-Bowers et al. (1995)	Klimoski& Jones (1995)	Spatz (1998)	Shanahan (2001)	Rasker et al. (2001)	Blendel et al. (2001)	Adam et al. (2002)	Parker (2008)	Ross et al. (2008)
Others:													
Material Resources			x	x			x					x	
Objectives and goals				x			x	x		x	x	x	x
Motivation	x								x				
Assessment/ feedback/audit/ monitoring	x			x			x		x		x	x	
Mutual trust & commitment/shared values							x			x	x	x	
Clear roles and responsibility							x			x	x	x	x
Situational factors:													
a) Reward structure/ organization support		x	x	x	x			x				x	
b) Level of environmental stress	x	x		x				x					
c) Educational system			x										
d) Information system	x		x				x						
e) Resource scarcity	x			x	x								
f) Management control		x		x									
g) Organizational climate	x			x		x			x	x			
h) Inter-group relations	x												
i) Competition	x												
j) Environmental uncertainty	x	x			x								

Research Question 1 looks at means of assessing and evaluating the team effectiveness level within a project team. An effective project team remains effective throughout the project by performing frequent assessment and evaluation. It is important for project teams to identify if they are performing the project according to the owner's expectations and progressing to achieve project goals. Through identification of different factors associated with team effectiveness, the team will have a general idea on what aspects need improvement and continue to strive being effective.

The next research question examines how team effectiveness factors contribute to project performance. By all means, this looks into whether there are relationships between team effectiveness factors with project performance aspects. This is essential for the team to know what team effectiveness factors need focusing to help improve project performance. The assessments provided by the team members and the project owners help the project teams maintain their effectiveness level throughout the project.

Finally, Research Question 3 seeks to develop a model that helps to explain team effectiveness in construction teams, with regards to project performance aspects. This model illustrates the variance of the team effectiveness factors and provides project team members knowledge on how much the factors are accounted for in project performance. Additionally, two sets of definitions of team effectiveness are developed from the perspective of project team members and project owners. Hopefully, the definitions will provide a better understanding to construction project teams on what drives team effectiveness from different perspectives.

The following chapter (Chapter 4) will discuss in detail the research methodology adopted for this study to answer these research questions, followed by the pilot study conducted and its details in Chapter 5.

CHAPTER 4. METHODS

Plans and procedures for research are considered vital elements for any study. Conducting research through selection of an appropriate research method will help researchers attempt to minimize the complexity of research and to determine the relationship between apparently distinct measures (Marczyk et al. 2005). The decisions made for selecting the most suitable and appropriate research methods should be based on the nature of the issue addressed or identified research problems, personal experience of the researchers, and also the audience of the study.

There are two main schools of research—the qualitative and quantitative approaches (Vanderstoep and Johnston 2009). In addition to both types of research, the mixed-method approach has started to gain popularity in the research world (Creswell 2009). Numerous discussions have been made as to the distinctions and applications for each method, either in terms of research strategies used or specific methods adopted to address these strategies. According to Newman and Benz (1998), both qualitative and quantitative methods represent different ends on a continuum. Mixed methods research, which integrates both qualitative and quantitative methods, stands in the middle of the continuum. Figure 4.1 indicates different zones of research:

1. Zone A - totally qualitative research.
2. Zone B - primarily qualitative research.
3. Zone C - totally integrated mixed method research.
4. Zone D - primarily quantitative research.
5. Zone E - totally quantitative research.

The arrow represents the Qualitative - Mixed – Quantitative continuum. As the movement approaches the middle of the continuum, it indicates a greater integration of research methods and sampling. As the opposite, movement away from the center towards either end indicates research methods are more separated or distinct.

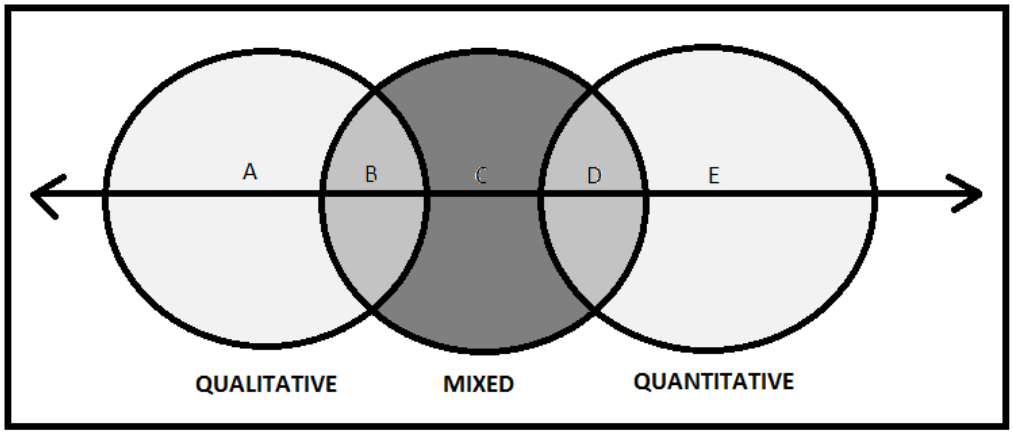

Figure 4.1. Mixed methods research continuum
(Adapted from Tashakkori and Teddlie 2005)

4.1. QUANTITATIVE RESEARCH AND SAMPLING

Quantitative research was originally developed in the natural sciences to study natural phenomena. Specifically, it is a tool to discover and recognize the meaning individuals or groups ascribe to a social or human problem (Creswell 2009).Vanderstoep and Johnston (2009) and Gay (1996) describe the quantitative approach as a method that specifies numerical assignments to explain, predict, and/or control the phenomena under study. This leads to quantifying the relationship between the variables identified earlier in the study (Hopkins 2000). By performing different types of analysis, the relationship between variables can be further elaborated and quantified.

Gay (1996) indicated four types of quantitative research—descriptive, correlational, causal-comparative, and experimental. Descriptive research involves data collection for hypothesis testing, which answers research objectives and current status of the study. Correlational research attempts to examine whether a relationship exists between two or more quantifiable variables. On the other hand, causal-comparative research demonstrates a causative relationship between an independent variable and a dependent variable without the researcher manipulating the independent variable. The last category, experimental research, is the opposite of causal-comparative research. Experimental research predicates and compares the cause-effect relationship, where the independent variable is in control, hence, affects the dependent variable.

The sample of subjects in quantitative research must be representative of the population for generalization purposes. Random sampling and non-random sampling are two ways to ensure the sample taken for a study is representative of the population. According to Vanderstoep and Johnston (2009), random sampling is when each member in a sampling frame has an equal chance of being chosen to take part in a study. Random sampling is divided into four types—simple random sampling, stratified random sampling, systematic sampling, and cluster sampling.

Simple random sampling is the most common sampling method used in experimental and survey research (McMillan and Schumacher 1997). It is achieved by selecting a certain number of participants from the total number of possible participants in the sampling frame. A larger sample size will closely reflect the percentage of the overall population. Additionally, the margin of error is computed to determine how close the sample size chosen is to the population.

Unlike simple random sampling, stratified random sampling involves selecting research participants, based on their association in a specific subgroup or stratum. This technique is used to diminish selection bias, where no group is underrepresented or overrepresented in a sample. Stratified sampling allows the sample to look more like the population in terms of mirroring the diverse subgroups. On the other hand, systematic sampling is a technique when a sample size is selected by going through the sampling frame list and chooses one entry from every fixed number of entries. Since the selection is based on where one is in the list, not everyone has an equal chance of inclusion. The last practice used for random sampling is called cluster sampling. It arbitrarily selects or assigns groups of people, based on variables, such as membership in a group, geography, or others.

Another sampling method is non-random sampling. It is the opposite of simple random sampling, where each member of the sampling frame does not have an equal chance of being selected as a participant in the study (Vanderstoep and Johnston 2009). The participants are selected, based on the uniqueness they possess or their accessibility to participate. There are two ways of conducting non-random sampling—convenience sampling and snowball sampling. Convenience sampling is achieved by choosing participants who are convenient for the study. However, the sample drawn does not represent the general population.

Alternatively, snowball sampling can be conducted by identifying other eligible participants from an initially sampled group of participants. This method is useful for a study that needs participants with special characteristics. In addition, snowball sampling has the tendency of introducing bias because the technique reduces the likelihood the sample will represent a good cross-section from the population. Nevertheless, people identified in snowball sampling are not representative either, since they might possess similar interests and are interconnected to each other.

Data gathered throughout quantitative research, either by using large-scale survey research through questionnaires and structured interviews or even laboratory experiments as research strategies, can be analyzed using diverse forms of statistical analysis, such as correlations, relative frequencies, or differences between means. Statistical analysis helps with interpretation of the data's meaning. The inferences made from data analysis helps generalize a sample drawn to a population.

4.2. QUALITATIVE RESEARCH AND SAMPLING

Qualitative research comes from a long tradition of field research, originally in anthropology and then subsequently in sociology, psychology, and other social sciences. According to Denzin and Lincoln (2000), qualitative research involves an interpretive and naturalistic approach pertinent to understanding the meanings, which people attach to phenomena (actions, decisions, beliefs, values, etc.) contained by the social world. It is particularly conducted to explore complex issues and to study processes that occur over time. Furthermore, qualitative research is typically used to achieve a deep understanding of certain issues, establish new theories, or evolve stories to describe a phenomenon (Trochim 2005). Ritchie and Lewis (2003) indicated the main factors of qualitative research consist of an overall research standpoint and the significance of the participants' frames of reference, the flexible nature of research design, the volume and richness of qualitative data, the unique approaches to analysis and interpretation, and results that derive from qualitative research. According to Johnson and Christensen (2007), there are different categories of qualitative research:

1. Phenomenology - the researcher attempts to understand how one or more individuals experience a phenomenon.
2. Ethnography - focuses on describing the culture of a group of people—shared attitudes, values, norms, practices, language, and material things of a group of people.
3. Case study research - provides a detailed account of one or more cases.
4. Grounded theory – generates and develops a theory from data the researcher collects.
5. Historical research – research about events that occurred in the past.

The sampling technique commonly used in qualitative research is called purposive sampling (Teddlie and Yu 2007), also known as non-random sampling. According to Maxwell (1997), purposive sampling is when a particular setting, person, or event is purposely selected for the important information it can provide that cannot be obtained elsewhere. This is similar to the non-random sampling discussed earlier in the quantitative section, where the methods used includes snowball sampling and convenience sampling.

Miles and Huberman (1994) indicated data for qualitative research are not recorded in numerical form and are gathered using flexible methods, and susceptible to the overall social context in which the data are generated. Unlike quantitative research, qualitative research utilizes the researcher as the main instrument for data collection. As reported by Trochim (2005), there are three types of qualitative data, listed as follows:

1. In-depth interviews:

   There are two types of interviews—individual and group interviews. These interviews can be recorded, using numerous ways, which include audio and video recordings, stenography, and written notes. Interviews are executed to scrutinize the ideas of the interviewees about the subject studied. The setup normally comprises an interviewer and one or more interviewees.
2. Observation:

   Observation conducted in qualitative research can include photographs and field research in a context or for a certain time period. It may use the same method of recording as in-depth interviews, as well as through drawings and all types of pictures.

3. Analysis of documents and texts:

   Existing documents, such as newspapers, magazines, books, memos, transcripts of conversations, reports, etc., are normally use in qualitative research. The content of the documents are often analyzed using content analysis.

Data collection for qualitative research can be collected through numerous methods, such as participant observation, direct observation, unstructured interviewing, and case study. Participant observation requires a researcher to become a participant in the culture or context under observation. This requires intensive work and may take months, since the researcher must blend in as part of the observations to ensure a natural phenomenon. On the contrary, direct observation focuses on the researcher not part of the context under observation, while being unobtrusive to overcome bias in the observation. An unstructured interview is the most common method to gather qualitative data and does not have an organized instrument. For case study, an in-depth study is conducted to determine a specific context or person. Case study usually adopts unstructured interviewing and direct observation as the method to gather further information pertaining to a subject. The use of observational methods is categorized into two groups—structured and unstructured observations (Yin 2003). Structured observations rely on frameworks of predefined actions, discussion content, or even body language to fit the activity within the variables and scope of the research question. An unstructured observation utilizes no preset framework. The concept driving unstructured observation is for the researcher to enter into the observations with no preconceptions regarding the expected outcomes.

The data collected are analyzed and interpreted using methods of analysis that reflect the complexity, detail, and context of the data in respect to the uniqueness of the study. The structure of the analysis will be categorized into themes that emerged from the data collected. Additionally, detailed explanations for each theme are developed, based on the participants' perspectives, which depict the meanings, processes, and contexts of the study.

4.3. SELECTION OF RESEARCH METHODS

After reviewing both research methods—quantitative and qualitative approaches—careful consideration was taken to identify appropriate research strategies to conduct this study. Some examples where quantitative research is best used are when measuring the incidence of various views and opinions in a chosen sample, quantifying data, and generalizing results from a sample to the population of interest. It is common for qualitative research to follow suit on quantitative research to explore some of the findings further. The methodology selection for this study has been based on the desire to match the particular research goal to the research strategy that will help achieve the study's goals. This study proposes to apply both quantitative and qualitative components. It is believed the use of quantitative and qualitative research provides better understanding and enhances the overall strength, validity, and reliability of the study.

Quantitative and qualitative methods used in this study were selected to address these objectives:

1. To evaluate and measure team effectiveness in construction project teams.
2. To determine how team effectiveness in construction project teams act as an indicator on construction project performance.
3. To model team effectiveness in construction project teams.

4.4. RESEARCH DESIGN

The research procedures for this study, Figure 4.2, are listed as follows:

1. Conduct literature review: An extensive literature review is performed from different sources, such as the Internet (Google Scholars), the library databases, and through the use of Interlibrary Loan service. Keywords, such as teamwork, construction teams, team effectiveness and project performance, are used to obtain relevant materials.
2. Perform pilot study: Once the literature review is completed, a pilot study is conducted to determine the most important team effectiveness factors relevant to the construction project teams. Details on the pilot study are further described in Chapter 5.

3. Develop survey instruments: Based on the results from the pilot study, develop a team effectiveness survey. The items for the survey are developed, based on the most important team effectiveness factors identified from the pilot study. This survey is aimed for construction project team members. Additionally, another survey (Project Performance Survey) is developed for the owner's representative to evaluate the construction project team. The survey consists of items measuring the project team on various project performance aspects found from the literature. Further details on the survey instruments are discussed in the instrumentation section in this chapter.
4. Perform data collection: The surveys are distributed to two different target respondents; the team effectiveness survey is distributed via email to construction project teams, and the project performance survey is sent via email to owner's representatives of the respective project teams.
5. Perform data analysis: Once data are obtained, several analyses are conducted using suitable quantitative and qualitative analyses to answer the research questions established for the study.
6. Develop a team effectiveness model: The outcome of the analyses are identified and developed into a model that illustrates team effectiveness in construction project teams.
7. Validate the model: The developed model is validated using a semi-structured interview. An interview is conducted with an award-winning construction project team recognized by the Design-Build Institute of America (DBIA).

4.4.1. Survey Development

The survey method is chosen as the quantitative component of this study to generalize the inferences made to the population. A survey is preferred, as it provides advantages, such as rapid turnaround in data collection and identifies attributes of a large population from a small group of people. The survey is cross-sectional, where the data are collected one point at the time.

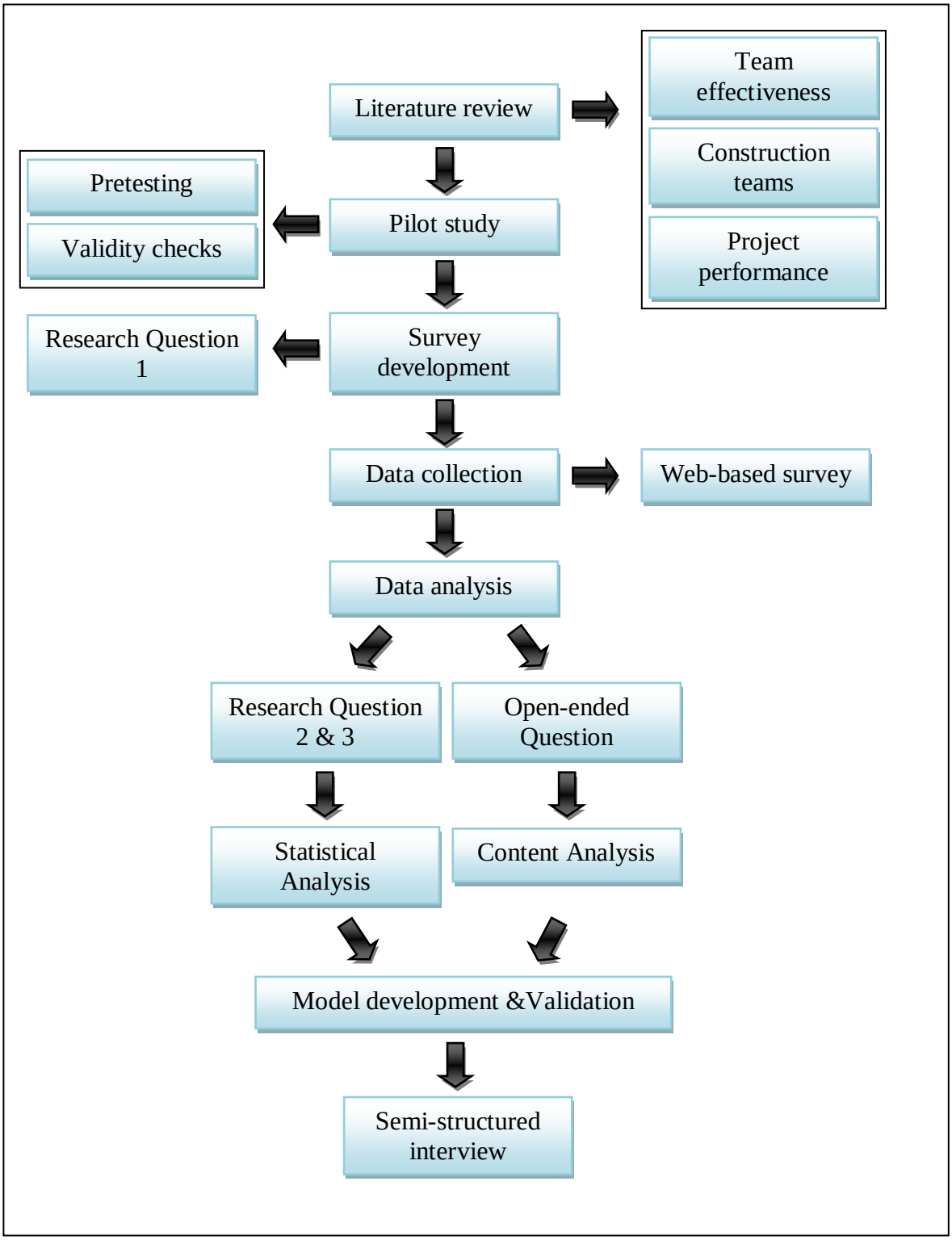

Figure 4.2. Research Procedures

The type of survey chosen for this study is the web-based survey (using Zoomerang program), which is administered online. There are several reasons for choosing a web-based survey:

- No cost for paper, postage, mailing, and data entry.
- Time required for survey implementation can be reduced.
- Once a database system is developed, cost of surveying additional respondents is much lower.
- Display of response data can be concurrent with completion of surveys. Data from web-based surveys are usually accessible in real time in graphic and numerical format.
- Reminders and follow-up on nonrespondents are practically effortless.
- Data from web-based surveys can simply be transferred into data analysis and statistical programs.

4.4.2. Population and Sample

The population of the study is construction companies in the Midwest area (12 states), Figure 4.3, in the United States (U.S.) which range from $100,000 to $1 billion in annual revenue. The proposed sampling design for this population is convenience sampling, where the respondents are selected, based on easy access/availability. The sampling frame for the study is a list of industry contacts obtained from different professors in the Construction Engineering department at Iowa State University, as well as from the Design-Build Institute of America (DBIA) and Associated of General Contractors of America (AGC) directory lists. These contacts are asked for voluntary participation via phone and email. There are several criteria utilized for this study:

- The term “construction teams” used in this study refers to the core project teams, which include several parties, but not limited to Contractor, Architect, Engineer, Subcontractor, and Owner’s representatives.
- The project team may be of any size.

- The project can be any type of construction projects, using any type of project delivery methods.
- The project chosen should be in progress or already completed within the past six months.

Once the contacts agree to participate in the study, they are asked to provide a contact person on project teams chosen for data collection purposes.

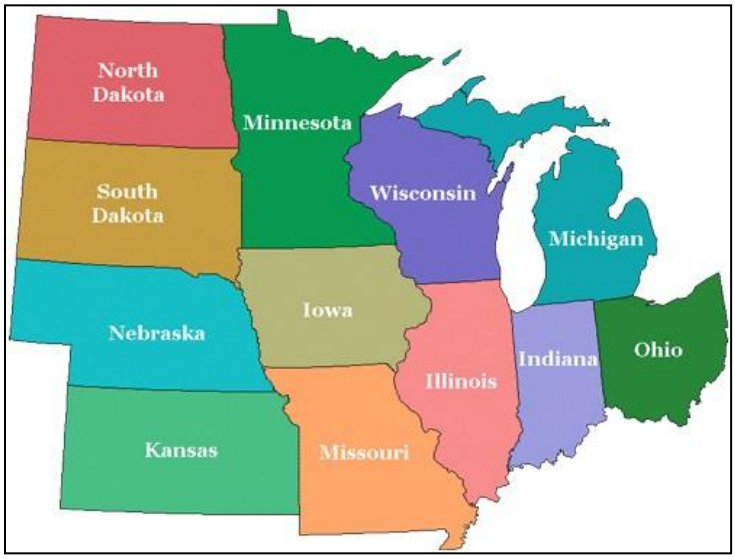

Figure 4.3.States within the Midwest area in the United States

4.4.3. Survey Administration

The survey is administered according to several steps. To ensure a high response rate, an email is sent to all respondents with the invitation/cover letter and the survey link attached. A duration of two weeks is given to all respondents to complete the survey. After one week, a reminder email is sent to nonrespondents and a thank you email is sent to respondents who completed the survey. After another two weeks, final reminders and thank you emails are sent. Because the number of respondents acquired is still inadequate, a series of phone calls are made to all nonrespondents to determine if they had completed the questionnaire. As a final conclusion to the survey administration, they are asked for the last time to complete the survey if they have not done so. Figure 4.4 illustrates the survey administration process and its timeline.

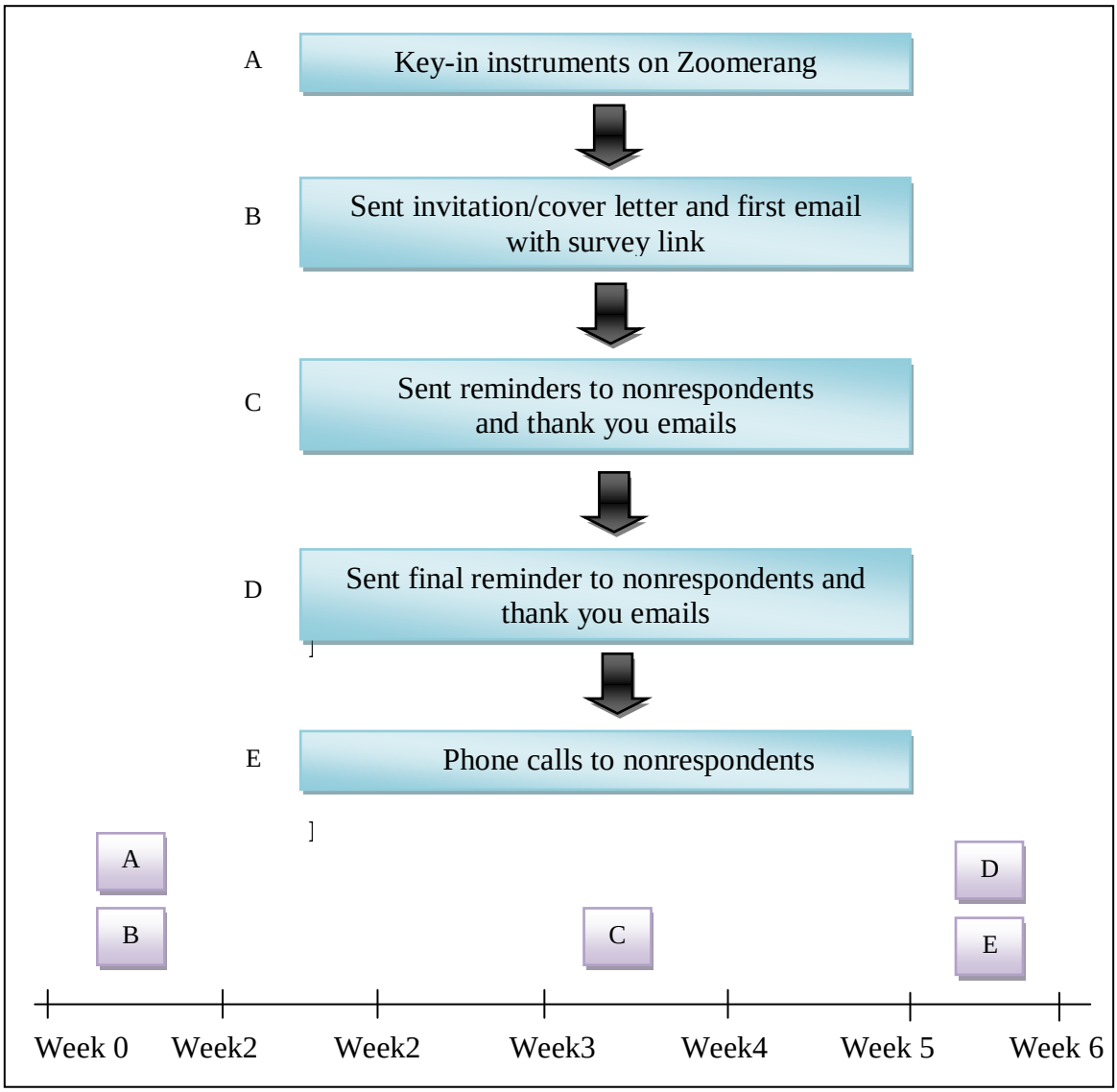

Figure 4.4. Survey administration process and its timeline

4.5. METHOD OF ANALYSIS

The analysis methodologies adopted in this study are further described according to the research questions outlined in the earlier chapters. For each research questions, detailed explanations are given to provide a better understanding on the structure of this chapter. The method of analysis used in this study is depicted in Table 4.1.

Table 4.1. Summary of Research Questions and Method of Analysis

No	Research Question (RQ)	Method of Analysis
RQ1	How can team effectiveness in construction be evaluated and measured?	Factor Analysis on the survey instrument
RQ2	How can team effectiveness act as an indicator of construction project performance?	See breakdown of analysis in RQ2a, 2b and 2c.
RQ2a	Which team effectiveness factors (IV) have the greatest variation between project teams (DV)?	One-way ANOVA using number of team as a factor with 16 levels (16 teams). Team effectiveness factors are treated as dependent variables.
RQ2b	Which team effectiveness factors (IV) have a significant relationship with project performance?	Bivariate correlations with all DV using group means for IV
RQ2c	Which team effectiveness factor is the best predictor in project performance?	*(Team level)*Multiple linear regressions for factors (IV) identified from RQ2b; Perform linear regression on team level.
		(Individual level) Replicate the DV values according to number of individual per team for multilevel effect. Run multiple linear regressions taking into consideration the observation on individual level.
RQ3	How to model team effectiveness in construction?	Using outcome from RQ2a,b,c and RQ3a

4.5.1. Research Question 1: How can Team Effectiveness in Construction be Evaluated and Measured?

One method of conducting evaluation and assessment is through the use of a survey instrument. In this study, there are two types of surveys developed as a means of assessing and evaluating the construction project teams—Team Effectiveness Survey and Project Performance Survey (Appendix A).

4.5.1.1. Team Effectiveness Survey

The Team Effectiveness Survey assesses the perceptions of the team members about their project team, categorized under six different team effectiveness factors. The survey is developed specifically to address construction teams that work on various types of projects, using different types of project delivery approaches. The survey, a measurement for team effectiveness, consists of both open- and closed-ended questions.

4.5.1.1.1. Team Effectiveness Factors

Prior to developing the team effectiveness survey, it is necessary to identify what should be measured. A list of team effectiveness factors was gathered, based on an extensive literature review of numerous assessment and evaluation surveys related to teams from other fields, such as manufacturing, military, social sciences, or business management. Additionally, team effectiveness models are analyzed and factors contributing to high-performing teams are identified. Once identified, a pilot study was conducted to assess the most important and relevant team effectiveness factors from the perspectives of construction industry practitioners. For the pilot study, nine team effectiveness factors (team goals and objectives, team leadership, company/top management support, audit and monitoring, roles and responsibility, creativity and innovation, team/task processes, team relationship, and communication) are used. Based on the pilot study conducted, six factors were chosen as the most important in contributing to construction project team effectiveness, based on their ranking value. These team effectiveness factors—Team Goals and Objectives, Team Leadership, Team Roles and Responsibilities, Team Relationship, Trust and Values, and Team Communication—aid in the further process of developing survey questions. Details on the pilot study procedures and its outcome are discussed in Chapter 5.

4.5.1.1.2. Response Scale

All close-ended questions in the survey use Likert-scaled items to evaluate the responses. Each of the factors include several survey questions measured as 5-point Likert-type items with response options ranging from strongly disagree to strongly agree. Other questions that do not utilize Likert items offer multiple answers selected by respondents.

4.5.1.1.3. Survey Questions And Other Relevant Items

Fifty-one survey items were grouped into six factors, based on different team measurements and assessments from various sources (Alexander 1985; Acharya et al. 2006; Gibson et al. 2003; Thomas et al. 1999; Bens 2000). These items are developed to measure each factor of team effectiveness to gain a better understanding of the team members' perceptions on different factors. The definitions and survey items for the Team Effectiveness and Project Performance factors are listed in Table 4.2a and 4.2b. Additionally, a set of instructions are prepared to explain the purpose of the survey and how to complete the items. For pretesting purposes, a comments and suggestions sheet was also provided. This sheet was used by the respondents to provide any commentary notes as ways of improving the quality of the survey.

4.5.1.1.4. Pretesting

Population and Sample

Because the Team Effectiveness Survey was developed for distributed to construction project teams, it is important to pretest the survey to a group of people, who have similar team characteristics and knowledge of working as a team in the construction business. Therefore, the Team Effectiveness Survey is pretested by ninety-six undergraduate students (graduating seniors) in the Capstone Class, a senior-design class in the Construction Engineering department at Iowa State University. This group is chosen for participation because of the nature of the class, where the students initially are grouped into teams working on designing construction projects. The students are asked to complete the questionnaire and provide comments regarding how well they understood the questions and the clarity of the items asked.

Table 4.2a. Definition of independent variables used in Team Effectiveness Survey

Variable Name	Measurement in survey	Conceptual definition	Characteristics	Number of items	Items of measurement	Scale
Team Leadership (TLEAD)	Overall team leadership and welfare	The degree and type of interdependence in work groups includes the differentiation of roles, the distribution of skills and resources, the manner in which goals are defined and achieved, and the manner in which performance is rewarded and feedback is given.	Shared leadership, decision making process, work performance and effort to improve	8	I feel comfortable with the concept of shared leadership. I feel comfortable with the decision-making process within the team. I spend time with team members to clarify team's expectations. Team exercises good judgment during decision-making process. Team members provide input/thoughts throughout the project. I help my team whenever anyone has difficulties performing tasks. The team helps me perform my job better. The team collaborates by sharing ideas to ensure tasks are performed effectively.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
Team Relationship (TREL)	Relationships among team members	A dynamic process which is reflected in the tendency for a group to stick together and remain united in the pursuit of goals and objectives. It can be described based on team type, structure, affinity and bonds, as well as how well the team manages conflict.	Conflict management, team unity, team welfare	9	I manage to handle team conflict well. Effective conflict management is exercised within the team. Team works constructively on issues arise until they are resolved. I care about the welfare of my teammates. My teammates care about each others. Good decisions are always made within the team regarding project matters. Decisions are made with the involvement of all team members. I carry my fair share of the work. The team members always looking out for the team.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)

Table 4.2a. Definition of independent variables used in Team Effectiveness Survey (cont'd)

Variable Name	Measurement in survey	Conceptual definition	Characteristics	Number of items	Items of measurement	Scale
Trust and Values (TV)	Trust and values placed within teams	Trust is depicted as a psychological state, involving expectations and feelings that lead to judgments about the trustworthiness of others, and as either rational or relational choice behavior that puts these expectations and feelings into observable action. Team values developed will help to shape the overall culture of a team.	Treatment and respect among team members, trust issues within teams	8	As a member of the team, I am treated with respect. Other team members are treated with respect. I trust my teammates in making decisions for the team. The team members trust each other. The team members show appreciation towards one another. The team members support each other. My contributions for the team are recognized. I believe trust is an important component in teams.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
Team Communication (COMM)	Team communication processes	Sharing of information between two or more individuals or groups to reach a common understanding. It is important that the information or ideas conveyed must be understood.	Communication in and out of meetings, honesty and level of interaction among team members.	9	The team believes trust is an important component. Effective conflict management is exercised within the team. Team works constructively on issues arise until they are resolved. I care about the welfare of my teammates. My teammates care about each others. Good decisions are always made within the team regarding project matters. Decisions are made with the involvement of all team members. I carry my fair share of the work. The team members always looking out for the team.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)

Table 4.2a. Definition of independent variables used in Team Effectiveness Survey (cont'd)

Variable Name	Measurement in survey	Conceptual definition	Characteristics	Number of items	Items of measurement	Scale
Team Goal and Objectives (TGO)	Goals and objectives of the team and the entire project	The degree and type of interdependence in work groups stems from several sources including the differentiation of roles, the distribution of skills and resources, and the manner in which goals are defined and achieved.	Level of achievement for project goals, team commitment and understanding of the project goal's and objectives.	6	I understand team's goals and objectives. My teammates understand team's goals and objectives. Team agrees on team's goals and objectives. Team goals and objectives are consistent with team members. Team is committed to achieve team's goals and objectives. Team achieves outlined team goals and objectives. I understand team's goals and objectives. My teammates understand team's goals and objectives.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
Team Roles and Responsibility (TRR)	The roles and responsibilities outlined by the team for each members		Helping each other can carry fair share of work, helping team members on performing task, understanding the rights and responsibility as a team.	9	Team members are willing to take initiative for unassigned tasks. I am willing to help with unforeseen problems that need immediate attention. Team members are willing to help with unforeseen problems that need immediate attention. I am clear on my individual roles in relations to the team as a whole. Team members are clear on individual roles in relations to the team as a whole. I agree with assigned roles and responsibilities. Team members have the necessary expertise to perform the tasks. Team members have the necessary skills to perform the tasks. I understand the responsibilities assigned to me.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)

Table 4.2b. Definition of dependent variables used in Project Performance Survey

Variable Name	Measurement in survey	Conceptual definition	Characteristics	Number of items	Items of measurement	Scale
Project Cost (COST)	All costing associated with the project; planning and managing project cost	The direct contractor costs for labor, material, equipment, and services; contractors overhead and profit; and other indirect construction costs.	The actual and baseline cost of a construction project	6	Project was completed/may be completed within budget. Contractor did seek alternative solutions with less emphasis on cost. Project costs were continuously monitored. Overall project cost is managed efficiently.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
					The actual overall cost of the project	Single-choice answer (1-Less than $100,000 to 5- More than $750,000)
					The budgeted cost of the project (including contingency).	
Project Schedule (SCHED)	Time management of the project	The act of putting together a timetable for when various tasks of a construction project will be started and completed. It is serves to ensure there is a correct match between labor, equipment and materials with a time line of project activities.	How the team deal with changes on construction project	7	The project was completed on time. Unforeseen physical and weather conditions have been considered in project schedule. The team established a sense of urgency and adjustments were promptly made to maintain or improve the schedule. The master schedule was up to date. Critical milestones were well-monitored. Reports and documentation were prepared within the time given.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
					Duration of the overall project	Single-choice answer (1-0-6 months to 5- more than 24 months)

Table 4.2b. Definition of dependent variables used in Project Performance Survey (cont'd)

Variable Name	Measurement in survey	Conceptual definition	Characteristics	No of items	Items of measurement	Scale
Project Phases & Tasks (PHASES)	The outcome, procedures and quality of the tasks performed in all construction phases	Conformance to the established requirements or standards aligned for the project, as well as exceeds the expectations of the owner in every aspect of the process, start to finish.	Quality satisfaction of the entire pre-construction, construction and post-construction process, including management	6	Project planning has been achieved correctly. Project construction has been completed correctly. Project has quality design. As the owner, I am satisfied with the time taken to issue design information. Construction activities during the project were inspected to ensure quality work. Procedures adopted by the project team ensured that the level of quality remains constant throughout the life of the project.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
Project Team (PTEAM)	Overall satisfaction on the project team' performance from owners' standpoint	A measurement of how good a team works together, or how good a team member feels being part of a team. The overall performance of the team as one unit.	Team members' knowledge, ability, skills, and professionalism working as a team	8	Good service of the contractor was demonstrated during the project. Contractor demonstrated good technical ability on the project. Professional and skilled people were hired for the project. Contract team had a friendly atmosphere and trust. Project team members demonstrated expertise necessary for the project. Project team communicates with the owner in an effective manner. Project team responds quickly to my needs with professional service. As the owner, I would like to work together again with the team members in future projects.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
Owner Satisfaction (OWNSAT)	Overall satisfaction on the project by the owner	A measurement of how good the owner feels (whether the end product is as specified in the beginning, or whether the team successfully deliver the project as per owner's specification and needs)	Satisfaction on the overall work performed, effective management throughout the project	5	Project team successfully achieved the project objectives. As owner, I am satisfied with the final product of the project. Project team exercise effective documentation system. Project completed met the quality standard specified during the earlier phase. Project site is kept clean and organized at all time.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)

Table 4.2b. Definition of dependent variables used in Project Performance Survey (cont'd)

Variable Name	Measurement in survey	Conceptual definition	Characteristics	Number of items	Items of measurement	Scale
Project Change Management (PCM)	Different types of changes occurred throughout the construction project (i.e. change orders)	A process of managing changes occurred within a construction project in terms of forecasting possible changes, identify changes that have already occurred, plan preventive measures and coordinate changes across the entire project.	How the team deal with changes on construction project	7	Project had no deficiencies during construction. Decisions to rework were based on cost not value of work. A defined change control system was used for the project. Project is flexible to accommodate the changes I request at any time. Change control system was well-managed by the project team.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
					Number of change orders occurred within the project.	Single-choice answer (None – More than 15)
					The most common causes of variations	Multiple choice answers (6 options)
Project Safety (SAFETY)	Construction Safety management	Preserving the health of construction personnel and of others affected by construction work and freedom from risk of injury that can happen due to accidents.	Implementation of proper safety management throughout the project	8	Safety is clearly a priority in this project. Exceptional efforts were made to establish effective safety procedures. Safety record keeping and reporting are well-managed and documented. Project safety inspections are conducted throughout the project. Project safety inspections are well-managed. Project team reports accident statistics to me on a regular basis. As owner, I establish specific safety goals for the team performing this project.	Likert Scale (1-Strongly Disagree to 5-Strongly agree)
					All type of incidents that has been recorded on this project	Multiple choice answers (6 options)

Data Analysis

The data collected from the pretesting are further analyzed using SPSS statistical software. From the data gathered, several statistical analyses can be conducted to examine the survey's validity and reliability. There are different ways to assess the validity of the survey, and one of them is construct validity. According to Leedy and Ormrod (2001), construct validity is concerned with ensuring a research effort is measuring what it is supposed to measure, according to its stated objectives. One way of assessing construct validity is by performing factor analysis on the data obtained.

i. Factor Analysis

According to Wood (2009), psychological constructs are defined as measures of ideas not directly measurable. For this study, the team effectiveness factors identified earlier can be considered as constructs. Since the Team Effectiveness Survey is developed with constructs identified after the pilot study was conducted, it is important to assess the survey results using a factor analysis. For this study, exploratory factor analysis was conducted to provide a rigorous structure to the patterns of responses to the items in the questionnaire (Warner 2011). Furthermore, factor analysis was used to identify the structure underlying such variables and to estimate scores to measure the latent factors themselves. To examine the underlying item structure, exploratory factor analysis is an appropriate method because it reduces the number of variables by allocating items across factors and detects the structure of the questionnaire responses from the correlational relationships among the survey items. Additionally, this method verifies the conceptualization for each construct, as well as examines whether there is more than one factor and whether the factor actually does represent the respective underlying construct. The procedures involved in exploratory factor analysis include factor extraction, estimating factor loadings, factor rotation, and factor labeling. For this study, the survey consists of six constructs (Team Goals and Objectives, Team Leadership, Team Relationship, Team Roles and Responsibility, Team Communication, and Trust and Values), where each of the constructs consists of several survey items corresponding to a construct.

ii. Validity and Reliability

Additionally, it is essential to examine the internal consistency of the patterns of responses to each item used for the questionnaire. Cronbach's α coefficient is used as an index to test survey reliability by measuring how well a set of items (or variables) measures a single one-dimensional monotonic latent construct. Cronbach's α is not a statistical test, but it is a coefficient of internal reliability (or consistency). Cronbach's α can be written as a function of the number of items and the average inter-correlation among the items. The formula used to calculate the standardized Cronbach's α value is:

$$\alpha = \frac{N.c\_bar}{v\_bar+(N-1).c\_bar}, \quad (1)$$

where N is the number of items, c_bar is the average inter-item covariance between the items and v_bar equals the average variance. Based on this standardized Cronbach's α formula, the value of Cronbach's α will increase when the number of items increases.

4.5.1.2. Project Performance Survey

The Project Performance Survey assesses the perception of the project owners about project performance and the team itself, which are grouped into seven aspects. The survey, the overall assessment of the project performance, consists of both open- and closed-ended questions.

4.5.1.2.1. Project Performance Aspects

The Project Performance Survey is designed, based on the findings from the literature related to project performance and key performance indicators in the construction industry. The factors identified for the Project Performance Survey are determined the main factors from the literature used to assess project performance. There are seven project performance aspects used as part of the development of the Project Performance Survey—Owner Satisfaction, Project Cost, Project Schedule, Project Phases and Tasks, Project Change Management, Project Safety, and Project Team.

4.5.1.2.2. Response Scale

All close-ended questions in the survey use Likert-scaled items to evaluate the responses. Each of the factors include several survey questions measured as 5-point Likert-type items with response options ranging from strongly disagree to strongly agree. Other questions that do not utilize Likert items offer multiple answers selected by respondents.

4.5.1.2.3. Survey Questions and Other Relevant Items

Forty-two survey items were grouped into the seven factors, based on different team measurements and assessments from various sources (Illinois Capital Development Board 2010; WHS/Acquisition & Procurement Office 2007). These items are developed to measure each aspect of project performance to gain a better understanding of the owners' perceptions on different aspects. Additionally, a set of instructions are prepared for the respondents to explain the purpose of the survey and how to complete the items. For pretesting purposes, a comments and suggestions sheet was also provided. This sheet was used by the participants to provide any commentary notes as ways of improving the quality of the survey.

4.5.1.2.4. Pretesting

Population and Sample

Because the group that pretested the Team Effectiveness Survey is undergraduate students from the Capstone Class that resembles construction teams, it is necessary to find a group of people related to the Capstone Class that plays the role of the owner. Therefore, the instructors of the Capstone Class are chosen, since they act as "the owner" in the class and know the performance level for each group. Therefore, the Project Performance Survey is distributed to the instructors of the Capstone Class for review and critique. The instructors are considered an expert group that provide critiques and offer suggestions for improvement of the quality of the survey.

Validity and Reliability

The instructors of the Capstone Class completed the survey in the beginning, and go through item by item in the survey to ensure each item is relevant to measure the project's

performance aspects. Additionally, they also provide critiques and suggestions to improve the reliability of the survey, i.e., clarity of the items and underlying meaning of the items.

4.5.2. Research Question 2: How Team Effectiveness in Construction Project Teams Act as an Indicator on Construction Project Performance?

To answer research question 2, several sub-questions are developed. The sub-questions developed are listed as follows:

4.5.2.1. Which Team Effectiveness Factors Have The Greatest Variation Between Project Teams?

To determine the variation between project teams, one-way analysis of variance (ANOVA) is conducted to determine if the differences between the team effectiveness factors' means are significant. Additionally, this statistical test helps make a conclusion about whether the independent variables (different teams) had an effect on the dependent variables (team effectiveness factors).

If there are differences in the team effectiveness factors between the teams, then the next step would be to determine whether the observed differences in the team may be attributed to just the natural variability among teams or whether there is a reason to believe the teams have different means in the population. The following is the hypothesis for research question 2a:

Null hypothesis, H_o:	The means of the team effectiveness factors of the 16 groups are equal.
Alternative hypothesis, H_a:	The means of the team effectiveness factors of the 16 groups are different from each other.

If the null hypothesis is not rejected, then there is no difference in the average of team effectiveness factors for each project team. Consequently, if the null hypothesis is rejected, this indicates at least one of the teams differs from the others.

4.5.2.2. Which Team Effectiveness Factors Have Significant Relationship With Project Performance?

There are several ways to determine whether an association exists between two variables, such as using a scatter plot and looking for the valuable numerical measure of association between two variables—the correlation coefficient. A scatter plot is a graph where two data values for an individual in a dataset are used to plot a point in two-dimensional space. The purpose for a scatter plot matrix is to check pairwise relationships between variables. The matrix contains all the pairwise scatter plots of the variables on a single page in a matrix format. It is recommended to run a scatter plot before performing a regression analysis to determine if there is a linear relationship between the variables. If the scatter plot does not indicate any increasing or decreasing trends, then attempting to fit a linear regression model to the data would not be recommended, since it would not be a useful model.

Once the relationship patterns between the variables are examined, it is necessary to perform an analysis to find the degree of association between pairwise variables quantitatively. Therefore, the bivariate correlation coefficient is conducted to determine the relationship between the independent variable (team effectiveness factors) and each of the dependent variables (aspects under project performance). The correlation coefficient is a number that summarizes the direction and degree (closeness) of linear relations between two variables. The correlation coefficient is also known as the Pearson Product-Moment Correlation Coefficient. According to Paler-Calmorin (1997), the Pearson product-moment correlation coefficient is used to find the degree of the correlation association to determine the relationship of two sets of variables quantitatively. The sample value is called r, and the population value is called ρ (rho). The conceptual definition of correlation coefficient is:

$$r = \frac{\sum xy}{NSxSy} \ , \tag{2}$$

where x and y are deviation scores,

$$x = X - \overline{X} \ \text{ and } \ y = Y - \overline{Y} \ . \tag{3}$$

S_x and S_y are sample standard deviations, which is,

$$Sx = \sqrt{\frac{\sum(X-\overline{X})^2}{N}} \quad . \tag{4}$$

In other words, correlation is the average of cross-products (also known as covariance) standardized by dividing both standard deviations. Substituting Eqs. (3) and (4) into Eq. (2), the value of r,

$$r = \frac{\sum xy}{\sqrt{\Sigma x^2}\sqrt{\Sigma y^2}} \quad . \tag{5}$$

The correlation value is used to measure the strength and direction of the linear relationship between the two variables.

4.5.2.3. Which Team Effectiveness Factors Contributed Uniquely in Explaining The Variance in Project Performance?

Once the association between the variables was identified, it is necessary to further explore which team effectiveness factors (independent variables) contribute uniquely to explain the variance in project performance (dependent variables). To explore the relationship between these variables, a linear regression is performed. This is an attempt to model the relationship between two variables by fitting a linear equation to observed data. Additionally, linear regression is a method to calculate the equation of the "best" straight line that passes through a set of points. The term "best" here means the "best fit" straight line—one that passes as closely as possible to as many points as possible (Simpson 2010). One variable is considered to be an explanatory variable and the other is considered to be a dependent variable. Prior to developing a linear model, it is suggested the variables are tested to determine if a relationship exists between the variables of interest (discussed in research question 2b). To calculate the equation for this best fit straight line, this begins with a set of n data points, (x_i, y_i), for $_i = 1, 2, 3,\ldots, n$. Then, calculations on the sum of x_i, the sum of y_i, the sum of squares of x_i, and the sum of products x_i y_i can be calculated as follows:

Sum of x_i : $\sum_{i=1}^{N} x_i$. (6)

Sum of y_i : $\sum_{i=1}^{N} y_i$. (7)

Sum of squares of x_i : $\sum_{i=1}^{N} x_i^2$. (8)

Sum of products x_i y_i : $\sum_{i=1}^{N} x_i y_i$. (9)

The slope, m, for the linear equation is as follows:

$$m = \frac{N\sum_{i=1}^{N} x_i y_i - (\sum_{i=1}^{N} x_i)(\sum_{i=1}^{N} y_i)}{N\sum_{i=1}^{N} x_i^2 - (\sum_{i=1}^{N} x_i)^2} \quad . \tag{10}$$

And, the intercept, b, value can be calculated from the equation below:

$$b = \frac{(\sum_{i=1}^{N} y_i)(\sum_{i=1}^{N} x_i^2) - (\sum_{i=1}^{N} x_i)(\sum_{i=1}^{N} x_i y_i)}{N\sum_{i=1}^{N} x_i^2 - (\sum_{i=1}^{N} x_i)^2} \quad . \tag{11}$$

From the equations above, the final equation for a linear regression is:

$$y = mx + b \, , \tag{12}$$

where x is the explanatory variable and y is the dependent variable. The slope of the line is b and m is the y-intercept (the value of y when x = 0).

In regression analysis, there are different ways the relative contribution for each predictor or independent variable can be assessed—namely the Enter method and Backward method. In the Enter method, the set of predictor variables that make up the model are specified. It also indicates each independent variable was entered in usual fashion. The success of this model to predict the criterion variable is then assessed. If Backward selection is chosen, all predictor variables should be entered into the model. The weakest predictor variable is then

removed and the regression recalculated. If this significantly weakens the model then the predictor variable is reentered, otherwise it is deleted. This procedure is then repeated until only useful predictor variables remain in the model.

It is recommended a regression diagnostics is performed, which examines the assumptions used in the analysis:

- Normality – The random errors are normally distributed.
- Homoscedasticity – The random errors have constant variance, when the variance for IV is equal to DV.
- Linearity – The random errors have zero mean.
- Independence – The random errors are independent.

In addition to the assumptions for regression, there is another aspect that needs examination in a regression—multicollinearity. Multicollinearity is considered a problem when variables are highly correlated in a multiple regression analysis. It is difficult to identify the unique contribution for each variable to predict the dependent variable because the highly correlated variables are predicting the same variance in the dependent variable. In this situation, the "overall" p-value may be significant, but the p-value for each predictor may not be significant.

Collinearity is examined, based on Tolerance and Variance Inflation Explained (VIF). Tolerance and VIF equations are:

$$Tolerance = 1 - R^2 \quad . \tag{13}$$

$$VIF = \frac{1}{Tolerance} \quad . \tag{14}$$

The collinearity problem in a regression analysis should be addressed and there are several ways to achieve this:

- Option 1 – Leave as is and conduct multiple regression analysis anyway. Multicollinearity only affects the results from the unique effect for each predictor.

Therefore, if one is only interested in the "overall" effect of the combined predictors, then multicollinearity is not an issue.

- Option 2 – Remove one of the variables from the analysis.
- Option 3 – Create a new "composite" of the highly correlated variables.

Once the collinearity issue is addressed, it is recommended to recalculate the regression analysis. From the regression equation obtained from this analysis, the predictors of project performance (from the team effectiveness factors) can be examined. If there are several predictors found, then it is necessary to determine the most significant team effectiveness factor that predicts project performance aspects.

4.5.3. Research Question 3: How to Model Team Effectiveness in Construction Project Teams?

Once the results from the previous research questions have been identified, a team effectiveness model can be developed. The model highlights the major findings from the statistical analysis performed for this study.

4.5.4. Defining Team Effectiveness

There is another section in the Team Effectiveness Survey and Project Performance Survey that requires participants to provide their opinions on how they define team effectiveness, and their (the team members and the owners) perspectives of whether their team is effective or not. For open-ended questions, there are several approaches that can be completed to analyze the data. The main purpose of analyzing qualitative data is to determine patterns and trends in the responses so conclusions can be made. The following procedures are used to analyze open-ended questions (Glenn 2007):

1. Read through the responses: Reading all the responses help to identify common themes.
2. Develop response categories:. Responses are categorized for the different themes identified.

3. Label each comment with one or several categories: This process is also called "coding," where at least one category is assigned to each response.
4. Examine the categorized responses: The categorized responses sometimes can be divided into several small categories. This helps determine the data trends and the main issues reported by respondents.
5. Check on the categories assigned. Once the data have been categorized and coded, it is recommended the researcher explains well the subject or theme should. The researcher should think about the content underlying the responses. This is important for coding purposes, as sometimes there are some responses that do not fit into the categories assigned earlier.
6. Write the analysis: Once the data are analyzed, and major patterns and trends are identified, a written summary follows.

4.6. FINDINGS VALIDATION

The team effectiveness study conducted is an effort to improve the overall effectiveness and efficiency of the construction project teams and indirectly contribute towards the improvement of the construction industry. Therefore, to ensure the study possesses high quality outcomes, it is important to ensure its methods, analysis, and findings are in accordance with proper validation techniques. For this study, face validity is chosen as the method for validation. Face validity is a subjective judgment of a nonstatistical nature that seeks the opinion of nonresearchers regarding the validity of a particular study (Leedy and Ormrod 2001).

According to Lucko and Rojas (2010), collaborations with appropriate representatives from the private and public sectors, e.g., industry practitioners, government agencies, and also the public at large, are very important in a practical field of study, such as construction engineering and management, to secure face validity of research endeavors. Face validity can be established by performing interviews as conducted by El-Diraby and O'Connor (2004). Conducting interviews with chosen participants relevant to the study helps attain a wide range of opinions. Besides, interviews provide internal reliability and allow richer feedback, as the interviewer can clarify and extend individual items ad hoc in a semi-structured

manner. Additionally, it is essential to take detailed notes or have an audio recording taken during the interview. The recorded interview should be transcribed and referred to the interviewee to ensure content of the transcription is accurate, thus, establishing content validity.

4.6.1. Methods

To establish validity checks for the findings and the model, it is necessary to find a construction project team recognized for its effectiveness and efficiency performing a construction project. Therefore, initial contact was made with the representative from (DBIA) to request information on several award-winning project teams. After several attempts to contact the award-winning project teams, only one project team agreed to participate in an interview. The type of interview conducted is a semi-structured interview, where the interviewer is prepared before the interview. Additionally, this type of interview allows interviewees the freedom to express their views in their own terms and provide reliable, comparable qualitative data.

Prior to the interview, an interview protocol and guide are established (see Appendix B). The interview protocol consists of information on how the interview is conducted. The interview guide comprises a list of open-ended questions and topics to cover during the conversation, usually in a particular order.

During the interview, it is recommended the interviewer jot notes to capture respondents' answers. However, sometimes it is difficult to focus the interview, while taking notes. This may result in detraction for the rapport development between the interviewer and interviewee. The best method to prevent this is for the interview session to be recorded digitally (audio or video).

4.6.2. Data analysis

The following are the procedures taken to analyze data from semi-structured interviews:

- The audio/video recordings or notes made during the interviews are transcribed and reread. Conversation is fully transcribed before identifying the main themes.

- Each line of the transcription is examined carefully to choose the main points before classifying the points into the main themes.
- Data coded are examined in terms of tracing interconnections with items and patterns.
- Items are grouped and linkages are made before the final write-up.

4.7. SUMMARY

This chapter discusses the methodology used to perform the study, using both quantitative and qualitative approaches. The quantitative methods are focused on Research Questions 1 and 2; whereas, a qualitative approach is applied to Research Question 3. With Research Question 1, an in-depth discussion on the development of Team Effectiveness and Project Performance Surveys is provided. Different aspects of survey development are explored, including the response scales and pretesting methods chosen—namely factor analysis and reliability testing. The next section provides information on the statistical testing proposed to answer Research Question 2, which has several sub questions. Several statistical tests are identified, including bivariate correlation, scatterplot matrix, and regression analysis.

For Research Question 3, the model is developed, based on the findings obtained from the previous research questions (1 and 2). Text analysis is used to analyze the content of open-ended questions completed by the survey participants. The qualitative component is also utilized for validation purposes, using the semi-structured interview. The interview is recorded, transcribed, and coded for analysis purposes.

The next chapter examines the results obtained from the quantitative and qualitative data analysis, and discusses relevant findings.

CHAPTER 5. PILOT STUDY

5.1. INTRODUCTION

As previously mentioned in Chapter 4, a pilot study was conducted to obtain insights from the construction industry on how an effective project team can be created and the main factors that drive team effectiveness from different perspectives. The findings obtained from the pilot study are intended for use in the development of the questionnaire in conjunction with the literature review.

To determine the main factors that drive a design-build team to be effective and highly functional, it is essential to provide an assessment on how well the team performs. Based on the identification of effective team's assessment through a review of prior research efforts in team performance and effectiveness, data collection was completed in two phases to meet the objectives of the study.

5.2. METHODOLOGY

The pilot study was performed through several phases, such as literature review and survey. For the first phase, a literature review was conducted to understand team concept and team performance in organizations, as well as their applications in the construction industry as a whole. Then, the concept of teams for design-build projects was reviewed and several models of team effectiveness were examined. A set of factors that contributes to team effectiveness was derived as an outcome of the literature review. These factors will be used as assessment categories for the second phase of this pilot study.

The second phase of this pilot study developed and distributed a survey for data collection purposes. Since this study is a pilot study, a sample of convenience was chosen as the sampling method. The sampling frame was a list of contacts ranging from owners, contractors, and architects. The respondents chosen for this pilot study were based on their active involvement in the design-build process. The survey consisted of thirty-three questions related to team assessment, based on nine categories believed to impact team effectiveness on a design-build project. It has two parts—demographic and team performance sections. The demographic section contains questions related to the amount of design-build projects the

participants were involved in their entire career, as well as the duration of their latest design-build team. The team performance section is divided into nine categories—

- team goals and objectives,
- team leadership,
- company/top management support,
- audit and monitoring,
- roles and responsibility,
- creativity and innovation,
- team/task processes,
- team relationship, and
- communications.

Each category was comprised of three rating questions, using a Likert-type scale and open-ended questions.

For the team goals and objectives category, the respondents were asked to state their level of understanding and commitment of their team members to achieve project objectives. Then, they were asked to provide ratings on the relationship of the team leader and team members, as well as the support received from top management of their companies. Later in the audit section, the respondents were asked about team assessments. Questions in the remaining categories include responsibilities of team members, level of creativity and effectiveness in decision-making, trust and respect, as well as interaction between team members.

The survey was administered online through Zoomerang, a type of software that helps create surveys and stores survey data online. An email with a brief introduction about the survey was sent to the selected participants, along with the survey's hyperlink, and an attachment of the survey for their convenience. The survey was sent to sixteen people, seven responded, which is equivalent to a 44% response rate.

5.3. DATA ANALYSIS AND DISCUSSION

The data obtained from the survey were analyzed using descriptive statistics as the data are insufficient for inferential statistical analysis. To simplify the data analysis for the nine categories mentioned earlier, an analysis was performed, based upon the responses provided,

according to the respondents' position within his/her organization. From the demographics section, the respondents were divided into four different position types, as shown in Figure 5.1. From the seven respondents, 43% (three respondents) are engineers (civil engineer, project engineer, and noise engineer). Twenty-nine percent of the respondents are project managers (two respondents) and the remaining positions are a Chief Executive Officer (CEO) from the subcontractor organization and a developer from an owner's organization. In addition, Table 5.1 summarizes the years of construction experience of the respondents for this pilot study.

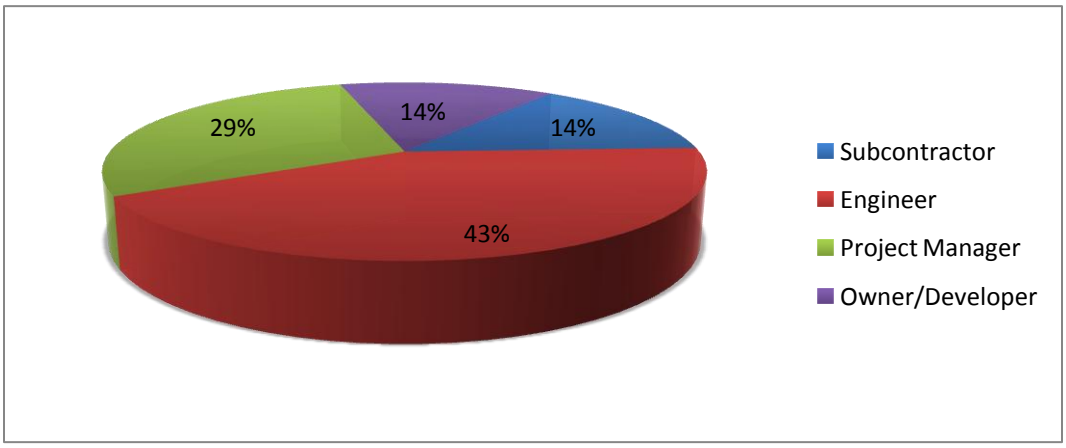

Figure 5.1. Percentage of participants by position type

In the literature review section it was identified as essential to look at team performance, based upon different aspects as listed in the survey to determine which aspects contribute towards the effectiveness of a team. For the category of team goals and objectives, three different questions were asked with regards to team members' levels of understanding of the team's objectives and goals, team members' commitment, and how their goals aligned with the overall team's objectives. As shown in Figure 5.2, almost all respondents agreed their team members understand the overall team's goals and objectives. In addition, their team's goals seem to align with the individuals' goals within their teams, and team members of the respondents showed commitment to achieve team goals and objectives. It is interesting to see

that owner has a slightly low rating, as they really have some power in the project to set goals or should at least.

Table 5.1. Respondents' years of experience

No	Position	Years of experience
1	Civil Engineer	4
2	Project Engineer	2
3	Noise Engineer	25
4	Project Manager 1	9
5	Project Manager 2	2
6	CEO	12
7	Developer	0.75

As illustrated in Figure 5.3, the team leadership category, 71% of the respondents (five respondents) described clarifications of each member's expectations were performed sometimes within the team. Two of the respondents indicated their team often consults on matters among team members, if any problem arises. This was interesting to observe from the subcontractor's point of view, where leadership and decision-making should be shared between team members. The subcontractor also mentioned a team that has strong leadership may contribute to an effective design-build team. On the other hand, some of the respondents seemed to be somewhat uncomfortable with the idea of sharing leadership and decision-making within its members. The owner was totally uncomfortable allowing other people on the team to make decisions and lead the team. Within this category, there was a mix between the respondents in their views of whether team leadership should be shared among its members or performed by an appointed leader.

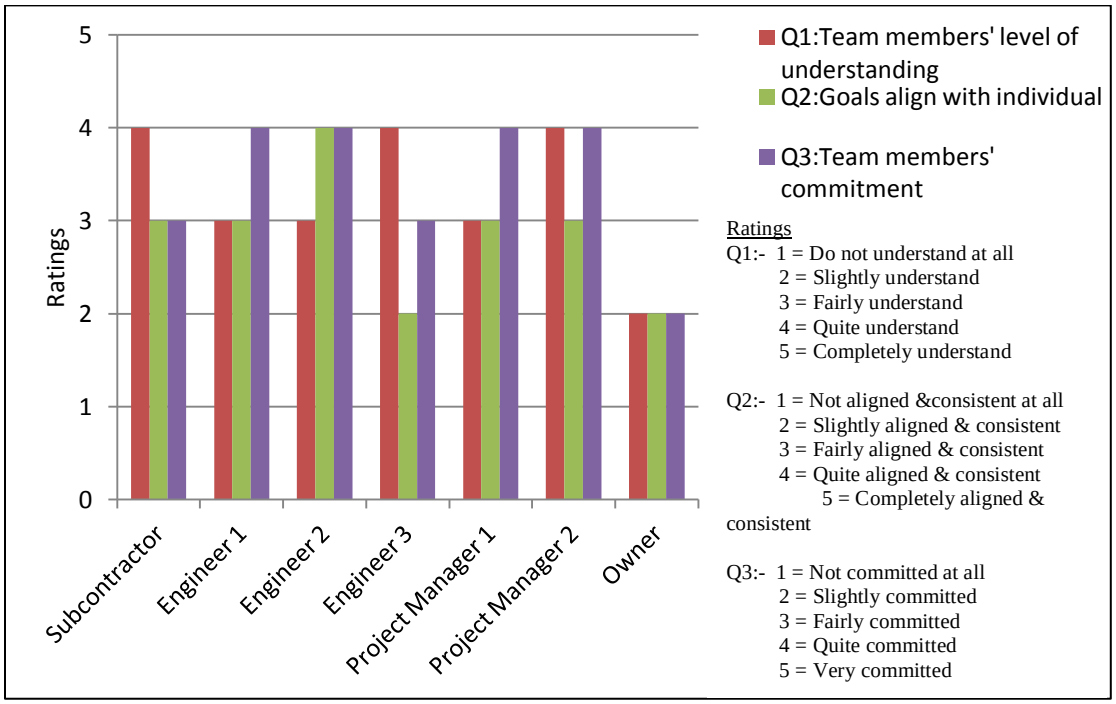

Figure 5.2. Responses for the team's goals and objectives

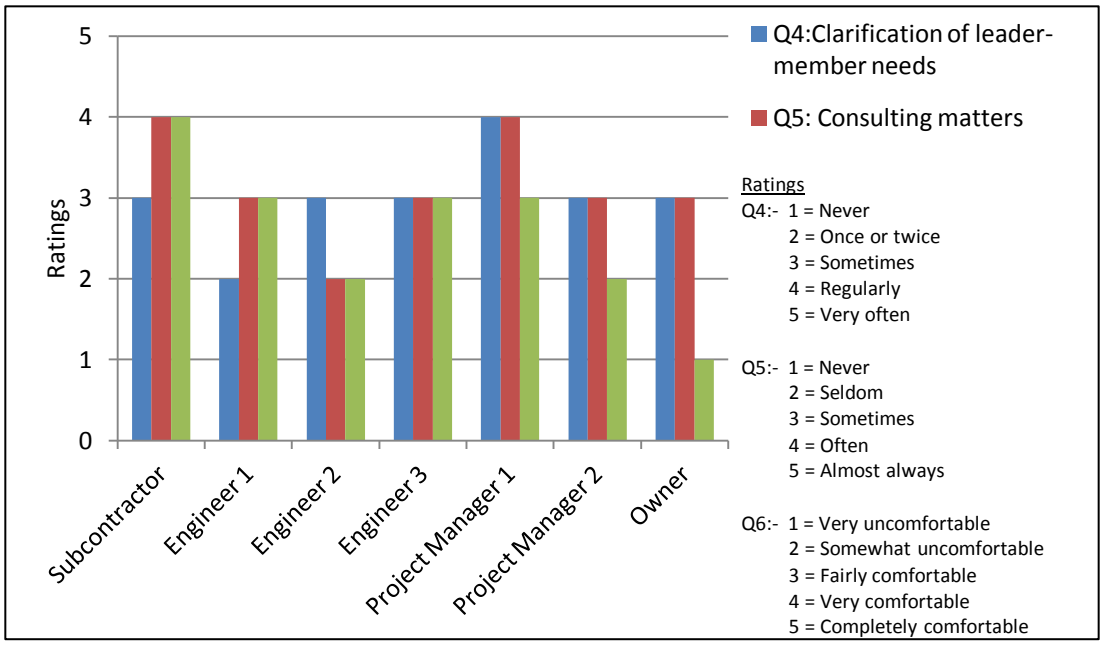

Figure 5.3. Responses for team leadership

For a team to be successful and effective, it is essential for a team to receive support from its top management within its organization. Most of the respondents received support from their top management to some extent, Figure 5.4. Respondents who received support have a good relationship with their top management, either a good or a fair working relationship. All the respondents agreed their top management viewed their team to be fairly successful as a place to develop employee's skills. Overall, having and maintaining good relationships with top management resulted in receiving good support from top management.

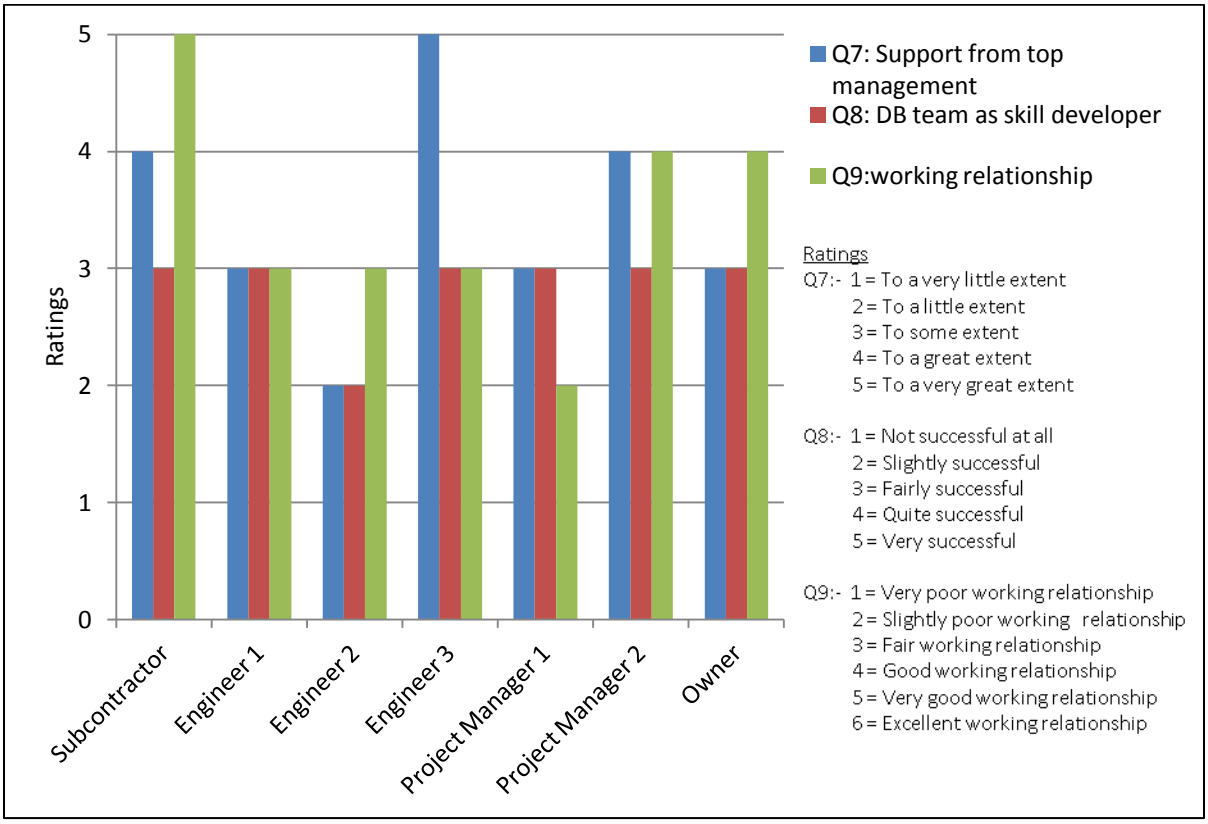

Figure 5.4. Responses for company/top management support

The respondents were also asked to evaluate the auditing and monitoring processes performed within their teams. Figure 5.5 reflects the overall evaluation and assessment completed by respondents' teams. Two respondents mentioned evaluation for team process and productivity, as well as tasks, were conducted all the time. However, four respondents indicated their team did not perform team assessment at all. On the contrary, four of them did

perform individual assessments at least once throughout the project. One can conclude most teams focus more on task and process evaluations rather than overall team or individual assessments, Figure 5.5.

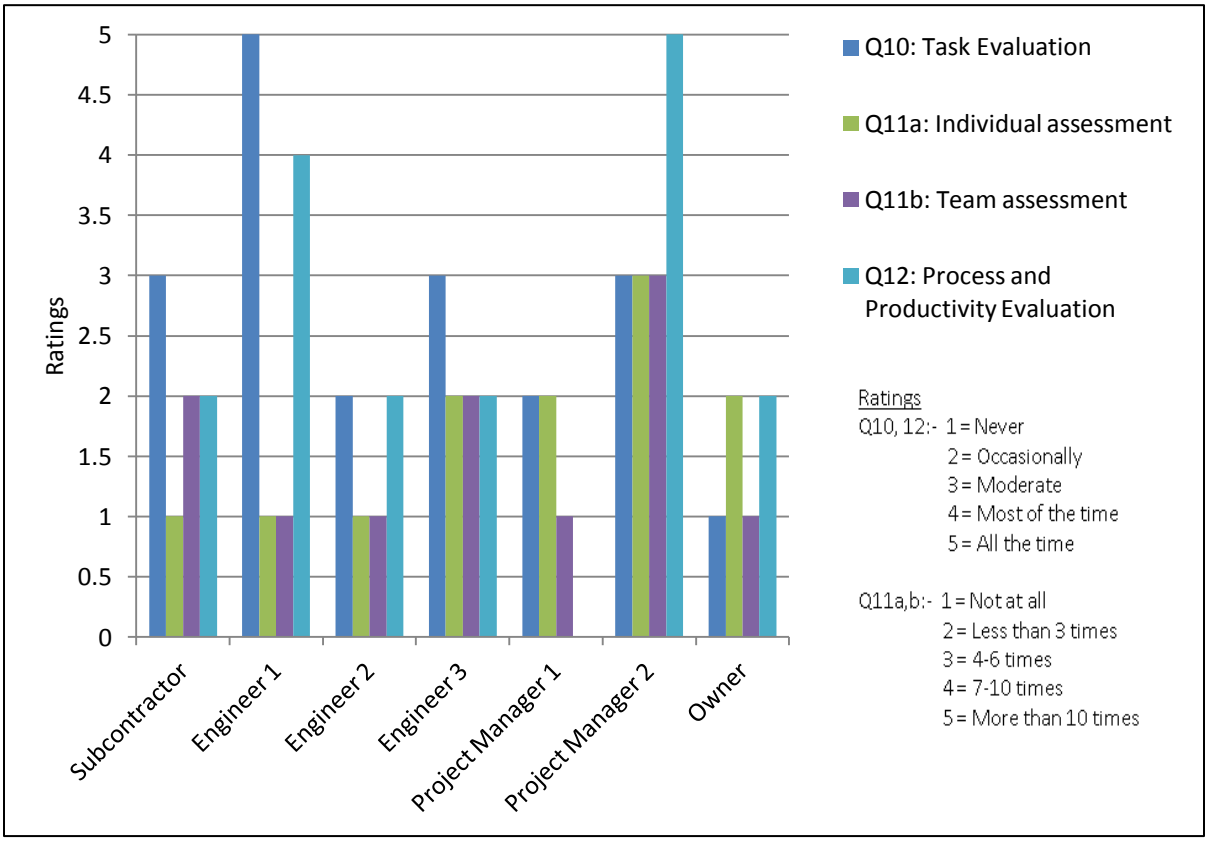

Figure 5.5. Responses for audit and monitoring

Almost all teams experienced confusion of assigned tasks and an unclear relationship between team members, as depicted in Figure 5.6. However, 86% (six respondents) indicated their team members were fairly certain of their individual roles within the team and the project. These respondents also agree their team members were willing to take an initiative for unassigned tasks, problems, or urgent situations. It can be observed that everyone except the owner had team members fairly certain about their individual roles for the project.

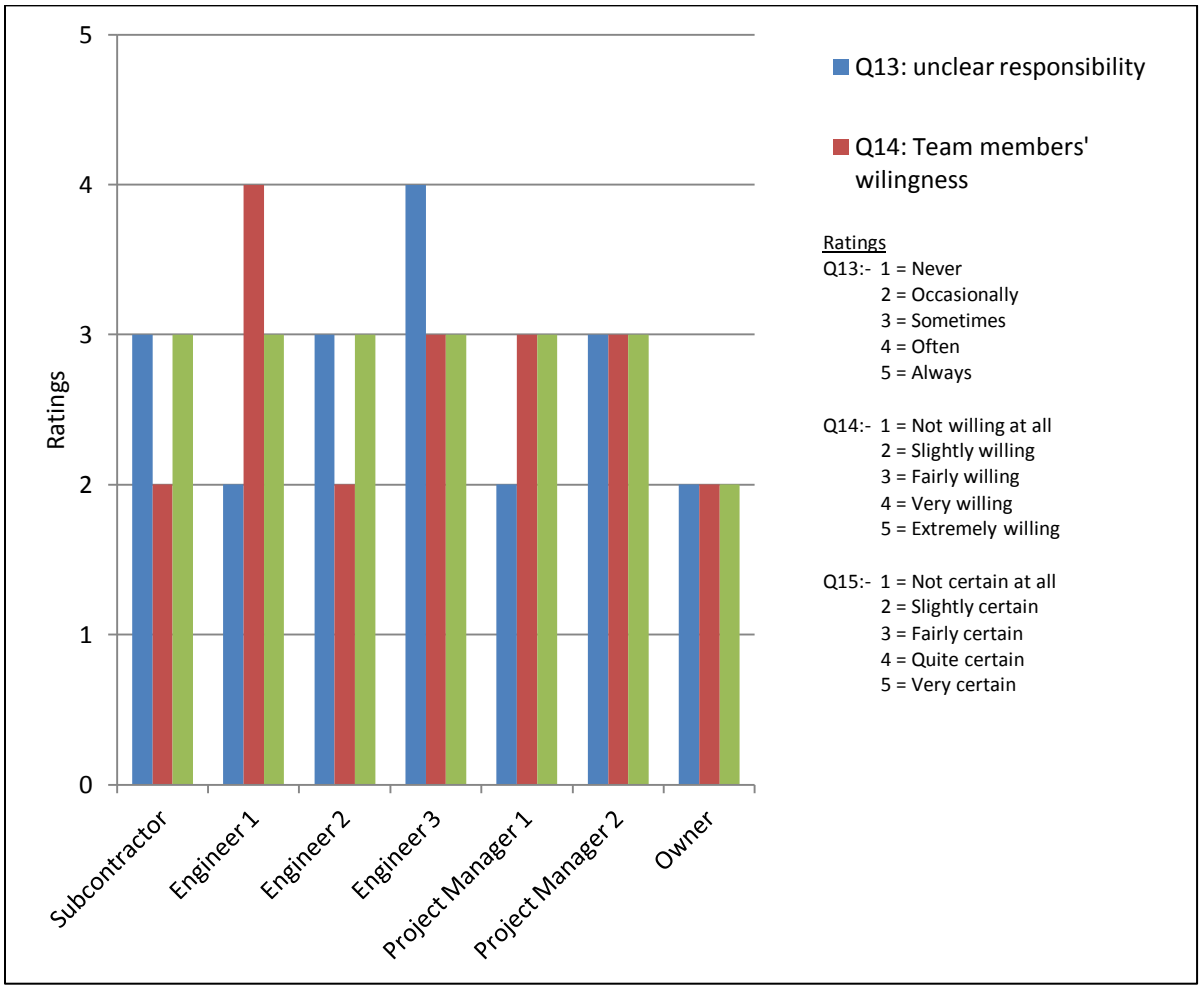

Figure 5.6. Responses for roles and responsibility

In terms of creativity and innovation, one engineer and one owner expressed their team members were always contributing ideas with regards to improvement of the project's success. Other teams, to some extent, did contribute ideas regarding project matters. Additionally, almost all respondents indicated their teams were encouraged to show initiative and exercise judgment. Figure 5.7 illustrates ranges in terms of the respondents' perception of overall levels of innovation and creativity within their teams, from slightly innovative and creative to quite innovative and creative.

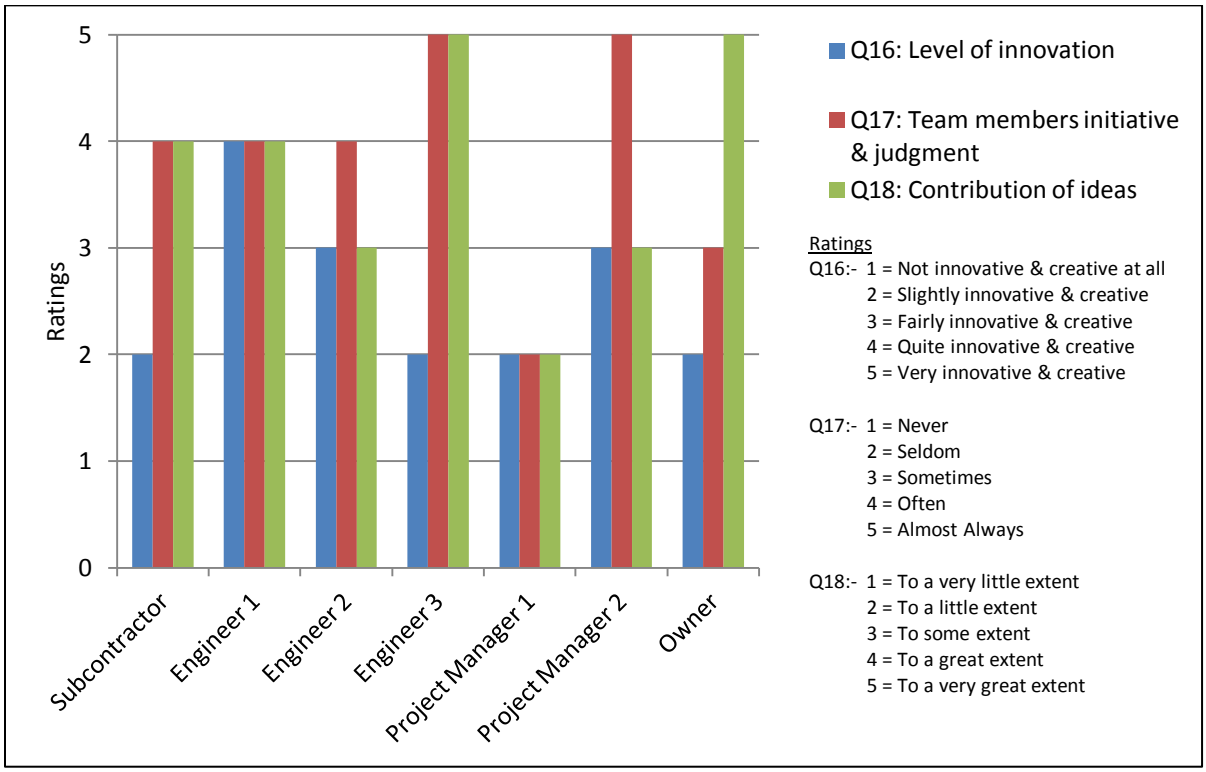

Figure 5.7. Responses for creativity and innovation

For a team to be considered successful, it should be able to achieve project goals and objectives outlined in the project phase. Proper planning of team and task processes are some of the examples that help a team become effective. Figure 5.8 shows only one respondent (Project Manager 1) found problem-solving within the team was somewhat ineffective compared to the other respondents. It is interesting to observe the respondents' perspectives on participation of their team members in team planning, team organization, and team functions. Two respondents indicated their team members' participation in three activities to be the same, which were to some extent. The remaining respondents have team members involved either to some extent or to a great extent. As far as team satisfaction on decision-making and problem-solving skills, three of the respondents depicted their team members were satisfied and another three respondents indicated their team members were neither dissatisfied nor satisfied.

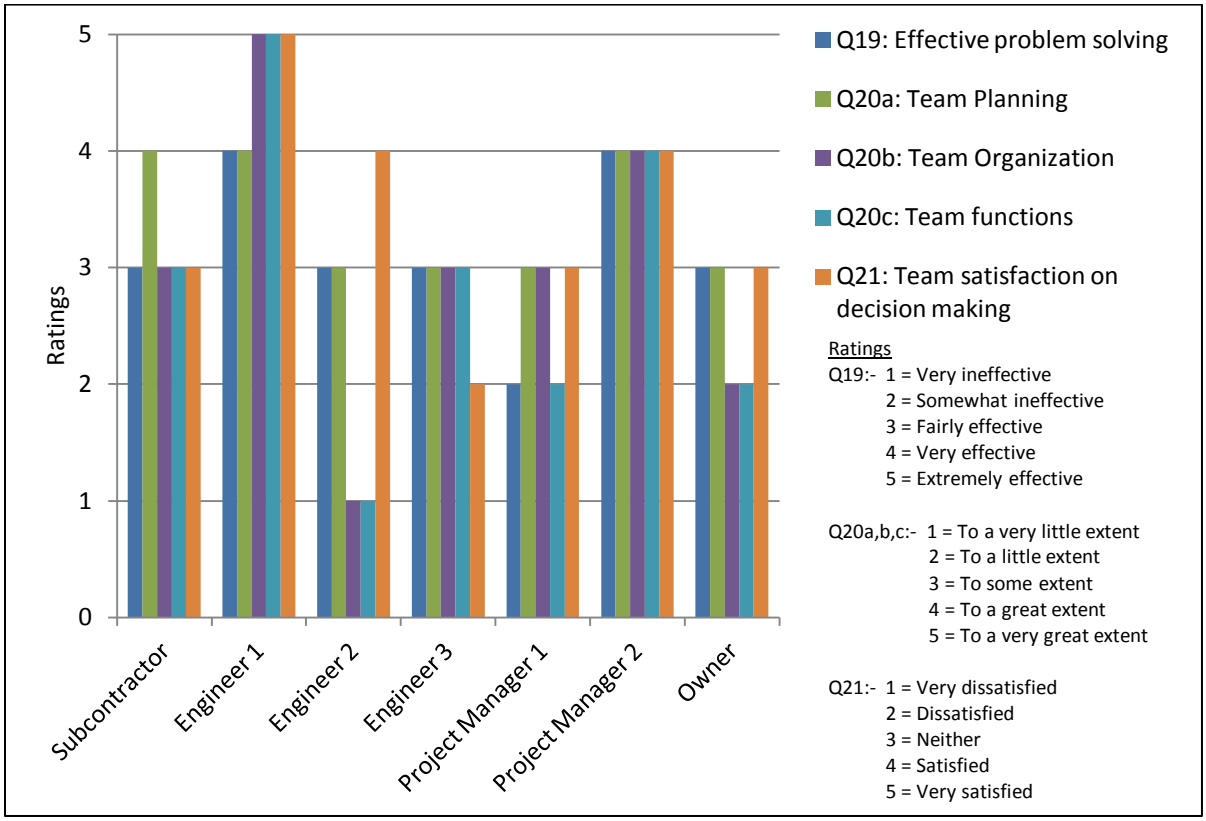

Figure 5.8. Responses for team/task process

The final two categories the respondents were asked to assess were team relationship and communications within the team. Figure 5.9 illustrates the responses obtained for team leadership; whereas, Figure 5.10 shows team communications. Four respondents described their team members do not care very much for the welfare and needs of each other, as compared to other respondents. All respondents' teams managed to handle team conflicts ranging from well to extremely well. The trust and respect elements were rated the same ranking by almost all respondents—either between team leader and team members, or within team members. Most teams have established trust and respect above and beyond average, and these results were due to the fact the teams conducted above average communication processes as depicted in Figure 5.10. The responses provided in the survey indicated open and honest communications were always the key to a good communication process. However, there still were some team members who were slightly friendly and easy, as described by two respondents. This always happens in almost all teams.

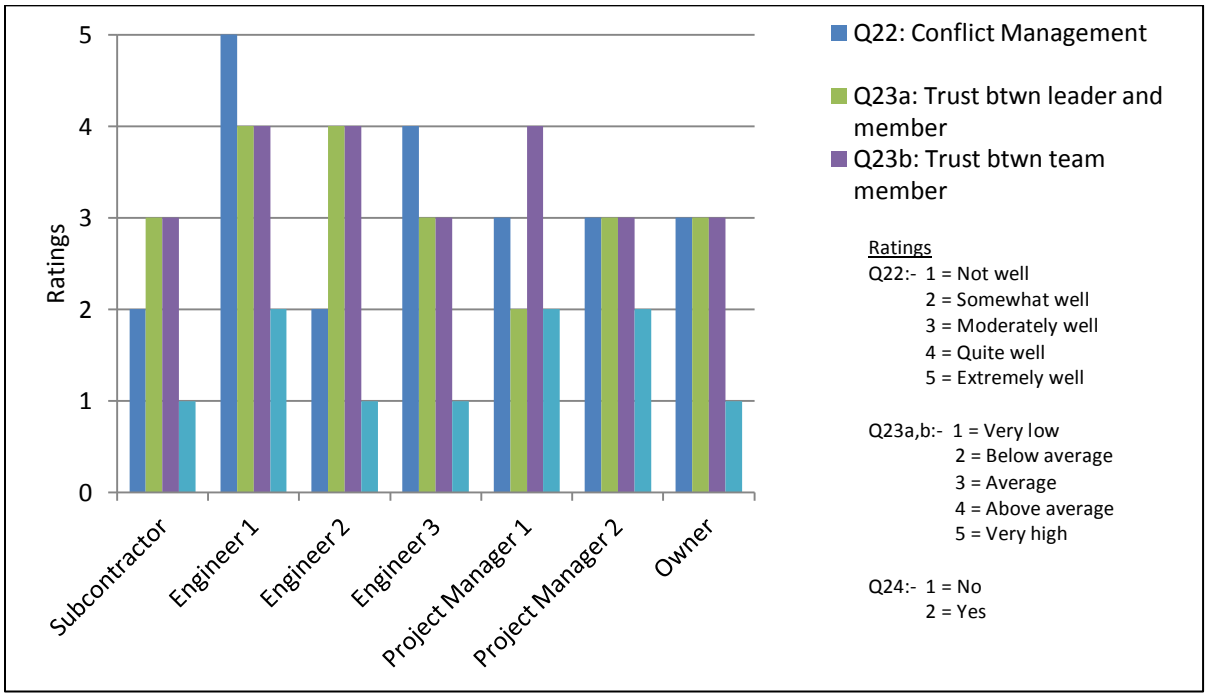

Figure 5.9. Responses for team relationship

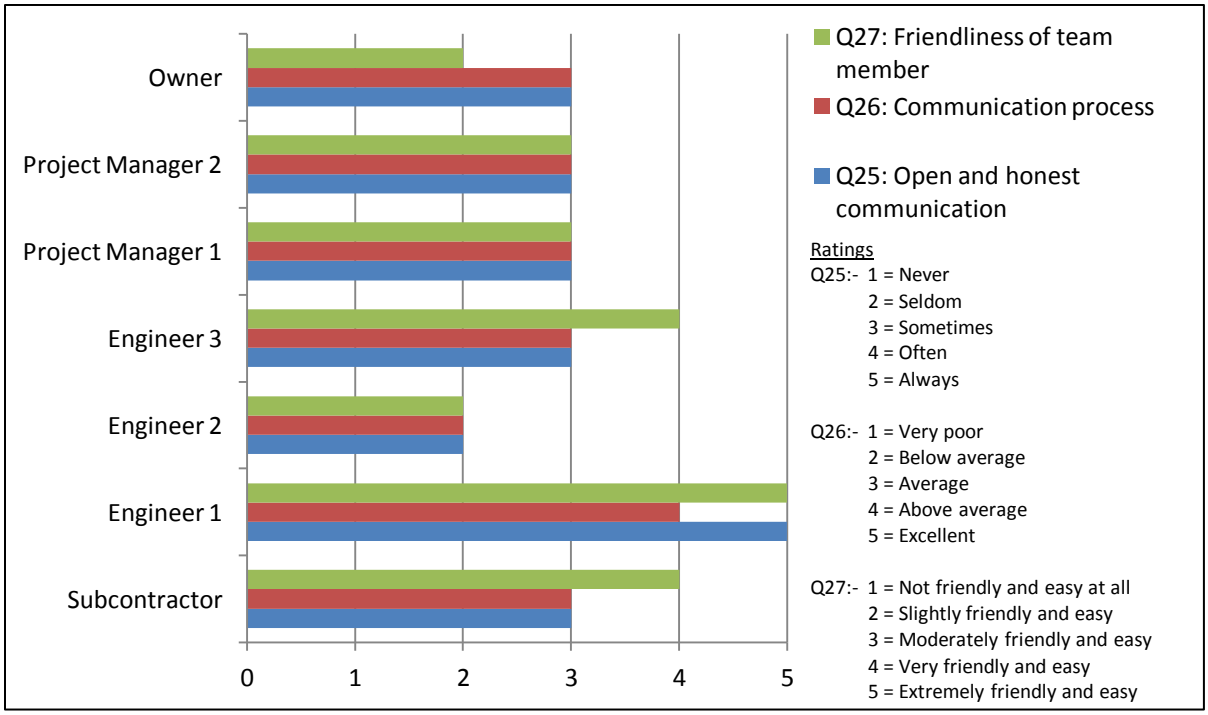

Figure 5.10. Responses for team communication

Finally, the respondents were asked to rank all nine categories as to which are the most important factors that contribute to team performance, which will result in an effective design-build team. As shown in Table 5.2, the top-ranked factors, according to the perspectives of the respondents, are team leadership, team goals, and objectives, as well as communications within team members. On the contrary, the least important factors ranked were auditing and monitoring, as well as team/task processes. In addition, three of the respondents provided recommendations on how team effectiveness can be incorporated into design-build teams. They suggested the importance of the right people assigned to the right task and to ensure sufficient team members to perform certain tasks. Moreover, strong leadership is crucial and more credit should be provided to teams that have performed together before and have systems for working together.

Table 5.2. Ranking of factors that contributes towards team effectiveness

Factors	Rank (1 - least important 9 - most important)						
	Subcontractor	Engineer 1	Engineer 2	Engineer 3	Project Manager 1	Project Manager 2	Owner
Team leadership	9	8	5	1	9	8	9
Team goals and objectives	8	9	4	7	8	9	7
Organization/ management support	2	7	3	3	4	7	1
Audit and monitoring	1	3	3	2	2	5	2
Roles and responsibility	6	5	6	8	5	7	5
Creativity and innovation	4	4	3	9	1	6	6
Team/Task processes	3	1	3	6	3	8	3
Team relationship	5	2	5	5	6	8	4
Communications	7	6	5	4	7	9	8

These factors are examined through a measure of central tendency, which is a value found to describe data sets through determining the central position of the data. Three types of central tendency measures are used—mode, median, and mean. Each type is more appropriate to use than others and depends on the data sets. The mean is used to describe the middle of a data set that does not have an outlier. The median is more appropriate for data

that have outliers, and mode is suitable to use when the data set is non-numeric or to determine the most popular/frequent item. In this pilot study, the participants are asked to ranked the factors, where ranking is an ordinal type of data. To determine the middle set of an ordinal data, the median is determined most appropriate. The median helps determine the central value of the data set, in this case the ranking from all the survey participants. The median value of the ranking obtained from the pilot study is shown in Table 5.3.

Table 5.3. Measure of central tendency (median) on the ranking of the factors

Factors	Median
Team leadership	8
Team goals and objectives	8
Organization/ management support	3
Audit and monitoring	2
Roles and responsibility	6
Creativity and innovation	4
Team/Task processes	3
Team relationship	5
Communications	7

5.4. PILOT STUDY LIMITATIONS

There are some limitations associated with the pilot study. First, the pilot study used a convenience sample, consisting of respondents from the design-build industry. The convenience sampling method was chosen, since it is well-suited to select participants due to a time constraint. In addition, this non-probability method is often used during initial research efforts to obtain a gross estimate of the results, without incurring cost or time required to select a random sample. The design-build industry was selected, since it is now emerging as the preferred project delivery method. The design-build delivery method promotes teamwork through close coordination within its team players to produce congruent results.

5.5. CONCLUSIONS

There are several conclusions that can be drawn, based on the data analysis. The team assessment provided by different construction parties (owner, engineers, subcontractor, and project managers) provides several pointers for creating an effective design-build team. First, it is important for team members to be committed to achieve project goals. They should understand clearly the project's goals, and ensure these goals and values of the team are aligned and consistent. Prior to the construction process, roles and responsibilities for each team member must be clarified to ensure no confusion arises. Additionally, the team leader of a design-build project should possess good leadership skills to create a sense of unity to bring everyone together and work collaboratively. Team leaders should promote shared leadership throughout the project and consult team members on matters concerning them. Auditing and monitoring the team as a whole and providing continuous assessment within the team's members help identify aspects for improvement. Since design-build projects provide room for creativity and innovation, team members should exercise both characteristics to ensure quality work will be achieved as the output of the project. An effective design-build team should also have good communication skills among its members to develop trust and respect within their working relationships. It is also crucial to organize all team members to be collaboratively-involved during the early construction phase for team planning, organizing, and decision-making processes.

Other conclusions that can be made are the top-ranked factors, according to the perspectives of different people within the construction industry. The top-ranked factors that contribute towards effective teams in design-build are team leadership, team goals and objectives, as well as communications within team members. This obviously ties in with the results obtained from the data collection, which highlight the importance of these three factors. On the contrary, the least important factors ranked were auditing and monitoring, as well as team/task processes.

Finally, Table 5.3 illustrates the items that have a median value of 5 and higher, and are chosen to be included in the development of the questionnaire:

a) Team leadership

It is the responsibility of the team's leader to guide the team to achieve specific project goals. An effective leader should ensure team members clearly understand project objectives and share his/her commitment to achieving them. The leader must help each individual on the team perform his/her very best.

b) Team Goals and Objectives

The team should define and agree collectively upon common team and project goals that provide purpose, focus, and direction. It is important that goals should be specific, measurable, attainable, relevant, and time-bound.

c) Team Communications

Communication skills are essential to recognize and respond to the principles of others, and to align and emphasize the values of the project team. Sharing values with the aim of establishing general project values should lead a team to the successful delivery of its projects.

d) Team Roles and Responsibility

Each team member should understand his/her individual or organization's duties, rights, and responsibilities prior to starting the project. This avoids future problems, when everyone on the team clearly understands what is required of him/her. In addition, it is necessary for team members to know their legal responsibilities, not only for their protection, but to shun worthless miscommunications and expenditures.

e) Team Relationships

A better understanding between team members is reached through the development of personal relationships and learning about each team member's strengths and what he/she can bring to the table. This leads to trust and with trust comes the possibility of a successful relationship and project. It is crucial for a team to respect and trust one another's respective role in the construction process and understand the risks inherent with these roles to ensure the project's success.

The factors described above are incorporated as part of the team effectiveness categories/dimensions in the questionnaire, together with other relevant team effectiveness factors as indicated in the literature review, and other team-based evaluation and assessment tools. Based on these factors, different types of questions will be developed, either closed-ended type of questions with ratings and scales, or open-ended questions.

The following chapter describes the results obtained from the quantitative and qualitative data analysis performed. Findings on statistical analysis such as Factor Analysis, Reliability test, Analysis of Variance (ANOVA), Bivariate Correlation and Regressions are provided in detail, along with discussions pertaining to the results. Additionally, summary from the text analysis conducted on the open-ended questions is also included.

CHAPTER 6. RESULTS AND DISCUSSION

The purpose of this chapter is to present, analyze, and discuss the results from the quantitative and qualitative data analysis performed to address the research questions described in the previous chapters. Conclusions from the discussion in this chapter are presented in Chapter 7, together with the practical implications of this study and recommendations for industry practitioners.

The research questions developed in this study are illustrated in Table 6.1. Each research question described includes a brief explanation of the methods chosen, results of the outcome from the methods, and a discussion on the results obtained. Because the primary research is looking into the role of team effectiveness on project performance aspects, it is necessary to determine if the team effectiveness factors provide a relationship with the project performance aspects. The results obtained will provide an important contribution to the construction team effectiveness literature, as well as to industry practitioners involved in construction project teams.

The quantitative side to the study explores team effectiveness factors and their relationship with project performance aspects. This chapter begins with a brief description of inferential statistics from the data analyses, followed by findings and discussions according to research questions. Research Question 1 used factor analysis to identify the structure underlying team effectiveness factors (independent variables) and to determine internal consistency using a reliability test (Cronbach's alpha). Research Question 2 focuses more on the variation among project teams, as well as relationships between the variables on an individual and team level analyses. This is achieved by performing ANOVA and several regression analyses. Research Question 3 looks more into developing a model that explains the shared variance between the team effectiveness factors that explains the project performance aspects. Additionally, the qualitative approach, using text analysis is performed on the open-ended questions regarding the definition of construction team effectiveness.

Once the research questions have been answered, a validation process is necessary to assess the accuracy of the findings obtained from this study. A semi-structured interview is conducted with a representative of an award-winning construction project team for validation purposes.

Table 6.1. Summary of research questions, method analysis, results and outcomes

No	Research Question (RQ)	Method of Analysis	Results	Outcomes
RQ1	How can team effectiveness in construction be evaluated and measured?	Factor Analysis on the survey instrument	A set of team effectiveness survey is tested on its reliability.	Team Effectiveness Survey
RQ2	How can team effectiveness act as an indicator of construction project performance?	See breakdown of analysis in RQ2a, 2b and 2c.	See results in RQ2a,2b and 2c	See outcomes in RQ2a, 2b and 2c
RQ2a	Which team effectiveness factors (IV) have the greatest variation between project teams (DV)?	One-way ANOVA using number of team as a factor with 16 levels (16 teams). Team effectiveness factors are treated as dependent variables.	Team goals and objectives (TGO), Team roles and responsibilities (TRR) and Trust and values (TV) have the greatest variation between the project teams.	The team effectiveness factors that have the greatest variation between project teams can be determined.
RQ2b	Which team effectiveness factors (IV) have a significant relationship with project performance?	Bivariate correlations with all DV using group means for IV	Team leadership (TLEAD), Team relationship (TREL), Team roles and responsibilities (TRR) and Trust and values (TV) have a significant relationship with project change management (PCM).	The strongest association between the team effectiveness factors and project performance aspects can be determined.
RQ2c	Which team effectiveness factor is the best predictor in project performance?	*(Team level)* Multiple linear regressions for factors (IV) identified from RQ2b; Perform linear regression at team level.	Team leadership (TLEAD) is the best predictor of project change management (PCM).	The predictors of project performance aspects can be determined (team level).
		(Individual level) Replicate the DV values according to number of individual per team for multilevel effect. Run multiple linear regressions taking into consideration the observation on individual level.	Team leadership (TLEAD) is the best predictor of project change management (PCM).	The predictors of project performance aspects can be determined (both individual and team level)
RQ3	How to model team effectiveness in construction?	Using outcome from RQ2a,b,c and RQ3a	Model of team effectiveness is developed from the results obtained in RQ2c	Model of team effectiveness for construction project teams

6.1. DESCRIPTIVE STATISTICS OF THE STUDY

This section discusses the descriptive statistics obtained from the demographic information from the first part of the Team Effectiveness Survey and Project Performance Survey. Figure 6.1 illustrates the number of team members who participated in the survey and the number of project teams involved. The surveys were mailed to 33 identified project teams; however, only 16 teams fully responded (48% response rate). All 16 teams have respondents (N) ranging from 5-12 people per team, with a total of 99 respondents. Project team 8 had the highest number of team members participating in this study—12—and there were six teams who had five people respond to the survey.

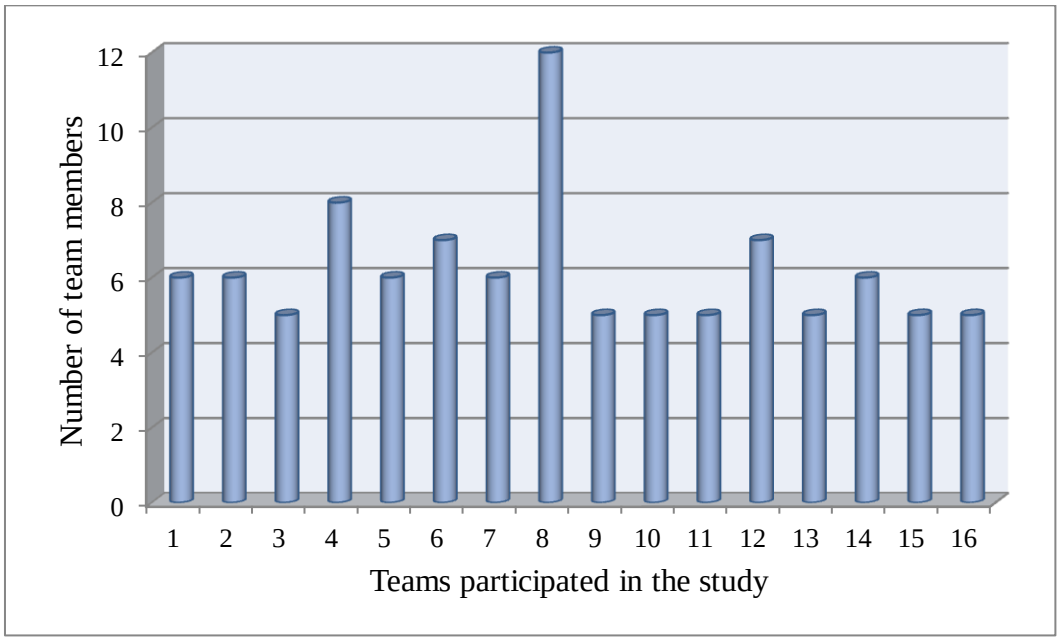

Figure 6.1. Survey participants

Figure 6.2 shows the amount of construction experience the survey participants have during their career. Between 99 individual survey participants across 16 teams, 57 people, or 58% (more than half of the sample) have more than 15 years of construction experience. The other half of the sample falls between 0 to 15 years of construction experience—four people (4%) with 0-5 years of experience, 22% (22 people) with 5-10 years of experience, and 16 people with 10-15 years of experience (16%).

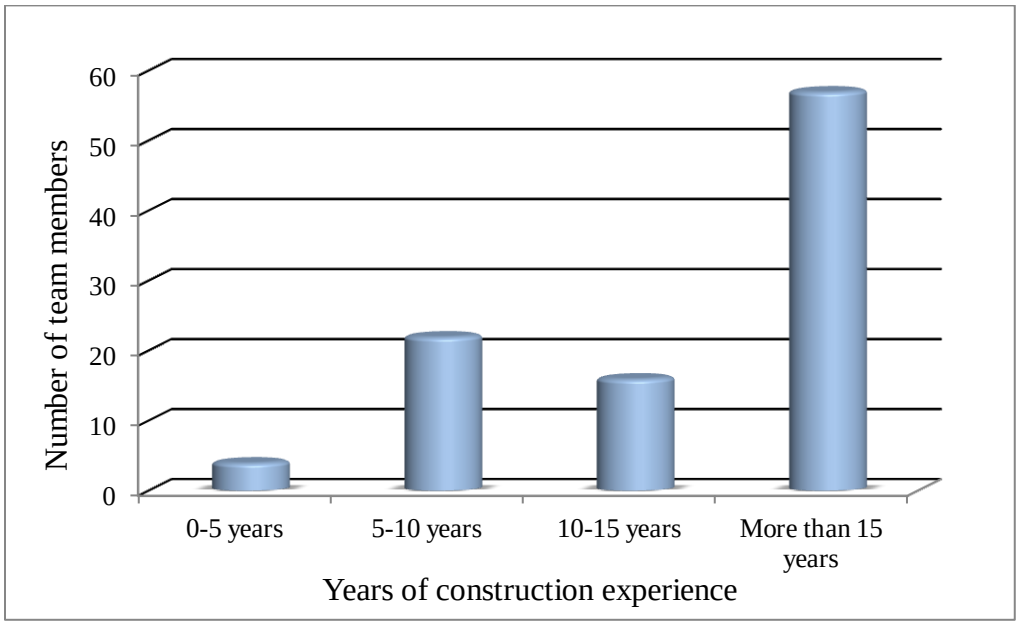

Figure 6.2. Years of experience of project participants

Figure 6.3 illustrates the categories of job positions and the percentage of team members corresponding to each of them. The majority of the survey participants are project managers (45%). The smallest number of participants is superintendent, which comprises 3% of the survey participants. Engineer, architect, subcontractor, and others fall within the 10-16% range (13, 12, 10, and 16%, respectively).

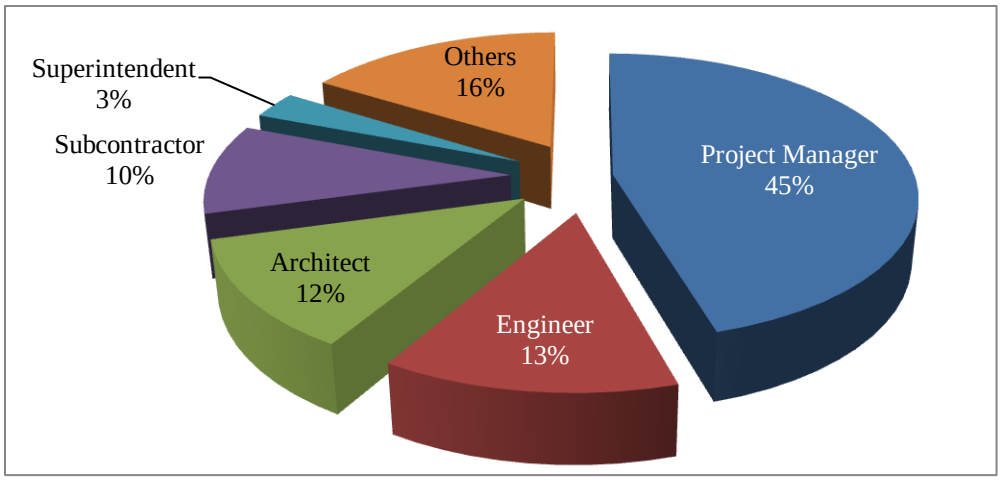

Figure 6.3. Job positions of the survey participants

Besides demographic information on the project participants, other data related to the construction project are collected as well. Figure 6.4 indicates the types of construction projects performed by the team participated in this study. The types of projects performed by the participating teams' ranges from commercial construction to retirement and assisted-living facilities. Between 16 projects, three are highway projects; six are government and military projects, recreational and retirement and assisted facilities. The other seven projects fall into the remaining type of construction projects.

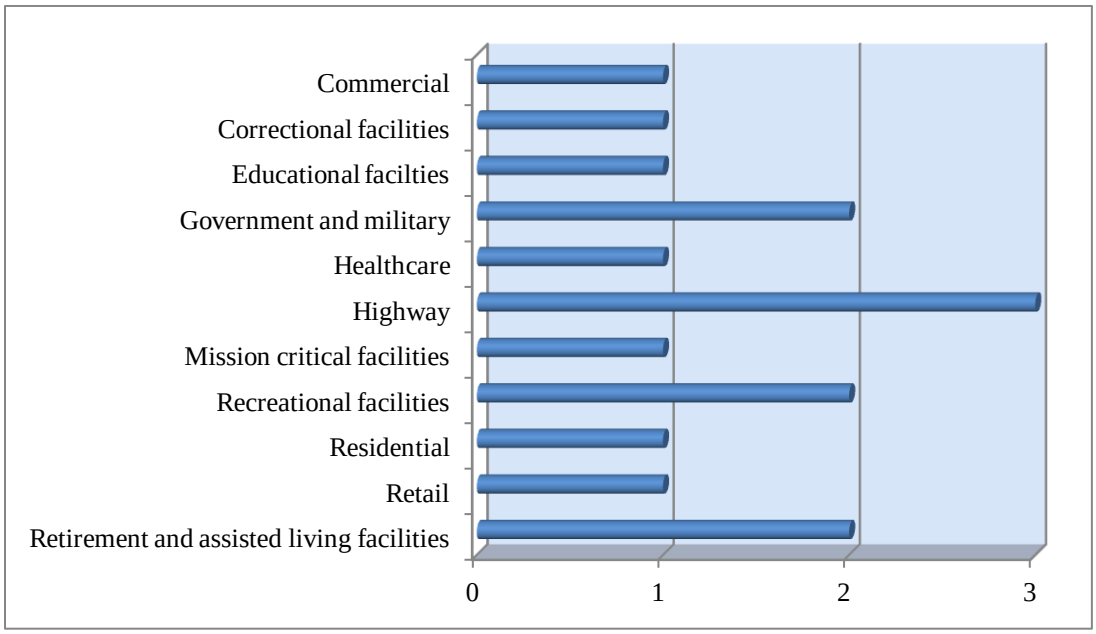

Figure 6.4. Types of construction projects performed by the team

Additionally, information about the project delivery method chosen for the projects is also obtained. Based on Figure 6.5, the proportion of different types of project delivery methods is displayed. Among the 16 projects, 38% (six teams) use Design-Bid-Build delivery method, followed by Design-Build (31%) with five teams. The remaining teams used CM at Risk, CM as Agent, and other types of project delivery methods (19, 6, and 6%, respectively).

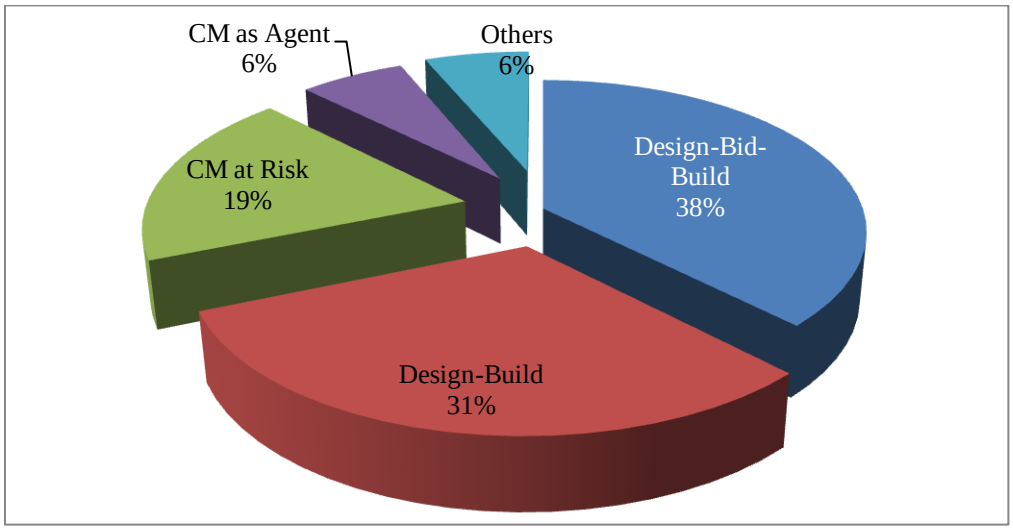

Figure 6.5. Types of construction delivery methods of the projects performed

Figure 6.6 indicates the overall contract value of the 16 projects performed by the teams participating in this study. Thirteen projects (81%) are valued more than $2 million, considered as large construction projects. The contract value for two projects (13%) is within the $100,001 and $500,000 range and only one project falls in the $1 million - $1.5 million category.

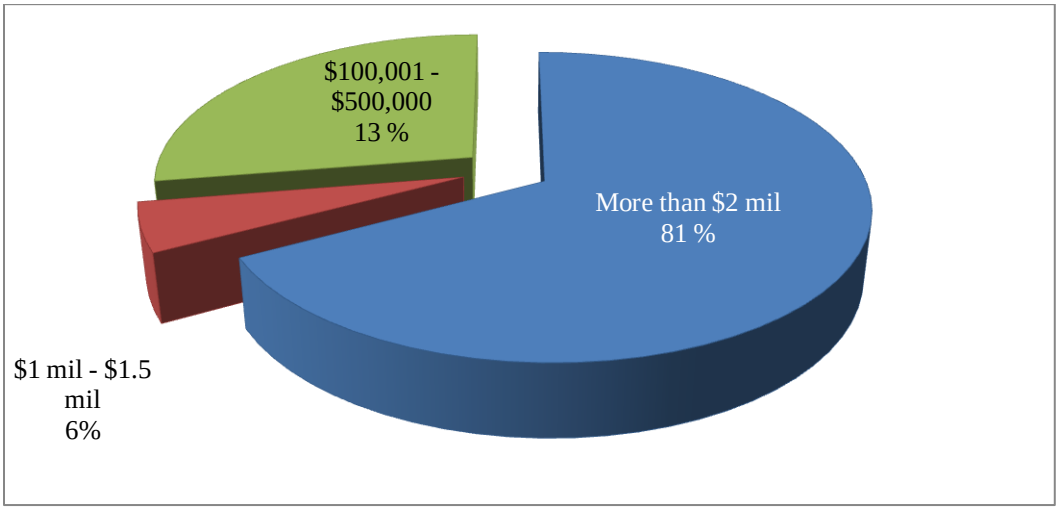

Figure 6.6. Contract value for the projects performed by the team

6.2. RESULTS FOR RESEARCH QUESTION 1

6.2.1 How can Team Effectiveness in Construction Be Evaluated and Measured?

As discussed in detail in Chapter 4, team effectiveness in construction can be evaluated and measured by using the Team Effectiveness Survey developed for the purpose of this study. Pretesting of the survey was conducted with a group of senior-level undergraduate students in the Construction Engineering Capstone Class at Iowa State University. Of the 96 questionnaires distributed, 60 were completed, which yields 62.5% response rate. The pretesting data are used to performed statistical tests, such as factor analysis and reliability tests.

6.2.1.1. Factor Analysis

In the exploratory factor analysis, the method of principal component is used to calculate the eigenvalues, communalities, and factor-loading coefficients for additional analysis. All questions included under each of the six constructs are tested separately, and only components with eigenvalues over one are retained; thus, removing all insignificant components from additional analysis.

Tables 6.2a, b, and c indicate the factor-loadings for the team effectiveness constructs. The values in each of the factor columns indicate the correlations between the original variables and the common factors. Based on the factor loadings, the communality values are computed. Communality is the extent to which an item correlates with all other items. Higher communalities are considered better. If communalities for a particular variable are low (between 0.0-0.5), then the variable will struggle to load significantly on any factor (Neill, 2011). Among the six constructs, three (Team Goals and Objectives, Team Communication, and Trust and Values) constructs demonstrate communalities of each of the construct's items greater than 0.6, an acceptable level. Constructs with items having low communalities (below 0.5) include Team Roles and Responsibilities (three items), Team Leadership (three items), and Team Relationship (one item). Low communality values means the variables are not well-defined by the factors. It is observed the items identified as having low communalities are double-barreled (that is, they contain two or more elements to which a respondent could respond); i.e., team members do not seem to be concerned with helping each other, carrying

their fair share of work, pulling in the same direction, or looking out for the team. These results suggest it may be appropriate for these items to be removed. The factor analysis could be re-run without these items before proceeding.

This analysis initially generated several dimensions. To obtain a meaningful factor solution, the data were rotated using Varimax rotation. This type of rotation is performed to achieve a simple structure by focusing on the factor-loading matrix, and results in factors that are mutually orthogonal (independent, with zero correlations). The factor-loadings for each item on four dimensions after factor rotation were performed are also shown in Tables 4a and b. Team Goals and Objectives, Team Communication, Team Leadership, and Team Relationship each have two factors. The loadings for each item are further examined to assign the factor where they are grouped. The factors are named according to what each set of items on that factor represented. Further actions are taken to improve the items as will be discussed in the next section.

For example, in Table 6.2a, for Team Goals and Objectives, the item "To what extent do you understand the team's goal and objectives?" has communality of .753, which shows 75.3% of the variance in that item are accounted for by the extracted factor (factor loading 1). Factor 1 in Team Goals and Objectives has accounts for 44.281% of total variance among the Team Goals and Objectives items and 22.811% are accounted for by factor 2, which resulted in 67.092% of total item variance being explained by the two factors combined.

Table 6.2a. Factor analysis results for team effectiveness construct (Team Goals and Objectives & Team Roles and Responsibilities)

D1: Team Goals and Objectives	Loadings			Communality	D2: Team Roles and Responsibility	Loadings			Communality
	Factor 1	Factor 2	Factor 3			Factor 1	Factor 2	Factor 3	
To what extend do you understand the team's goal and objectives?	.865			.753	There is often confusion about responsibilities, assignments or unclear relationships between team members.	-.729			.531
I agree on the team's goal and objectives.	.837	.152		.724	How certain are the team members about their individual roles in relations to the team as a whole?	.728			.530
To what extend do the rest of the team understand the team's goal and objectives?	.718	.475		.741	Does the team have necessary complementary skills and expertise?	.658			.434
The team meets outlined team goals and objectives.	.207	.784		.658	How willing are the team members to take initiative for unassigned tasks, problems or urgent situations that might need member attention?	.595			.354
Are the team goals and objectives of the team consistent with team members?	.179	.712		.540	There are clear agreements on roles and responsibilities.	.592			.351
Please rate the commitment of your team members in achieving team goals and objectives.		.778		.610					
Eigenvalue	2.657	1.369			Eigenvalue	2.199			
% of Total Variance	44.281	22.811			% of Total Variance	43.984			
Total Variance		67.092%			Total Variance	43.984%			

Table 6.2b. Factor analysis results for team effectiveness construct (Team Communication & Team Leadership)

D3: Team Communication	Loadings			Communality	D4: Team Leadership	Loadings			Communality
	Factor 1	Factor 2	Factor 3			Factor 1	Factor 2	Factor 3	
Are the communications in and outside meetings effective?	.632	0.527		.677	We collaborate by sharing ideals to ensure that our team's responsibilities are performed in an effective manner.	.870			.756
Please rate the overall outcome of team meetings.	.715	0.377		.653	How do the project manager feels about sharing leadership, decision making and responsibilities with members?	.819	.177		.702
Please describe the meeting process within your team.	.770			.599	The project manager is comfortable with the concept of shared leadership with team members	.410	.359		.297
Is communication between team members open and honest?	.217	.761		.626	My project manager coaches me when I have difficulty performing a task. In addition, he/she also helps me to perform my job better on a regular basis.		.750		.562
Please describe the communication between team members.	.757			.573	The project manager and team members spend time in clarifying what they expect from each other.	.129	.686		.488
How friendly and easy to approach other people on your team?		.795		.632	Project manager does not exercise good judgment and does not offer good advice.	.167	.625		.418
Eigenvalue	2.734	1.025			Eigenvalue	2.129	35.488		
% of Total Variance	45.569	17.088			% of Total Variance	1.095	18.250		
Total Variance		62.656%			Total Variance		53.738%		

Table 6.2c. Factor analysis results for team effectiveness construct (Trust and Values & Team Relationship)

D5: Trust and Values	Loadings			Communality	D6: Team Relationship	Loadings			Communality
	Factor 1	Factor 2	Factor 3			Factor 1	Factor 2	Factor 3	
Team members actively show appreciation for, support and affirm one another.	.773	0.328	0.193	.742	How well does your team handle conflicts?	.787	-.108		.631
Please rate the level of trust between members of the team	.383	0.729		.803	Does the team work constructively on issues arise until they are resolved?	.794	.229		.682
Please rate the level of trust between the project manager and team members	.374	.746	-0.325	.680	Team members care about the welfare of each others.	.395	-.580		.492
I feel valued as a team member.	.714		0.512	.773	Do the team members agree on how decisions were made within the team regarding project matters?	.148	.832		.715
All team members are treated with respect.	.709		-.178	.536	Team members do not seems concerned with helping each other, carrying their fair share of work, pulling in the same directions, or looking out for the team.	.359	-.198		.168
Do you feel that your contributions in terms of information or ideas are recognized or utilized?			.886	.791					
How important is it to have trust in your team?	-.223	0.698	.266	.608					
Eigenvalue	2.593	1.284	1.056		Eigenvalue	1.57	1.118		
% of Total Variance	37.038	18.343	15.088		% of Total Variance	31.409	22.369		
Total Variance			70.470%		Total Variance		53.778%		

6.2.1.2. Validity and Reliability Analysis

In general, the closer the value Cronbach's alpha coefficient is to 1.0, the more reliable is the instrument. As stated in Nunnally and Bernstein (1994), a Cronbach's alpha value equal to or greater than 0.70 is considered satisfactory. Reliability estimates between 0.70 and 0.60 are acceptable; whereas, an alpha below 0.60 usually is regarded as unacceptably low. Table 6.3 details the values of Cronbach's alpha for the items included in each construct. In conclusion, except for the Team Relationship factor, the reliabilities for each dimension are considered acceptable (greater than 0.60). The alpha value of the Team Relationship factor is 0.394, which is low, mainly due to items that have a multidimensional structure, which results in a lack of internal consistency.

For this study, attempts to establish validity have been made by developing questionnaires based on the literature review, existing survey instruments, and team assessments from other fields, including psychology, medicine, and education. For an instrument to be valid, it needs to be reliable; however, reliability does not guarantee validity. The statistical methods discussed earlier help to establish validity; that is, they ensure what are intended to be measured, in fact, are measured correctly using suitable scales.

According to Field (2005), a Cronbach's alpha value less than 0.30 should be dropped, since it means there is an item that does not correlate with the overall scale. As depicted in Table 6.3, the Cronbach's alpha value for Team Relationship is slightly low (0.394), but is not less than 0.30. To improve the alpha value, an item that has a low value in the "Alpha If Item Deleted" should be removed. Based on these results, adjustments of this nature can be undertaken for subsequent research.

Table 6.3. Reliability analysis results for team effectiveness constructs

Team effectiveness construct	Reliability (alpha coefficient)
Team Goals and Objectives	0.730
Team Leadership	0.629
Team Roles and Responsibilities	0.621
Team Communication	0.758
Team Relationship	0.394
Trust and Values	0.629

Based on the results obtained from the pretesting process, it was determined several constructs do have more than one underlying factor. This is mainly due to one or more of the following circumstances:

- The rating and scales of some questions are unsuitable.
- Some items may be double- and triple-barreled questions.

Therefore, to ensure the Team Effectiveness Survey possesses a high level of item quality, all comments and suggestions provided by the respondents from the pretesting phase should be addressed and implemented. To improve the reliability and consistency of the survey, appropriate measures should be taken—namely to rewrite the questionnaire to improve clarity for respondents, changing and adjusting the ratings and scales accordingly, and dropping items with low values in the "Alpha If Item Deleted" section of the SPSS output for Cronbach's alpha.

After the suggested measures were taken, the survey is used for data collection. Another round of reliability analysis is performed on the data obtained to examine if the reliability of the survey improved. Table 6.4 illustrates the new Cronbach's alpha values for each of the Team Effectiveness Constructs.

Table 6.4. Reliability analysis results for team effectiveness constructs (2nd round)

Team effectiveness construct	Reliability (alpha coefficient)
Team Goals and Objectives	0.910
Team Leadership	0.900
Team Roles and Responsibilities	0.909
Team Communication	0.925
Team Relationship	0.892
Trust and Values	0.874

The reliability analysis performed suggested the overall team effectiveness survey does have a very strong Cronbach's alpha coefficient value (>0.80). This indicates the Team Effectiveness Survey is reliable for future usage.

6.3. RESULTS FOR RESEARCH QUESTION 2

6.3.1. Which Team Effectiveness Factors Have The Greatest Variation Between Project Teams?

One-way analysis of variance (ANOVA) is chosen to answer this research question. This statistical test helps make a conclusion, whether different teams had an effect of the team effectiveness factors. Based on the SPSS output of one-way ANOVA for each team effectiveness factor, discussions on the results is divided into several sections.

6.3.1.1. Descriptive Statistics

Appendix C contains the descriptive statistics of different team effectiveness factors for each of the teams.

a) Team Goals and Objectives:

The lowest mean between 16 teams is 3.42 (Team 9), and the highest mean is 5.00 (Team 11). The standard deviation for Team 9 is 0.29, and the standard deviation for Team 11 is zero. Team 11 has the highest mean and zero standard deviation, in addition to the same average responses for the lower bound and upper bound (5.00). On the other hand, the mean of Team Goals and Objectives for the Team 9 is between 2.96 and 3.88.

b) Team Leadership:

Under the Team Leadership variable, almost all teams have a mean above 4.00 (14 team); whereas, Team 9 still has the lowest mean (2.88) compared to the other teams. The team with the highest mean is Team 1 (4.95). Team 14 has the lowest standard deviation (0.06) and the highest standard deviation is 0.78 (Team 10). Team 10 reported a minimum mean value of leadership (2.97) and a maximum value of 5.27, which has a broader range compared to the other teams.

c) Team Roles and Responsibility:

The mean value for team roles and responsibility ranges from 3.35 (lowest mean – Team 9) and highest of 4.98 (Team 3). Lowest standard deviation determined Team 3

(0.05) and the highest standard deviation from Team 7 (0.79). The higher the standard deviation value, the higher is the standard error. Since the confidence interval depends on the standard error of the mean, the confidence interval for Team 7 is wider than the other teams.

d) Team Relationship:

All teams' mean values for team relationships range from 2.94 to 4.78. Team 1 has the highest mean value and Team 9 has the lowest mean value. Team 7 (0.97) reported the highest standard deviation and the lowest standard deviation value is 0.06 (Team 9). This resulted in Team 7 with the widest confidence interval and Team 9 with the smallest confidence interval between the teams.

e) Trust and Values:

All teams reported high mean values (> 4.00), except for Team 9 (3.11). The lowest standard deviation is reported from Team 11 (0.06) and highest from Team 7 (0.76). Team 7 reported a minimum mean value of leadership (3.42) and maximum value of 5.30, which has the broadest range compared to the other teams.

f) Team Communication:

There are two teams with mean values below 4.00, namely Teams 9 and 15. The team with highest mean value is Team 11 with 4.70. Team 9 has a zero standard deviation and standard error; whereas, Team 15 has 0.83 for standard deviation and 0.41 of standard error of means. This resulted in Team 15 with the widest confidence interval and Team 9 with a zero confidence interval among the teams (lower and upper bound has the same value of 3.56).

6.3.1.2. Homogeneity of Variance

One of the assumptions for the one-way ANOVA is assuming the variances within the groups compared are similar. In SPSS, tests of similar variances can be determined from

Levine's Test of Homogeneity of Variances. If the significance value is determined greater than 0.05, then homogeneity of variances is assumed. Table 6.5 illustrates the summary of the significance value from Levine's Test of Homogeneity of Variances.

Table 6.5. Significance values from the Levine's Test of Homogeneity of Variances for each team effectiveness factors

Team Effectiveness Factors	Significance value from Levine's Test	Homogeneity of variances assumed?
Team goals and objectives	0.007	No
Team leadership	0.001	No
Team roles and responsibility	0.001	No
Team relationship	0.000	No
Trust and values	0.005	No
Team communication	0.000	No

Since none of the team effectiveness factors have values greater than 0.05, the assumption of homogeneity variances is violated. Therefore, the next step would be to examine the Robust Tests of Equality of Means Table, using an adjusted F test such as Welch statistics or the Brown-Forsythe statistics. If the adjusted F ratio is determined significant ($p < 0.05$), the null hypothesis is rejected. Thus, at least one of the teams' mean is significantly different from the other teams (or at least two of the team means are significantly different from each other). Table 6.6 indicates the significant values for both Welch and Brown-Forsythe statistics for all team effectiveness factors.

Based on Table 6.6, there are no values obtained for significant values from both Welch and Brown-Forsythe tests for both team effectiveness factors; Team Goals and Objectives and Team Communication. The Robust Tests of Equality of Means cannot be performed for Team Goals and Objectives and Team Communication because at least one team from each factor has a zero variance. Since all team effectiveness factors are assumed to have significant values less than 0.05 ($p<0.05$), the null hypothesis is rejected. Also, there are differences in the means across teams for each of the team effectiveness factors. Therefore, additional interpretation on a post hoc test is necessary to determine which team's means is significantly different from the other teams' means.

Table 6.6. Significance values from the Robust Tests of Equality of Means for each team effectiveness factors

Team Effectiveness Factors/Statistic Tests	Welch	Brown-Forsythe
Team Goals and Objectives	.	.
Team Leadership	0.000	0.001
Team Roles and Responsibility	0.000	0.001
Team Relationship	0.000	0.000
Trust and Values	0.000	0.000
Team Communication	.	.

There are several post hoc tests that can be used in this analysis. Bonferroni test is a good choice when homogeneity of variances is assumed, since it is a conservative test and tends to not over report significant findings. However, the assumption of equality of variances is not met in this case; therefore, Tamhane's test is preferred.

The Multiple Comparisons in SPSS one-way ANOVA shows which teams differ from each other. Table 6.7 consists of teams that have different means from other teams and are significant. It summarizes the mean differences of the teams to simplify the analysis. Among all team effectiveness factors studied, only four factors show at least one team is significantly different from another team. Under the Team Goals and Objective factor, there is a significant difference in team means between Team 3 and Team 8 with Team 9 ($p = 0.041$ and 0.040, respectively). The Roles and Responsibilities have the most number of teams that have a significant difference. Team 3 has 1.625 units higher in means compared to Team 9. Besides Team 3, there are another four teams that also have mean differences under Team Roles and Responsibilities. Team 11 has a higher mean than Team 9 for Trust and Values (1.86111). Other teams that have different means from Team 9 for Trust and Values include Teams 1, 4, and 8. Finally, there is only one team that has a significantly different means to another team for Communication—Team 1 to Team 9 ($p=0.027$).

Table 6.7. Summary of multiple comparisons for all teams with significant findings using Tamhane's test

Team Effectiveness Factor	Team Number (I)	Team Number (J)	Mean Difference (I-J)	Significant value
Team Goal and Objective	3	9	1.50000	0.041
	8	9	1.18939	0.040
Team Roles and Responsibility	1	9	1.39000	0.004
	3	9	1.62500	0.017
	8	9	1.12273	0.001
	11	9	1.55000	0.001
	14	9	1.35000	0.002
Trust and Values	1	9	1.80000	0.000
	4	9	1.31746	0.024
	8	9	1.22222	0.003
	11	9	1.86111	0.001
Communication	1	9	0.88889	0.027

6.3.1.3. *Eta*-within (η_{within}) and *Eta*-between ($\eta_{between}$)

The proportion of variation between the teams can be measured using $\eta_{between}$; whereas, η_{within} measures the proportion of variations within teams. Based on the calculation of both $\eta_{between}$ and η_{within} from the one-way ANOVA results, Table 6.8 is developed. Based on Table 6.8, all variables, except for team communication (COMM), were significant at the .05 level. This show the significant variables have more variations between the teams rather than within teams. Therefore, it would be more meaningful and valid to conduct a further analysis using group means to represent a project team.

Table 6.8. Eta-within and Eta-between for all team effectiveness factors

No	Variable Name	Rsquared (SS_b/SS_t)	Eta-Between (R)	Eta-Within (1-Rsquared)	Significance level for F-Test of Eta-Between
1	Team Relationship	0.480	0.693	0.520	0.000
2	Trust and Values	0.460	0.679	0.540	0.000
3	Team Leadership	0.443	0.665	0.557	0.000
4	Team Roles and Responsibility	0.439	0.663	0.561	0.000
5	Team Goals and Objectives	0.394	0.628	0.606	0.001
6	Team Communication	0.331	0.575	0.669	0.067

6.3.1.4. Non-parametric testing – Kruskall-Wallis Test

Because the sample size is small (16 teams), normality of the data is not assumed, since small deviations can occur from the normal distribution. Therefore, it would be a good idea to perform non-parametric tests to cross-check the results from the one-way ANOVA. The non-parametric test substituting one-way ANOVA is called the Kruskal-Wallis test and uses the ranks of observations. This test allows the comparison of more than two independent groups. Based on Table 6.9, all the team effectiveness factors (Team Goals and Objectives, Team Leadership, Team Roles and Response, Team Relationship, Trust and Values, as well as Team Communication) were tested to determine if their distributions are the same across the 16 teams. It was discovered five of the six factors do have different distributions between the teams. Only Team Communication does not have any different distribution among the teams. In comparison to the one-way ANOVA results in the previous section, Team Communication shows the smallest mean difference among the other factors. The small mean difference in Team Communication (one-way ANOVA analysis) indicates the variance between teams is small and has no distinct difference in means across the teams. Based on the overall analysis of a one-way ANOVA, it can be concluded that Team Goals and Objectives, Team Roles and Responsibilities, and Trust and Values, were found to have the

greatest variation among project teams. Table 6.9 illustrates the output from the Kruskal-Wallis test performed in SPSS.

Table 6.9. Results from Kruskal-Wallis test

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of goalsandobjectives is the same across categories of Team number .	Independent-Samples Kruskal-Wallis Test	.005	Reject the null hypothesis.
2	The distribution of leadership is the same across categories of Team number .	Independent-Samples Kruskal-Wallis Test	.024	Reject the null hypothesis.
3	The distribution of rolesandresponse is the same across categories of Team number .	Independent-Samples Kruskal-Wallis Test	.003	Reject the null hypothesis.
4	The distribution of teamrelation is the same across categories of Team number .	Independent-Samples Kruskal-Wallis Test	.015	Reject the null hypothesis.
5	The distribution of trustvalues is the same across categories of Team number .	Independent-Samples Kruskal-Wallis Test	.008	Reject the null hypothesis.
6	The distribution of comm is the same across categories of Team number .	Independent-Samples Kruskal-Wallis Test	.112	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

6.3.1.5. Discussion

The parametric (one-way ANOVA) and non-parametric (Kruskal – Wallis test) tests yielded similar results, which indicate Team Communication is not significant (rejected H_o = the means of the team effectiveness factors of the 16 groups are equal). Team Goals and Objectives, Team Roles and Responsibilities, and Trust and Values were determined to have the greatest variation among project teams. Since five out of the six variables do have more variations between the teams, it would be more meaningful to use group means for the team-level analysis to answer the next research questions.

6.3.2. Which Team Effectiveness Factors Have a Significant Relationship With Project Performance?

As discussed in Chapter 4, it is relevant to examine the nature of the relationship between the variables before further analyses are performed. Therefore, the scatter plot is used to determine if there is a linear relationship between the variables. Figure 6.7 shows the scatter plot matrix consisting of the variables used in this study. Each small chart illustrates the correlation between the given pair of variables (listed on the left side and below). The dots represent the project teams. The cluster of project teams in each small chart can be used to obtain a sense of whether the two variables are positively, negatively, or uncorrelated. The yellow cell indicates the "divider" of the matrix, where all variables that correlate with themselves are equivalent to 1. The upper-right part of the matrix is a mirror image of its lower-left side. The lower-left side of the matrix is used for interpretation in this section. Based on Figure 6.7, there are positive linear relationships among the variables, specifically indicated by the aqua colored cells for relationships between independent variables and the green colored cells for relationships between the dependent variables. Another association between the variables can be observed in the purple colored cells—between the dependent and independent variables. The remainder of the cells did not show any association or relationship among the variables.

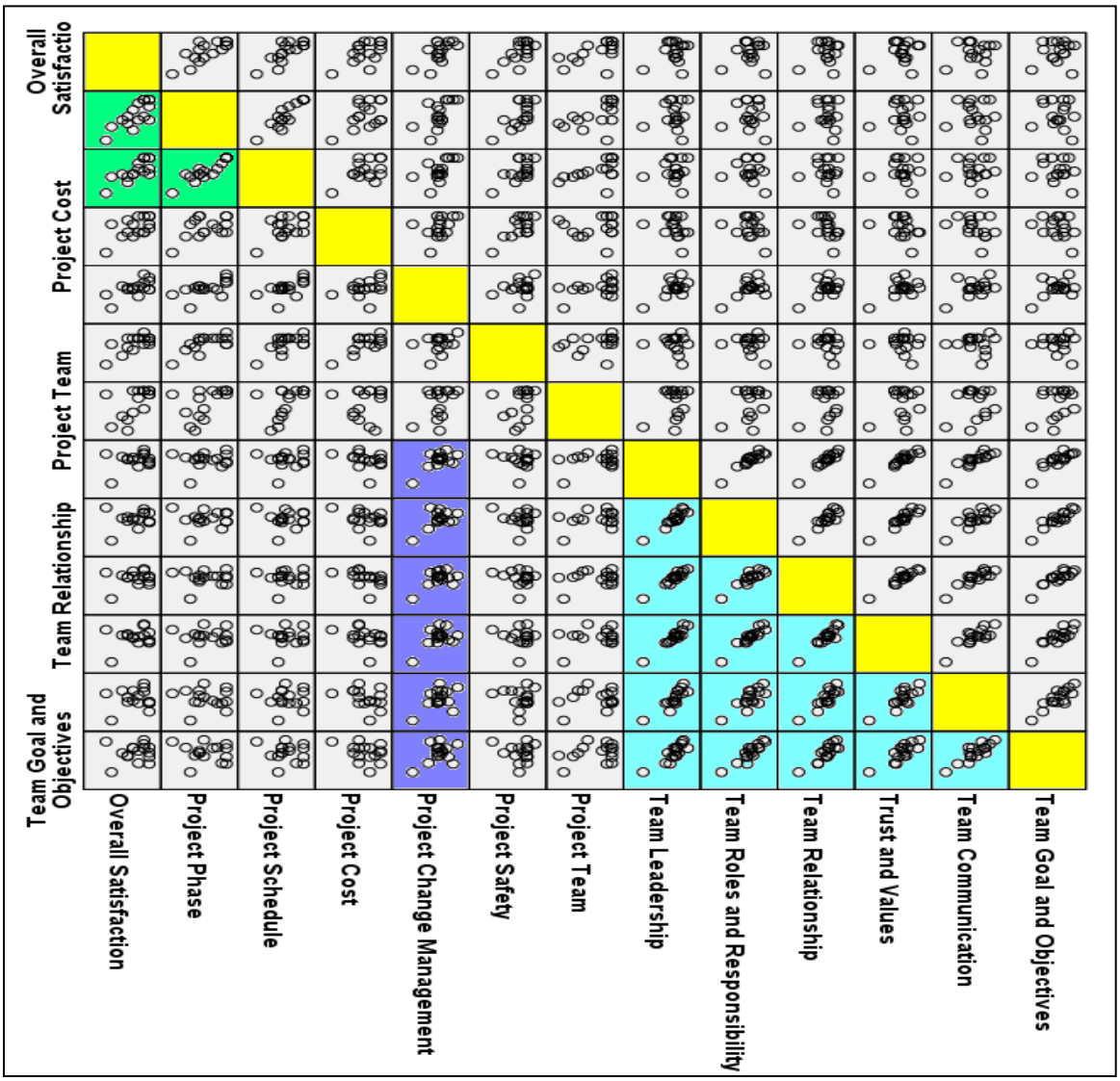

Figure 6.7. Scatterplot matrix

The relationships among the variables from the different colored cells are illustrated in Table 6.10. All independent variables have an association or relationship among themselves, where the increase of an independent variable resulted in an increase of the other independent variables (aqua colored cells). The green colored cells indicate the dependent variables that have a relationship among themselves. They are between a) Overall Satisfaction and Project Phases & Tasks, b) Overall Satisfaction and Project Schedule, and c) Project Schedule and Project Phases & Tasks. In terms of association between the independent variables and dependent variables, all independent variables (Team Goals and Objectives, Team

Communication, Trust and Values, Team Relationship, Team Roles and Responsibilities and Team Leadership) are found to have a relationship with Project Change Management (purple colored cells).

Table 6.10. Relationship between independent variables from scatterplot matrix

Y-Axis	Increase/Decrease	X-axis	Increase/Decrease
Team Goals and Objectives	↑	Team Communication	↑
		Trust and Values	↑
		Team Relationship	↑
		Team Roles and Responsibilities	↑
		Team Leadership	↑
Overall Satisfaction	↑	Project Phases & Tasks & Tasks	↑
		Project Schedule	↑
Team Leadership	↑	Project Change Management	↑
Trust and Values	↑		
Team Relationship	↑		
Team Roles and Responsibilities	↑		
Team Communication	↑		
Team Goals and Objectives	↑		

Once the pattern of relationships has been identified through the scatter plot matrix, further testing is required to quantify the relationships between the variables. Therefore, associations between variables can be determined using a bivariate correlation. The Pearson correlation coefficient, r, can take values between -1 through 0 to +1. The sign (+ or -) of the correlation affects its interpretation. Coefficient value of -1 indicates a perfect negative correlation; +1 indicates a perfect positive correlation, and 0 shows no correlation at all. When the correlation is positive ($r > 0$), as the value of one variable increases, so does the other. These numbers measure the strength and direction of the linear relationship between the two variables.

Based on Table 6.11, there is a positive correlation between the variable Project Change Management with different Team Effectiveness Factors. Team Leadership and Project

Change Management are highly correlated (r = .654, p = ≤.01). In addition to Team Leadership, there are another three Team Effectiveness factors that also have high correlations with Project Change Management—Team Relationship (r = .531, p = ≤.05), Team Roles and Responsibilities (r = .558, p = ≤.05) and Trust and Values (r = .525, p = ≤.05). Therefore, the significant variables (Team Leadership, Team Roles and Responsibilities and Trust and Values) are further analyzed to determine which is the most significant predictor in Project Change Management.

Table 6.11. Summary of Pearson's correlation coefficient using team means

Variable Name	Overall Satisfaction	Project Phases & Tasks	Project Schedule	Project Cost	Project Change Management	Project Safety	Project Team
Team Goals and Objectives	.130	-.134	-.161	-.334	.398	-.105	.315
Team Leadership	.250	.118	.074	-.310	.654**	-.121	.304
Team Relationship	.206	.018	-.018	-.415	.531*	-.164	.241
Team Roles and Responsibilities	.184	.010	-.087	-.318	.558*	-.182	.313
Trust and Values	.235	.096	-.003	-.353	.525*	-.104	.244
Team Communication	.111	-.057	-.004	-.356	.456	-.075	.146

**p<0.01, *p < 0.05. Other p-values are greater than 0.05.

6.3.3. Which Team Effectiveness Factor is The Best Predictor In Project Performance?

The approach identified to answer this research question is to perform an analysis on two levels. Due to the nature of the sample used (team and its members), a multilevel analysis is suitable. It examines data on the team level (among project teams) and on the individual level (across project teams).

6.3.3.1. Analysis on the Team Level

From section 6.3.2, based upon the results obtained from the scatter plot matrix and Pearson correlation coefficient table, one aspect from Project Performance is identified. This only aspect has a strong association with four independent variables:

1) Team relationship vs. Project change management
2) Team roles and responsibilities vs. Project change management
3) Trust and values vs. Project change management
4) Team leadership vs. Project change management

Regression Analysis 1 (Results from Bivariate Correlation test – Enter Method)

Several regression analyses are performed to identify which team effectiveness factors are the best predictors for project change management. For a linear regression, the best method to interpret the model is by looking at the value for R^2. It is an overall measure on the strength of association and does not reflect the extent to which any particular independent variable is associated with the dependent variable. Table 6.12 illustrates the R^2 value from the first linear regression. The value of R^2 is 0.66, which means 66% of the variance in Project Change Management can be explained by variation in Team Relationship, Team Roles and Responsibilities, Team Leadership, and Trust and Values.

Table 6.12. Model summary for Linear Regression 1

Model	R	R^2	Adjusted R^2	Std Error of the Estimate
1	.816	.666	.545	.51596

Moreover, as shown in Table 6.13, the overall model to predict Project Change Management is statistically significant ($F(4,11) = 5.487$, $p = 0.011$). Looking at the predictors individually, Team Roles and Responsibilities ($\beta = .070$, $p > .05$), Team Relationship ($\beta = -2.042$, $p > .05$), and Trust and Values ($\beta = -2.198$, $p > .05$) are insignificant predictors for Project Change Management. Team Leadership ($\beta = 4.771$, $p < .05$) is found the best predictor for this model.

Table 6.13. ANOVA for Linear Regression 1

Model	Sum of Squares	df	Mean Squared	F	Sig.
Regression	5.842	4	1.461	5.487	.011
Residual	2.928	11	.266		
Total	8.771	15			

The regression diagnostics examine several assumptions—normality, homoscedasticity, linearity, and independence. A normal probability plot (P-P Plot) of the standardized residuals provides an indication of whether or not the assumption of normality of the random errors is appropriate. In the P-P plot, a perfectly normal distribution would show a straight line sloping upward at a 45-degree angle. Minor departures from this are expected from normal patterns of variability. Based on Figure 6.8, the standardized residuals are not too far from the straight line. Therefore, the normality assumption is satisfied. Additionally, a visual inspection of the normal probability plot did not show any major outliers or other irregularities, therefore, providing some evidence of homoscedasticity.

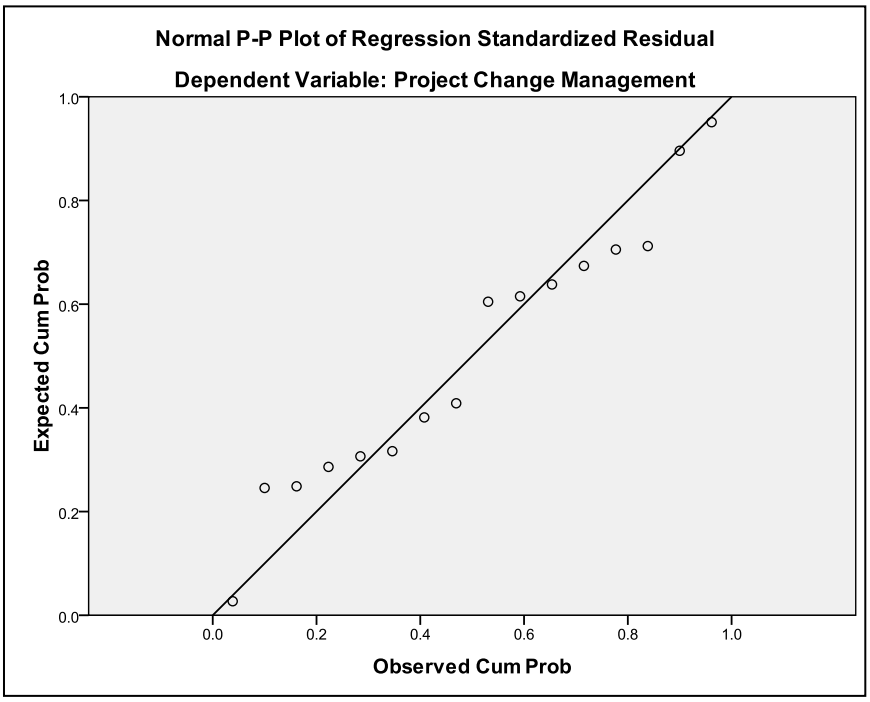

Figure 6.8. Normal probability plot of standardized residuals for Linear Regression 1

Besides regression diagnostics, another component that should be examined is collinearity or the collinearity issue. As discussed in Chapter 4, the collinearity issue arises when the variables are highly correlated with each other to predict the dependent variable. Table 6.14 shows collinearity is present in the model.

Collinearity is examined, based on the value of Tolerance and Variance Inflation Explained (VIF). A tolerance close to one means little collinearity; whereas, a value close to zero suggests collinearity may be a threat. The reciprocal of the tolerance is known as the *Variance Inflation Factor (VIF)*. This measures the amount of increase for a variance of an estimated regression coefficient, due to collinearity. The squared root of the VIF indicates how large is the standard error, compared with what it should be, if that variable was uncorrelated with the other independent variables in the equation. If VIF values are greater than 10, this signifies a collinearity problem (Yaffee 2004).

According to Table 6.14, the tolerance values for four independent variables (Team Roles and Responsibilities, Team Relationship, Trust and Values and Team Leadership) are .103, .073, .059, and 0.41 respectively. This implies there are *some* nearly collinear relations for

Team Roles and Responsibilities and Team Relationship variables, and a collinearity problem for variable most of the variables.

Table 6.14. Collinearity statistics for Linear Regression 1

Model	Unstandardized Coefficients		Sig.	Collinearity Statistics	
	B	Std Error		Tolerance	VIF
Constant	.892	1.642	.598		
Team Roles and Responsibilities	.070	1.064	.949	.103	9.707
Team Relationship	-2.042	1.123	.096	.073	13.656
Trust and Values	-2.198	1.292	.117	.059	16.907
Team Leadership	4.771	1.431	.006	.041	24.569

Even though the overall model is significant and has multicollinearity issues, the fact the value for R^2 is non-trivial helps demonstrate some relationships in the model are worth pursuing further.

In summary, it was determined from the analysis that Team Leadership is the best predictor for Project Change Management. According to Table 6.14, the regression model showed a high positive correlation ($r = 0.816$, $p < .05$) with Project Change Management. Linear regression demonstrated a significant positive relationship ($F(4,11) = 5.487$, $p < .05$) using the Enter Method. The regression equation for this model is demonstrated as follows:

$$\hat{y} = .892 + 4.771\, x_1 + 0.70\, x_2 - 2.042\, x_3 - 2.198\, x_4 \quad (16)$$

where x_1 = Team Leadership,

x_2 = Team Roles and Responsibility,

x_3 = Team Relationship,

x_4 = Trust and Values.

From the results obtained, it is determined Team Leadership is the best predictor of Project Change Management. The other predictors are determined insignificant ($p > .05$). This indicates other factors are probably better predictors for Project Change Management than leadership within the team.

Regression Analysis 2 (Results from Bivariate Correlation test – Backward Method)

Another method for regression analysis is the Backward Method. SPSS enters all the predictor variables into the model. This regression method resulted in a partial model, as it begins with a full model and eliminates the variables that do not significantly enter the regression equation. This procedure is then repeated until only useful predictor variables remain in the model. The four predictor variables are used in this model (Team Roles and Responsibilities, Team Relationship, Team Leadership and Trust and Values) with Project Change Management as the dependent variable. According to Table 6.15, Team Roles and Responsibilities was removed from Model 2.

Table 6.15. Variables entered/removed from Linear Regression 2

Model	Variables Entered	Variables Removed	Method
1	Trust and Values, Team Relationship, Team Roles and Responsibilities, Team Leadership		Enter
2		Team Roles and Responsibility	Backward (criterion: Probability of F-to-remove >=.100)

As illustrated in Table 6.16, the Backward Method starts with a full model with an R^2 of .666. The variable, Team Roles and Responsibility, is eliminated during the first step because it has the lowest partial correlation for any variable, given all the predictor variables entered into the regression equation. Even after one predictor is eliminated, the value of R^2 remains the same. According to Table 6.17, the overall model in Model 2 was significant ($F(3,12) = 7.976$, $p < .05$).

Table 6.16. Model summary for Linear Regression 2

Model	R	R^2	Adjusted R^2	Std Error of the Estimate
1	.816[a]	.666	.545	.51596
2	.816[b]	.666	.582	.49409

Table 6.17. ANOVA for Linear Regression 2

Model	Sum of Squares	df	Mean Squared	F	Sig.
1 Regression	5.842	4	1.461	5.487	.011[a]
Residual	2.928	11	.266		
Total	8.771	15			
2 Regression	5.841	3	1.947	7.976	.003[b]
Residual	2.930	12	.244		
Total	8.771	15			

a. Predictors: (Constant). Trust and Values, Team Relationship, Team Roles and Responsibility, Team Leadership.

b. Predictors: (Constant), Trust and Values,Team Relationship, Team Leadership

c. Dependent Variable: Project Change Management

Based on the beta value in Table 6.18, the predictor Team Leadership ($\beta = 4.795$, $p < .05$) is significant. Therefore, it is a strong predictor for Project Change Management. Similarly with the Enter Method, it is also assumed this model met all assumptions (linearity, independence, homoscedasticity, and normality). The normal P-P plot (Figure 6.9) indicates the residuals are coming closer to the straight line, which indicates the assumption of normality is valid. Multicollinearity is still present, which indicates strong correlations between the predictors.

Table 6.18. Coefficients for Linear Regression 3

Model		Unstandardized Coefficients		Sig.	Collinearity Statistics	
		B	Std. Error		Tolerance	VIF
1	(Constant)	.892	1.642	.598		
	Team Leadership	4.771	1.413	.006	.041	24.569
	Team Roles and Responsibility	.070	1.064	.949	.103	9.707
	Team Relationship	-2.042	1.123	.096	.073	13.656
	Trust and Values	-2.198	1.292	.117	.059	16.907
2	(Constant)	.946	1.368	.503		
	Team Leadership	4.795	1.303	.003	.044	22.786
	Team Relationship	-2.048	1.072	.080	.074	13.549
	Trust and Values	-2.158	1.088	.071	.076	13.075

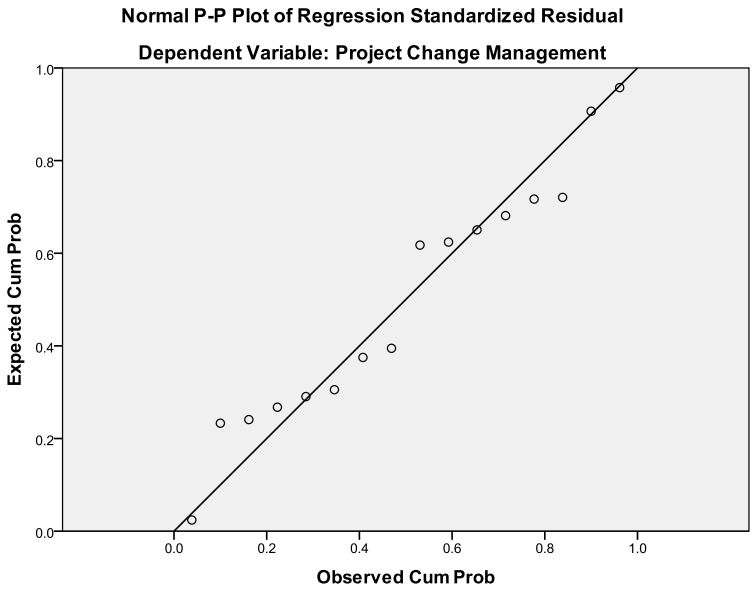

Figure 6.9. Normal probability plot of standardized residuals for Linear Regression 2

Therefore, from Table 6.18, it was determined in Model 2, Team Leadership is the best predictor among all other variables that comprise the composite variable. Model 2 has the following equation:

$$y = 0.946 + 4.795\, x_1 - 2.048\, x_2 - 2.158\, x_3 \quad , \qquad (17)$$

where x_1 = Team Leadership,

x_2 = Team Relationship,

x_3 = Trust and Values.

Discussion

Changes occurring on construction projects can lead to different issues within the construction project team. Poor coordination and management of change orders may increase dissatisfaction between the owner and the project team, and may even cause team members to enter disputes. Therefore, considering responses from the owner's perspective, it is important for the project team to have good leadership, especially when there are several change orders to be addressed. An effective project manager should be able to lead and ensure change orders are completed accordingly and within the expectations of the owner.

6.3.3.2. Analysis on the Individual Level

Section 6.3.3.1 explains in detail how to determine which team effectiveness factors explain variability in the project performance aspect, Project Change Management, on the project team level. Based on the results from the Correlation Bivariate analysis, it was determined there are four independent variables (predictors) that have the strongest association with Project Change Management on the team level. Because multilevel analysis is a common means of analyzing team-based data, an individual-level analysis should be performed as well. Therefore, this section discusses the findings of statistical analysis performed across the project teams (taking into consideration the individual responses from all teams). Because there are only 16 owner's representatives in this study and 83 project team members, the data set is disaggregated to allow for multilevel effects. According to Gelman and Hill (2007), replicating the values of the team level to allow a multilevel analysis is recommended. The best method to achieve this is to take the values of 16 observations individually and replicate the values according to the number of team members on each project team. In this manner, the number of observations at the team level is increased and the model will provide a better estimate of variance.

Prior to performing the regression analysis, it is important to conduct a correlation analysis to examine if there is a strong relationship between the independent variables and

the dependent variable (Project Change Management). It can be seen from Table 6.19 that all the predictors were highly correlated with the dependent variable on the individual level; therefore, it is wise to include all in the regression analysis.

Table 6.19. Correlations for variables (individual-level analysis)

	Pearson Correlation Projectchangemanagement	Sig. (1-tailed)
Project Change Management	1.00	.006
Team Goals and Objectives	.272	.000
Team Leadership	.443	.000
Team Roles and Responsibility	.383	.000
Team Relationship	.376	.000
Trust and Values	.359	.009
Team Communication	.259	.006

Regression Analysis 3 (Using All Independent Variables – Enter Method)

Because all independent variables are highly correlated with Project Change Management, they are included in the next regression analysis performed using the Enter Method. This model resulted in an R^2 value of 0.229, which means 22.9% of the variance in Project Change Management can be explained by variation in Team Goals and Objectives, Team Leadership, Team Relationship, Team Roles and Responsibilities, Communication, and Trust and Values (Table 6.20).

Table 6.20. Model summary for Linear Regression 3

Model	R	R^2	Adjusted R^2	Std Error of the Estimate
1	.479[a]	.229	.169	.62659

The regression analysis, based on Table 6.21 predicting Project Change Management from Team Relationship, Team Roles and Responsibilities, Team Goals and Objectives, Team Communication, Team Leadership, and Trust and Values, is statistically significant ($F(6,76) = 3.771$, $p = 0.002$). Based on the Beta values for the team effectiveness factors, only Team Leadership ($\beta = 0.594$, $p < .05$) is significant. Therefore, this indicates Team

Leadership is a strong predictor for Project Change Management on the individual level (Table 6.22).

Table 6.21. ANOVA for Linear Regression 3

Model		Sum of Squares	df	Mean Squared	F	Sig.
1	Regression	8.884	6	1.481	3.771	.002[a]
	Residual	29.839	76	.393		
	Total	38.723	82			

a. Predictors: (Constant). Comm, goalsandobjectives,trustvalues, rolesand response, teamrelation, leadership.

Table 6.22. Coefficients for Linear Regression 3

Model		Unstandardized Coefficients		Sig.	Collinearity Statistics	
		B	Std. Error		Tolerance	VIF
1	(Constant)	1.824	.681	.009		
	goalsandobjectives	-.296	.218	.180	.271	3.696
	leadership	.594	.270	.031	.169	5.907
	rolesandresponse	.249	.288	.390	.210	4.771
	teamrelation	.127	.281	.653	.194	5.143
	trustvalues	-.036	.266	.892	.225	4.440
	comm	-.217	227	.343	.396	2.523

For the regression diagnostics, it is assumed the model met all the assumptions (linearity, independence, homoscedasticity, and normality). The normal P-P plot (Figure 6.10) shows the residuals are closer to the straight line. On the other hand, as indicated in Table 6.22, the value of tolerance for all variables shows little collinearity. However, the values of VIF for all variables are less than 10, which signify that collinearity is not a threat.

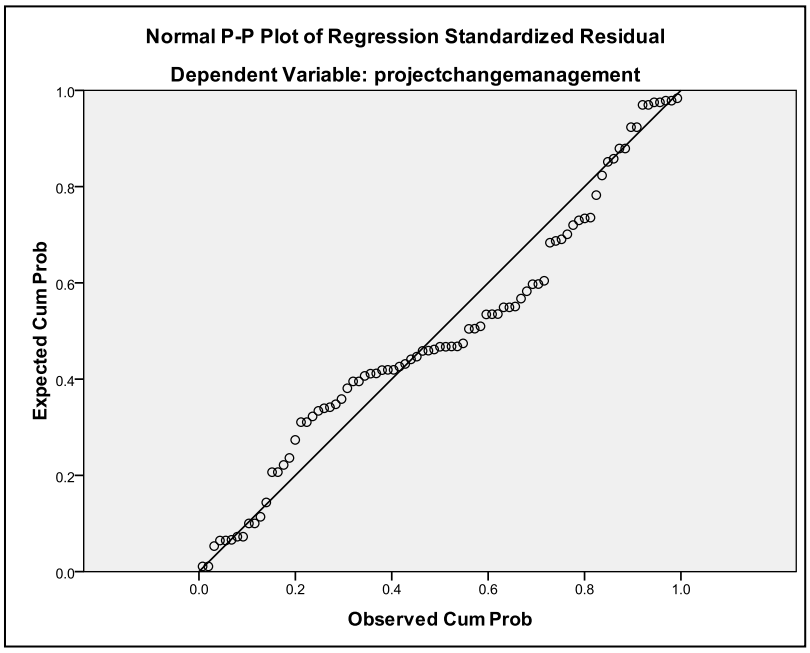

Figure 6.10. Normal probability plot of standardized residuals for Linear Regression 3

In summary, it was determined from the analysis that Team Leadership is the best predictor for Project Change Management. The regression model showed a medium positive correlation ($r = 0.479$, $p < .05$) with Project Change Management. Linear regression demonstrated a significant positive relationship ($F(6,76) = 3.771$, $p < .05$) using the Enter Method. Team Leadership increased approximately two-thirds of Project Change Management for each increase in team leadership ($\beta = 0.594$). Team Leadership only accounts for 22.9% of the variability of Project Change Management, which is minimal. The regression equation for this model is demonstrated as follows:

$$\hat{y} = 1.824 - 0.296\, x_1 + 0.594\, x_2 + 0.249\, x_3 + 0.127\, x_4 - 0.036\, x_5 - 0.217\, x_6 \quad (17)$$

where x_1 = Team Goals and Objectives

x_2 = Team Leadership,

x_3 = Team Roles and Responsibility

x_4 = Team Relationship

x_5 = Trust and Values and

x_6 = Team Communication.

From the results obtained, it is determined Team Leadership is the best predictor of Project Change Management. The other predictors are determined insignificant ($p>.05$). This indicates other factors are probably better predictors for Project Change Management than leadership within the team.

Regression Analysis 4 (Using All Independent Variables – Backward Method)

Previous regression analysis using the Enter Method for individual-level analysis indicated Team Leadership is the best predictor for Project Change Management. However, to ensure the outcome is consistent and to examine which variables are removed first, it is relevant to perform another regression using the Backward Method. Variables used are the same as for the Enter Method—all team effectiveness factors (Team Goals and Objectives, Team Roles and Responsibilities, Team Relationship, Team Communication, Team Leadership, and Trust and Values). Table 6.23 indicates that Trust and Values was removed from Model 2 and Team Relationship was removed from Model 3. This is followed by the removal of Team Communication, Team Roles and Responsibilities, and Team Goals and Objectives from the models remain.

Table 6.23.Variables entered/removed from Linear Regression 4

Model	Variables Entered	Variables Removed	Method
1	Team Goals and Objectives, Team Leadership, Team Roles and Responsibility Team Relationship Trust and Values Team Communication		Enter
2		Trust and Values	Backward (criterion: Probability of F-to-remove >=.100)
3		Team Relationship	Backward (criterion: Probability of F-to-remove >=.100)
4		Team Communication	Backward (criterion: Probability of F-to-remove >=.100)
5		Team Roles and Responsibility	Backward (criterion: Probability of F-to-remove >=.100)
6		Team Goals and Objectives	Backward (criterion: Probability of F-to-remove >=.100)

Based on Table 6.24, the Backward Method begins with a full model with an R^2 of .229. The variable, Trust and Values, is eliminated during the first step because it has the lowest partial correlation of any variable given all the predictor variables entered into the regression equation. The next variables eliminated, in order, were Team Relationship, Communication, Team Roles and Responsibility, followed by Team Goals and Objectives, which resulted in a model with R = .443. Table 6.25 indicates all models are determined significant ($F(1,14) = 6.336$, $p < .05$).

Table 6.23. Model summary for Linear Regression 4

Model	R	R Square	Adjusted R Square	Std Error of the Estimate
1	.479[a]	.229	.169	.62659
2	.479[b]	.229	.179	.62659
3	.477[c]	.227	.188	.61934
4	.468[d]	.219	.189	.61868
5	.460[e]	.211	.192	.61784
6	.443[f]	.197	.187	.61973

Table 6.25. ANOVA for Linear Regression 4

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.884	6	1.481	3.771	.002[a]
	Residual	29.839	76	.393		
	Total	38.723	82			
2	Regression	8.877	5	1.775	4.580	.001[b]
	Residual	29.846	77	.388		
	Total	38.723	82			
3	Regression	8.804	4	2.201	5.738	.000[c]
	Residual	29.919	78	.384		
	Total	38.723	82			
4	Regression	8.485	3	2.828	7.389	.000[d]
	Residual	30.238	79	.383		
	Total	38.723	82			
5	Regression	8.185	2	4.093	10.721	.000[e]
	Residual	30.538	80	.382		
	Total	38.723	82			
6	Regression	7.614	1	7.614	19.825	.000[f]
	Residual	31.109	81	.384		
	Total	38.723	82			

a. Predictors: (Constant), comm, goalsandobjectives, trustvalues, rolesandresponse, teamrelation, leadership
b. Predictors: (Constant), comm, goalsandobjectives, rolesandresponse, teamrelation, leadership
c. Predictors: (Constant), comm, goalsandobjectives, rolesandresponse, leadership
d. Predictors: (Constant), goalsandobjectives, rolesandresponse, leadership
e. Predictors: (Constant), goalsandobjectives, leadership
f. Predictors: (Constant), leadership

According to the Beta values in Table 6.26, the predictor Team Leadership in model 6 ($\beta = 0.489$, $p < .05$) is significant. Therefore, this indicates Team Leadership is a strong predictor for project change management. Similarly, with the Enter Method, it is also assumed this

model met all the assumptions posited (linearity, independence, homoscedasticity, and normality). The normal P-P plot (Figure 6.11) shows the points are becoming closer to the straight line. Multicollinearity is not an issue as the values ranges are smaller than 10.

Table 6.26. Coefficients for Linear Regression 4

Model		Unstandardized Coefficients		Sig.	Collinearity Statistics	
		B	Std. Error		Tolerance	VIF
1	(Constant)	1.824	.681	.009		
	goalsandobjectives	-.296	.218	.180	.271	3.696
	leadership	.594	.270	.031	.169	5.907
	rolesandresponse	.249	.288	.390	.210	4.771
	teamrelation	.127	.281	.653	.194	5.143
	trustvalues	-.036	.266	.892	.225	4.440
	comm	-.217	227	.343	.396	2.523
2	(Constant)	1.811	.670	.008		
	goalsandobjectives	-.297	.217	.174	.271	3.685
	leadership	.585	.259	.027	.181	5.535
	rolesandresponse	.238	.276	.391	.225	4.448
	teamrelation	.117	.269	.666	.208	4.798
	comm	-.219	225	.333	.399	2.506
3	(Constant)	1.836	.664	.007		
	goalsandobjectives	-.273	.208	.194	.290	3.444
	leadership	.635	.231	.007	.226	4.431
	rolesandresponse	.253	.273	.356	.228	4.381
	comm	-.200	.219	.365	.415	2.409
4	(Constant)	1.543	.581	.010		
	goalsandobjectives	-.306	.205	.139	.299	3.339
	leadership	.553	.212	.011	.266	3.756
	rolesandresponse	.241	.272	.379	.229	4.369
5	(Constant)	1.778	.516	.001		
	goalsandobjectives	-.221	.180	.225	.386	2.593
	leadership	.657	.176	.000	.386	2.593
6	(Constant)	1.540	.480	.002		
	leadership	.489	.110	.000	1.000	1.000

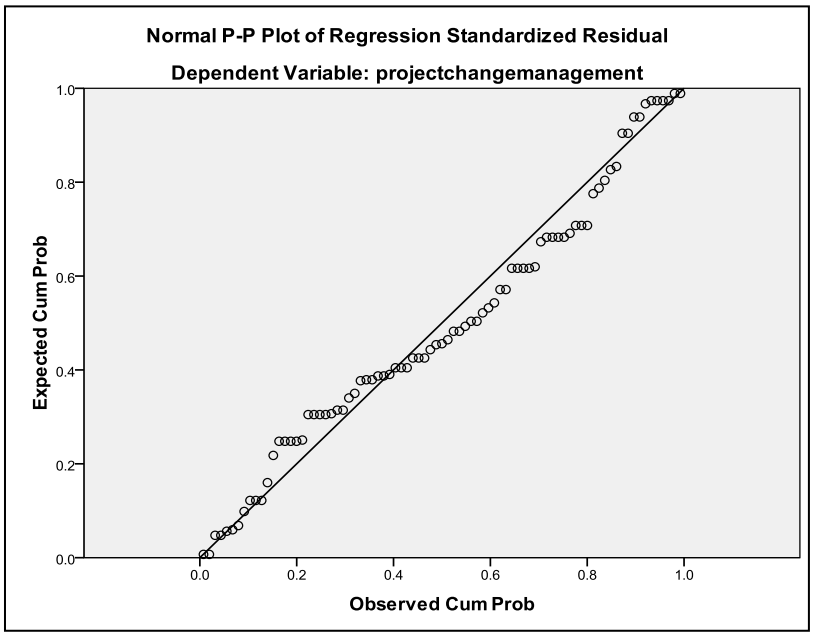

Figure 6.11. Normal probability plot of standardized residuals for Linear Regression 4

Therefore, from Table 6.26, it was determined in Model 6, Team Leadership is the best predictor among all other independent variables—the team effectiveness factors. Model 6 utilized the following equation:

$$y = 1.540 + 0.489\, x_1 \quad , \tag{18}$$

where x_1 = Team Leadership, one of the team effectiveness factors. Based on the regression analyses performed on the individual level, it can be summarized the best predictor for Project Change Management is Team Leadership. The regression analyses performed for the individual-level analysis using the Enter and Backward methods resulted in the same final model. Both methods indicate Team Leadership is the best predictor for Project Change Management.

Based on the regression analyses performed on the individual level, it can be summarized the best predictor for Project Change Management is Team Leadership.

Discussion

Change orders on construction projects include different types of services, such as preparation, reproduction, and distribution of drawings and specifications, negotiations with relevant parties pertaining costs, coordination of communications, approvals, and record

keeping relative to changes occurring throughout the project, as well as revisions and recommendations relative to these changes. The effectiveness level of change management can be improved when effective team leadership is exercised within the project team. It is essential for the project manager to ensure that the services related to change orders are completed accordingly, and within the given timeframe. Problems that arise on the jobsite related to managing changes should be addressed promptly and to the satisfaction of the owner.

6.4. RESULTS FOR RESEARCH QUESTION 3

6.1.1. How to Model Team Effectiveness in Construction?

Research Question 3 looks into how team effectiveness in construction project can be modeled. Prior to developing the model, it is essential to gather all findings obtained from the statistical analysis. The results obtained from the statistical analysis can be summarized into the following:

- It was determined that Project Change Management was the most significant among other project performance aspects with regards to team effectiveness. Other aspects examined (Owner Satisfaction, Project Cost, Project Schedule, Project Phases & Tasks, Project Safety, and Project Team) do not have any association with any of the team effectiveness factors (team goals and objective, team leadership, team roles and responsibilities, team relationship, trust and values, and communication).
- On the individual-level analysis (responses gathered from construction project team members as individuals), all team effectiveness factors were determined significant with Project Change Management. Based on the regression analysis performed for the regression, the amount of variance explained by the predictors accounted for 22.9%.

Because the outcome from this study highlights the relationships among the team effectiveness factors with Project Change Management, it is necessary to provide a better understanding in terms of their associations. For this aspect, a semi-partial correlation is better suited. Through a semi-partial correlation, measurement of association between two

continuous variables can be determined, while controlling for the other variables. Additionally, it provides how much each independent variable contributes to the R^2 value of the model. Table 6.27 displays the squared partial correlations for each team's effectiveness factors.

Table 6.27. Semi partial coefficients for Linear Regression 4

Model		All predictors	
		Part Correlations	Squared semi-partial Correlation
1	(Constant)		
	Team Goals and Objectives	-.136	.0185
	Team Leadership	.222	.0493
	Team Roles And Responsibility	.087	.0076
	Team Relationship	.045	.0020
	Trust And Values	-.014	.0002
	Team Communication	-.096	.0092

The squared partial correlations can be interpreted as the proportion of the criterion variance associated uniquely with the predictor. The correlations values in Table 6.27 are used to develop a better model to illustrate the variance accounted by the team effectiveness factors. Based on Figure 6.12, the entire planetary gear illustrates the variance accounting for Project Change Management (R^2 = .229). Team Leadership is the main predictor of Project Change Management, and it is the main element in the planetary gear. Other team effectiveness factors are illustrated by the other gears surrounding the Team Leadership gear. Among the six team effectiveness factors, Trust and Values has the smallest variance.

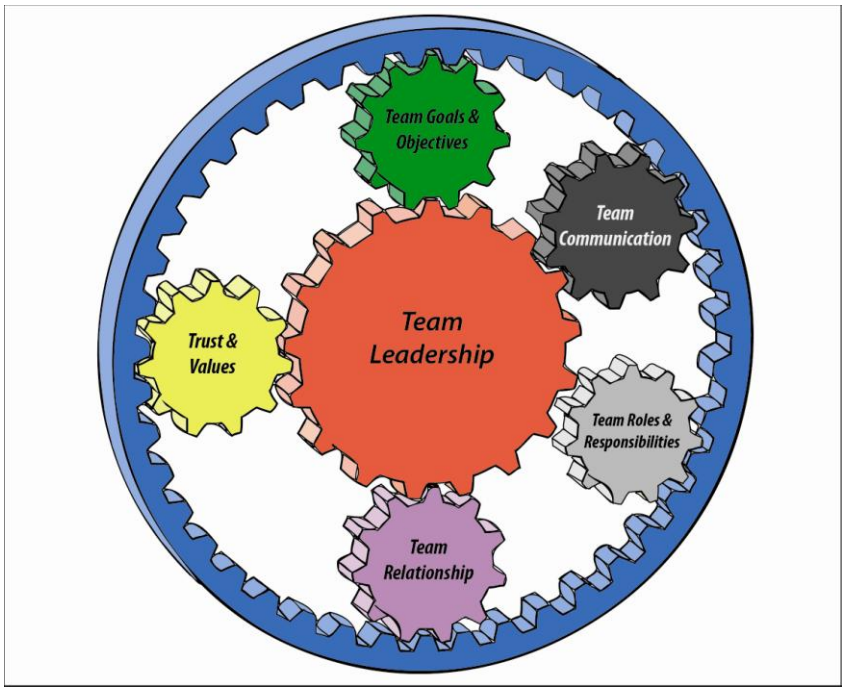

Figure 6.12. Team effectiveness model in Project Change Management

For a construction project team, the team effectiveness factors are found to account for 23% of the variance in Project Change Management. The sum of squared semi-partial correlations from Table 6.31 (0.0868) when subtracted from the overall R^2 resulted in the value for common variance shared by the multiple predictors, which is 0.1422. This common variance is referred to the overlapping variance among the predictors due to multicollinearity.

The factors illustrates in Figure 6.12 are relevant and contribute to the effectiveness of Project Change Management. An effective project team that practices good change management exercises effective Team Leadership. Simultaneously, a construction project team should have clear and defined Team Goals and Objectives, practice effective communication strategies, know and understand their roles and responsibilities, while establishing good working relationships, and help each other to ensure the change orders and other services related to changes on the jobsite are completed in a timely manner and satisfy all parties.

6.5. DEFINITION OF TEAM EFFECTIVENESS

6.5.1. Team Members' Perspective

Another component of the survey comprises several open-ended questions on their understanding of the term "team effectiveness," and whether they viewed their team as a successful team. Appendix C consists of the responses gathered from the open-ended question—"Team effectiveness is said based on team performance, the ability of the team to meet the approval of its client, interdependent functioning, and the extent to which the team is satisfied with team membership. Based on the above statement, do you consider your team "effective"? Please justify your answer." From a total of 16 teams, 87% of the teams (14 teams) considered their team to be effective (Figure 6.13).

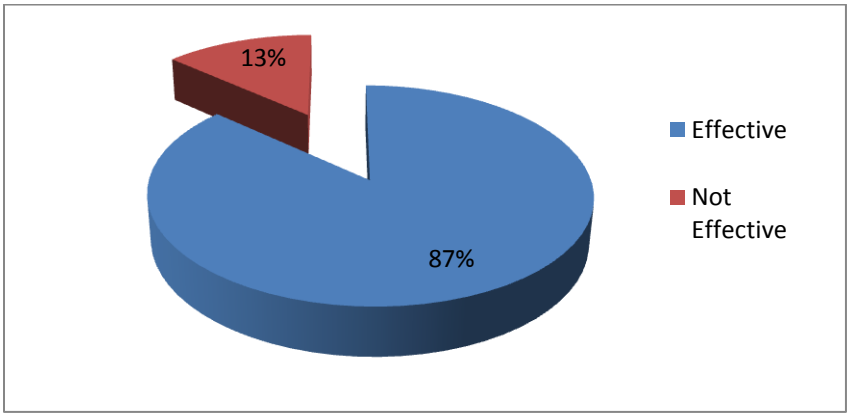

Figure 6.13. Overall effectiveness of project team from teams' perspective

Based on Appendix D, the responses of why the team members considered their team to be effective or not are clustered according to the team and themes. Some of the variables used throughout this study are identified as the themes in their responses—Team Goals and Objectives, Team Roles and Responsibilities, Team Leadership, Trust and Values, Team Communication, Team Relationship, Owner Satisfaction, Project Phases & Tasks, Project Schedule, Project Cost, Project Safety, and Project Team. Based on Appendix D, all teams that considered themselves effective have responses that fall into all the identified themes. All the effective teams are found to highlight the importance of establishing good working relationships, ensure members know and understand their roles and responsibilities for the project, and practice effective communications to satisfy and meet the owner's requirements

until the completion of the project within the schedule and cost specified an earlier stage of the project. According to the responses in Appendix D, Team 14 mentioned they experienced some issues from the beginning with an unclear project scope. But, somehow they managed to work through and resolve this issue. Team 10 acknowledged they are effective in certain areas and would like to become a better team by learning to become more effective. Team 13 reacts to problems quickly and tries to receive a clear idea of what is expected from the owner. The two teams that considered themselves "ineffective, faced issues with the owners, experienced delays in getting different aspects, communication issues, and lack of knowledge on how to become an effective team.

Another question asked is "How do they define team effectiveness within a construction project team?" Responses on the definition provided by the team members across 16 teams are listed in Appendix D. Among all themes identified, Team Communication, Team Roles and Responsibility, Owner Satisfaction, Team Goals and Objectives, and Project Phases & Tasks are frequently mentioned by the participants as their definition of team effectiveness for a construction project. Therefore, from the clustered responses in Appendix D and the most frequently mentioned themes, it can be concluded the definition of team effectiveness in a construction project by team members is:

> "The ability of the team to clearly define, agreed and understands projects' common goals and their roles and responsibilities to accomplish assigned tasks and deliver a completed and well-built project compliant with the highest quality, as well as effectively embrace owner's expectations during the entire project through the use of effective communication strategies."

6.5.2. Owners' Perspective

In addition to the team members, owner's representatives were asked to complete the same open-ended question on their understanding of the term team effectiveness and whether they viewed their team as a successful team. However, among 16 owner's representatives, three did not provide any responses to the question – "Team effectiveness is said based on team performance, the ability of the team to meet the approval of its client, interdependent

functioning, and the extent to which the team is satisfied with team membership. Based on the above statement, do you consider your team "effective"? Please justify your answer." Twelve owner's representatives agreed their teams are effective, and only one thinks that his/her team is ineffective. Based on Appendix D, the teams are effective because they understand their roles and responsibilities, communicate well, trust each other, establish good working relationships, and manage to complete the project on time and within budget. One team, considered ineffective, was determined to have communication issues within the team and, therefore, experienced delays throughout the project.

Another question asked "How do they define team effectiveness within a construction project team?" For this question, only 14 owner's representatives provided the definition of team effectiveness and are listed in Appendix F. Among all themes identified, Project Schedule, Project Cost, Team Relationship and Project Team are frequently mentioned by the owner's representatives as their definition for team effectiveness in a construction project. This is expected, as owners would first and foremost look into the ability of the team to complete the project within the cost and timeframe given. Therefore, from the clustered responses in Appendix F and the most frequently mentioned themes, it can be concluded the definition of team effectiveness in a construction project from the owners' perspective is:

> "The ability of the team members to work together in a flexible manner, helping each other, put forth effort, and functions well as a team to overcome issues and complete the project within the given timeframe and cost."

6.6. SUMMARY

The purpose of this chapter is to present the results from the quantitative and qualitative data analysis. The following are the three main research questions used to organize this chapter:

1. How can team effectiveness in construction be evaluated and measured?
2. How can team effectiveness act as an indicator of construction project performance?
3. How to model team effectiveness in construction?

The statistical analysis used to address the main research questions and its sub questions are discussed in Chapter 4. Their findings and discussions are presented in this chapter. This chapter begins with Research Question 1, where Factor Analysis results used to evaluate the pretest data obtained are presented. The reliability test is also performed to ensure the Team Effectiveness survey is reliable and can be used for data collection purposes. For Research Question 2, there are several sub questions that look into the relationship between team effectiveness factors with project performance aspects on the team and individual levels. Bivariate correlation and scatterplot matrix are used to identify the associations between the team effectiveness factors and project performance aspects. The only project performance aspect determined found to have a relationship is Project Change Management. Because there are several team effectiveness factors determined to have a relationship with Project Change Management, regression analysis is performed to identify which is the best predictor of Project Change Management at team and individual levels.

Research Question 3 looks into developing a model to illustrate team effectiveness in construction. The relationship between team effectiveness factors with Project Change Management on the individual level is modeled using the semi-partial correlations and shared variance. Additional finding from the study (open-ended questions from surveys) utilizes the qualitative approach, using text analysis to analyze responses obtained from the open-ended questions on the surveys.

It is a good practice to validate the results obtained from the quantitative and qualitative analysis in this study. The validation of the results obtained from this study is discussed further in the next chapter.

CHAPTER 7. FINDINGS VALIDATION

This chapter discusses the results obtained from the validation of the findings from this study. As mentioned in the Methods chapter (Chapter 4), the validation process is achieved through a semi-structured interview with an award-winning project team (Project ABC) recognized by DBIA. Fourteen questions were asked to the interviewee regarding team effectiveness and opinion regarding the findings from this study. The questions are listed in Appendix D (Interview Protocol & Guide).

7.1. SEMI-STRUCTURED INTERVIEW

The interview began with some demographic questions on the background of the interviewee, the project team, and the project completed. The interviewee (Mr. John Doe*) was a senior project manager for the ABC project, who was responsible for the project management and construction phase. He has 14 years of construction experience and has worked on more than 20 projects since he joined Company XYZ. His team won an award for the best project team when constructing Project ABC, which is collaboration between City D, the University of K, and G County bio authority. This project is a design-build, architect-led project with the selection process based on a competitive proposal. The project took 14 months in total duration and cost around $4.4 million. The overall project team consisted of five or six people with two teams—construction team and designer team. The construction team consisted of three people and the designer team was two people. The architect is the main contact point in this project.

When asked about why his team was selected to receive the reward, the interviewee said:

> "We maintained our budget, I know for a fact that we probably have the most aggressive schedule and I think we beat the schedule originally; there is no question that the owner was satisfied with what we provided them, one thing that was big for them was local participation – we were able to do that. The quality of work was good, and really, the project went off without any major issues. It was a very good project and a good model for the alternative delivery method."

*Pseudonym used to maintain confidentiality and anonymity.

Clearly, the team is recognized, due to the ability of them to work within the given budget, complete the project within the time frame, and the end product was good quality work that satisfied the owner. As a design-build project, the project is awarded after the conceptual design was around 15-20% completed. The construction started by releasing the footing and packages after approximately 85% of the entire design was completed.

According to Mr. John Doe, an effective construction team is a team that practices effective communication skills, members are clear on their roles and responsibility, trust is in place, and everyone has common goals. Additionally, the ability of the team to stay on schedule, keep within the budget, and develop a good working relationship, also are part of an effective project team.

When asked on what his team did to become an effective team, Mr. John Doe said:

> "….we ran very effective meetings. We try to keep them an hour long; we met on a regular basis, well even through design…"
> "Once we got into construction we met weekly with the architect and every other week with the owner to identify when potential risk and walk through them."
> "…what kept us on track and part of it was the availability of the team members… if there was anything that came up, they come to look at the project and get the in no time to react as quickly as possible."

Besides the initiative and effort to strive as an effective team, there were one or two hiccups that occurred during the construction process. The team viewed problems as theirs, instead of the owner's, due to single source of responsibility in the design-build delivery method. According to Mr. John Doe, the team determined how to solve the problems as much as they could during the preconstruction process. An example of a problem occurred during construction. There was an issue with the floor finishes and the construction team did everything on their end to correct this, but the subcontractor did not come through. However, the team found alternatives to overcome delays and were upfront with the owner regarding the situation.

To maintain a level of effectiveness, the project manager went through the evaluation process with the team three times throughout the course of the project. During the third evaluation, the project manager checked if everyone was satisfied with the team's performance. The team provided feedback to the owner and conducted a plus-delta meeting to improve as a team.

7.1.1. Perspectives on Findings of the Study

The interviewee was also asked on his perspective of the findings obtained from this study. According to Mr. John Doe, the six team effectiveness factors used (Team Goals and Objectives, Team Leadership, Team Roles and Responsibilities, Team Relationship, Team Communication, and Trust and Values) in developing the team effectiveness survey is the main contributors to being an effective team.

> "…I think the 6 factors that you listed… you definitely going along the right path… from my experience I would agree that if you could successfully achieve those factors in each project then you'd be in good shape."

From the interviewee's experience, it is better for a team to define its team goals and objectives as early as possible, since decisions made throughout the project should be aligned with the goals outlined. The ABC project team certainly established good working relationships, enjoyed working together, and headed into the same direction. The roles and responsibility of the team members are clearly defined—everyone knows his/her scope of work. The team has people with sufficient experience to be a leader, especially when the owner lacked construction experience. The owner asked many questions to the team and the team did a good job in leading (both the architect and the project manager) through the design and construction process, and established trust with the owner. During the weekly meetings, the team ensured everyone had the same understanding and spoke within the team. However, the team experienced an issue during the decision-making process on the owner's side, as the owner had committees to make decisions, which resulted in a loss of time and cost, due to the time taken for the process.

Besides the team effectiveness factors, the interviewee was also asked on his perspective of the Project Change Management being the only project performance aspect that had a relationship between the team effectiveness factors. Mr. John Doe believes the method the changes are presented to the owner is important. The changes need to be delivered from a trusted person to ensure the owner is a happy customer when the project is completed. Additionally, inaccurate changes affect relationships, and leadership, and ineffective communication result in frustration among team members. It is the team's responsibility to explain to the owner why such changes occurred and trust is an important element, as the owner will question the team's value and integrity as it involves cost, which is a reason it is important to make the owner understand the changes that occurred.

For the ABC project, the team practiced the open-book concept in change management. The project carried contingency in its contract and the team used a spreadsheet to track the contingency money used and was reviewed in every meeting. To ensure the team has sufficient money to complete the project, all expenses and changes occurred are communicated between the owner and the team. The owner asked questions pertaining to the changes, if he disagrees, and the team tried to address the issues. Change orders on the project were related to architectural look and functions. The team had approximately 30 changes on the project totaling approximately $235,000, with one change order equal to $155,000.

During the interview, the interviewee was asked how Team Leadership plays an important role in Project Change Management. He mentioned the person who explains the change has to be somebody respected by the team. An effective project manager should be a person able to justify the reasons the changes occurred to the team. When there are changes occurring on projects, it is important for the project manager to lead the team effectively and find solutions.

Finally, Mr. John Doe talked about his perspective on how Team Roles and Responsibility affect Project Change Management. According to him, the team should know more about what the owner expects and this should be established early during the preconstruction process. During this stage, the team members' responsibilities must be clearly defined should changes occur throughout the construction process.

7.2. SUMMARY

The semi-structured interview was conducted with a representative from Company XYZ, which was part of an award-winning construction project—Project ABC at City D. Mr. John Doe shared his experiences on the aspects that made his team win the award and his opinions on team effectiveness in construction project teams. Fourteen questions were asked during the interview, ranging from demographics to questions related to team effectiveness.

In summary, the findings from the study align with the factors that made Project Team ABC an effective and successful team. Team ABC managed to successfully achieve the six team effectiveness factors (Team Goals and Objectives, Team Leadership, Team Roles and Responsibility, Team Relationship, Team Communication, and Trust and Values). Additionally, the team had effective project managers who managed to lead the project overall and justify any change orders to the team. The team members are also clear on their roles and responsibilities through addressing the changes that occurred.

The next chapter concludes all the findings obtained from this study gathered through survey development, data analyses, and the validation process. The limitation and future direction of the study are also included in the discussion.

CHAPTER 8. CONCLUSIONS

This chapter presents the conclusions developed from the research results presented in Chapter 6. It focuses on converting the information obtained from the results into knowledge. Additionally, this chapter also provides information on the relevance of the study, limitations experienced throughout performing the study, as well as a direction for future research.

This study begins by looking at Research Question 1, which is how can team effectiveness in construction be evaluated and measured. To answer this research question, a review of literature is conducted on the team effectiveness model to determine team effectiveness factors. Once the factors are identified, a pilot study is conducted to narrow the factors. For the pilot study, a survey is developed and sent via email to a group of industry practitioners asking for their perspective on the most important team effectiveness factors for a successful construction team.

The team effectiveness factors obtained from the pilot study and literature review are Team Goals and Objectives, Team Leadership, Team Relationship, Team Roles and Responsibilities, Team Communication, and Trust and Values. These factors are utilized to develop a Team Effectiveness Survey geared towards team members in a construction project. Another survey, Project Performance Survey, is also developed to assess the performance of the team on different project performance aspects. These aspects, Project Cost, Project Schedule, Project Safety, Project Team, Project Change Management, and Project Phases and Tasks, served as measures evaluated by the project's owner.

Both surveys are piloted, using a group of undergraduate students in the Capstone Class, a senior-level class in the Construction Engineering Program at Iowa State University. For the Team Effectiveness Survey, the data collected are analyzed using factor analysis and reliability testing to determine the underlying structure of the variables, as well as testing the reliability of the survey. Instructors of the Capstone Class pilot the Project Performance Survey, since they have knowledge of the students working as teams in this class. After the surveys are revised, they are used for data collection purposes for this study. Again, reliability testing is conducted with the new data and all team effectiveness factors demonstrate high reliability (Cronbach's Alpha range is between 0.874 to 0.925) (Table 6.4, Chapter 6).

For Research Question 2, there are three sub-questions listed under the main question, as follows:

a) Which team effectiveness factors (IV) have the greatest variation between project teams (DV)?
b) Which team effectiveness factors (IV) have a significant relationship with project performance?
c) Which team effectiveness factor is the best predictor for project performance?

For sub-question (a), a one-way ANOVA is performed by using a number of team as a factor with 16 levels (16 teams). Team effectiveness factors are treated as dependent variables. The results from the one-way ANOVA performed indicate that Team Goals and Objectives, Team Roles and Responsibilities, and Trust and Values have the greatest variation between the project teams. Team Communication is the only insignificant factor. This show the significant variables have more variations between the teams rather than within teams. Because five out of six variables have more variations between the teams, it would be more meaningful to use group means for the team-level analysis to represent a project team.

By using the group means, the next sub-question (sub-question b) can be answered, which is looking into team effectiveness factors that have a significant relationship with project performance. The relationship or association between variables can be determined by performing a Bivariate Correlation. The output from a Bivariate Correlation indicates Team Leadership, Team Relationship, Team Roles and Responsibilities, and Trust and Values have a significant relationship with Project Change Management. The next sub-question is examined to determine which one of these factors is the best predictor for Project Change Management.

Sub-question (c) is developed as a continuation from the previous sub-question (Which team effectiveness factor is the best predictor in project performance?). Using the outcome from sub-question (b), a linear regression is performed. However, during the first regression run, the model is insignificant, due to collinearity among the independent variables. Therefore, a new compound variable is transformed to minimize the collinearity effect before

another regression analysis is conducted. From the regression analysis, it is determined Team Roles and Responsibilities is the best predictor for Project Change Management on the team level (based on the use of group means). For a study of teams, there is a multi-level effect that exists due to this type of condition. To perform an individual-level analysis, replication of dependent variables' responses is performed according to the number of individuals per team for the multilevel effect, since the data obtained are disaggregated. Then, a Bivariate Correlation is performed on the variables to determine which has a relationship. It was determined Team Leadership is the best predictor for Project Change Management on the individual level.

Research Question 3 looked into modeling team effectiveness. Based on the outcomes of the sub-questions, it is necessary to provide a better understanding in terms of the associations among team effectiveness factors and Project Change Management. A planetary gear was developed to illustrate the variance accounted for in Project Change Management. Team Leadership is the best predictor (0.0493) and Trust and Values is the lowest significant predictor (0.0002). The model also identified collinearity exists, as the shared variance between is accounted for 14% from the R^2 value. This is due to the predictors being highly correlated with each other.

Another sub-question in Research Question 3 is looking into the definition of team effectiveness. The definition is developed from the responses obtained from the open-ended questions in the surveys. Text analysis is chosen to analyze the data, which is a qualitative type of data analysis. There are two different definitions of team effectiveness developed from the construction team and the owner's standpoint:

> "The ability of the team to clearly define, agree, and understands projects' common goals, their roles, and responsibilities to accomplish assigned tasks and deliver a completed and well-built project that is compliant with the highest quality, as well as effectively embrace owner's expectations during the entire project through the use of effective communication strategies." (C*onstruction team)*

> "The ability of the team members to work together in a flexible manner, helping out each other, put in effort, and functions well as a team to overcome issues and complete the project within the given timeframe and cost." (*Project Owner*)

From the definitions above, it can be concluded the team members' understanding of team effectiveness focuses on Team Goals and Objectives, Team Communication, and Team Roles and Responsibility to complete the project as expected by the owner. From the owner's perspective, a team should be able to work together and complete the project within the given timeframe and cost. These definitions provide a general idea and assist project teams to identify what team effectiveness factors should be the focus for a team to become effective.

The outcome of this study echoes findings from the literature. In this study, Team Leadership is determined the most significant predictor in Project Change Management, and according to Queensland Government (2011), the role of leadership in any change management effort cannot be underestimated, and is repeatedly cited as the number one contributor to change success. Moreover, Acharya et al. (2006) indicates leadership is a factor that yields desirable team interpersonal effectiveness in perceived project success.

The outcomes of this study are validated through a semi-structured interview with a representative from an award-winning project team (Project Team ABC). Based on this interview, it is determined the findings aligned with the factors that made Project Team ABC an effective and successful team. The team had effective project managers, who managed to lead the project overall and managed the change orders accordingly. Additionally, the team members are also clear on their roles and responsibilities through addressing and managing the changes occurred.

Therefore, it can be summarized that team effectiveness is important in construction project teams and project performance. The team effectiveness factors identified (Team Goals and Objectives, Team leadership, Team Relationship, Team Roles and Responsibilities, Team Communication, and Trust and Values) have an impact on the performance of the construction project, specifically on Project Change Management. The project manager is responsible for ensuring the team members work together effectively to achieve project goals and has the resources necessary to complete their tasks. Team

effectiveness for a construction project team is assessed and evaluated in an attempt to achieve project goals, based on different project performance measures, such as time, cost, quality of the tasks performed, owner's satisfaction, project team, safety practices, and the changes management implemented on the project.

8.1. LIMITATIONS OF THE STUDY

This dissertation takes team effectiveness and project performance as the subjects for survey development and conducted quantitative and qualitative research on the team effectiveness factors that influence project performance. It reached specific conclusions about team effectiveness for construction teams. However, there are some limitations to this research, including:

- Due to limited time and personal ability, the surveys conducted for the purpose of this study were targeted at construction companies in the Midwest of the United States. Project teams located in other parts of the United States are not included as part of the sample. The possible limitation of this scenario is results may not generalize construction companies in other areas or in other countries other than the Midwest in the U.S.
- This study only has 16 project teams; it would be better if more project teams participated in the study to increase the statistical power. In the future, when conditions permit, the samples will be extended and include more project teams.
- The dataset used in this study is disaggregated to allow for the examination of multilevel effects. Therefore, it is suggested the number of participants on the team level be increased to address this issue in the future.
- Participants volunteered to participate in the study in response to e-mail requests, due to the convenience sampling method. A self-selection bias may present as the company may identify project teams, who volunteered for participation as teams. The team selected may be a team that has positive experiences with their project team and this could adversely affect the data.
- Because the study of teams needs to have a multilevel effect (individual- and team-level analyses), it is important to obtain both project team and the owner to participate

in the survey. However, since the survey participation is voluntary, it is challenging to get project teams and the owner on the same project to participate in the study.

- The optimum value or minimum value for each team effectiveness factor that may lead to an optimum or minimum effectiveness level of Project Change Management cannot be determined, since it is not included within the scope of this study. Optimization software might be better suited to determine the predictor values to obtain the optimum value of project change management effectiveness.

Despite the limitations of this study, its findings can be a useful developmental tool for construction project teams and for researchers planning to conduct research in this area.

8.2. RESEARCH IMPLICATION

This study contributes to the body of knowledge on project teams in construction, as well as teams, in general. The survey development process used in this study can be utilized by researchers interested in other constructs related to different aspects of teams and performance within organizations. The Team Effectiveness Survey and the Project Performance Survey are designed for use by construction project teams that promote collaboration and teamwork as part of their working culture. The instruments are also intended for assessment and evaluation of the construction project team, and can be used anytime throughout the construction process. However, it is recommended the best time to evaluate the effectiveness of a team is after a few months of project kickoff, in the middle of the construction process, and at the end of the project. The team members and owner's representatives should have the knowledge for working together as a team to be able to better assess the team for improvement.

The model developed and information obtained from the statistical analyses performed on the relationship between the team effectiveness factors and the project performance aspects are intended to provide construction project teams with the general idea on what factors should be the main focus to improve team effectiveness on project performance aspects. Furthermore, the definition of team effectiveness from the team's members and owner's point of view are developed to provide a better understanding on what team effectiveness really means to different parties working on a construction project.

8.3. FUTURE RESEARCH

This study can be pursued further, looking into the following:

- Determination of the optimum effectiveness level of Project Change Management by using optimization software to quantify the optimum value for each predictor. This may assist project teams to know the effect for each predictor, if it did not reach the optimum level suggested.
- Predicting team effectiveness in construction project team by quantifying the team effective factors and providing a method to select team members, based on an evaluation of the probable effectiveness of an individual. This early evaluation of team members provides the project owner and project manager an opportunity to provide proper training, intervention, or change the combination of people chosen for the team.
- Examination on personality of construction project team members and how personality contributes to the level of team effectiveness, based on The Big Five Personality Traits. This may help project owners to better understand the impact of hiring individuals with different personalities and how the individuals may contribute to increase in overall effectiveness of the team.

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APPENDIX A. TEAM EFFECTIVENESS AND PROJECT PERFORMANCE SURVEY

TEAM EFFECTIVENESS SURVEY

Dear Participant,

This survey will only be used for a research purposes only. This study examines different factors associated with team effectiveness (Leadership, Cohesion, Trust, Communication, and Interdependence) and to what extent these factors lead to create effective project teams.

This questionnaire should take about 10 minutes of your time to complete. The information collected will be kept confidential and will be stored on a password-protected computer with limited access to only this researcher. When completing this survey no identifying information will be collected with your responses. Your participation in this survey is completely voluntary.

For questions or concerns, please contact Hida Azmy at *hida@iastate.edu*

Thank you for your time.

1- Please select the size of your team.

- ○ 2-4 people
- ○ 5-6 people
- ○ 7-10 people
- ○ More than 10 people

2- Please specify your gender

- ☐ Male
- ☐ Female

3- Please check the answers below which most closely match your opinion regarding **project team goals and objectives.**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. I understand team's goals and objectives.	☐	☐	☐	☐	☐
b. My teammates understand team's goals and objectives.	☐	☐	☐	☐	☐
c. Team agrees on team's goals and objectives.	☐	☐	☐	☐	☐
d. Team goals and objectives are consistent with team members.	☐	☐	☐	☐	☐
e. Team is committed to achieve team's goals and objectives.	☐	☐	☐	☐	☐
f. Team achieves outlined team goals and objectives.	☐	☐	☐	☐	☐

4- Please check the answers below which most closely match your opinion regarding **project team leadership.**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. I feel comfortable with the concept of shared leadership.	☐	☐	☐	☐	☐
b. I feel comfortable with the decision-making process within the team.	☐	☐	☐	☐	☐
c. I spend time with team members to clarify team's expectations.	☐	☐	☐	☐	☐
d. Team exercises good judgment during decision-making process.	☐	☐	☐	☐	☐
e. Team members provide input/thoughts throughout the project.	☐	☐	☐	☐	☐
f. I help my team whenever anyone has difficulties performing tasks.	☐	☐	☐	☐	☐

5- Please check the answers below which most closely match your opinion regarding **project team roles and responsibility.**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Team members are willing to take initiative for unassigned tasks.	☐	☐	☐	☐	☐
b. I am willing to help with unforeseen problems that need immediate attention.	☐	☐	☐	☐	☐
c. Team members are willing to help with unforeseen problems that need immediate attention.	☐	☐	☐	☐	☐
d. I am clear on my individual roles in relations to the team as a whole.	☐	☐	☐	☐	☐
e. Team members are clear on individual roles in relations to the team as a whole.	☐	☐	☐	☐	☐
f. I agree with assigned roles and responsibilities.	☐	☐	☐	☐	☐
g. Team members have the necessary expertise to perform the tasks.	☐	☐	☐	☐	☐
h. I understand the responsibilities assigned to me.	☐	☐	☐	☐	☐
i. Team understands the responsibilities assigned to them.	☐	☐	☐	☐	☐

6- Please check the answers below which most closely match your opinion regarding **project team relationship.**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. I manage to handle team conflict well.	☐	☐	☐	☐	☐
b. Effective conflict management is exercised within the team.	☐	☐	☐	☐	☐
c. Team works constructively on issues arise until they are resolved.	☐	☐	☐	☐	☐
d. I care about the welfare of my teammates.	☐	☐	☐	☐	☐
e. My teammates care about each others.	☐	☐	☐	☐	☐
f. Good decisions are always made within the team regarding project matters.	☐	☐	☐	☐	☐
g. Decisions are made with the involvement of all team members.	☐	☐	☐	☐	☐
h. I carry my fair share of the work.	☐	☐	☐	☐	☐
i. The team members always looking out for the team.	☐	☐	☐	☐	☐

7- Please check the answers below which most closely match your opinion regarding **trust and values within the project team.**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. As a member of the team, I am treated with respect.	☐	☐	☐	☐	☐
b. Other team members are treated with respect.	☐	☐	☐	☐	☐
c. I trust my teammates in making decisions for the team.	☐	☐	☐	☐	☐
d. The team members trust each other.	☐	☐	☐	☐	☐
e. The team members show appreciation towards one another.	☐	☐	☐	☐	☐
f. The team members support each other.	☐	☐	☐	☐	☐

g. My contributions for the team are recognized.	☐	☐	☐	☐	☐
h. I believe trust is an important component in teams.	☐	☐	☐	☐	☐
i. The team believes trust is an important component.	☐	☐	☐	☐	☐

8- Please check the answers below which most closely match your opinion regarding **project team communication.**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Interactive communication is present within the team.	☐	☐	☐	☐	☐
b. Team members participate in team's discussion.	☐	☐	☐	☐	☐
c. I participate in team meetings.	☐	☐	☐	☐	☐
d. The team members trust each other.	☐	☐	☐	☐	☐
e. Team meetings are well-facilitated.	☐	☐	☐	☐	☐
f. Team meetings produce clear outcomes.	☐	☐	☐	☐	☐
g. There are disagreements during team meetings.	☐	☐	☐	☐	☐
h. Communications outside meetings are effective.	☐	☐	☐	☐	☐
i. I am honest with my teammates.	☐	☐	☐	☐	☐
j. Team members are honest with each other.	☐	☐	☐	☐	☐

Thank you for completing the questionnaire.

PROJECT PERFORMANCE SURVEY

Dear Participant,

This survey will only be used for a research purposes only. This study examines different factors associated with project performance (Cost, Schedule, Task, Safety, Change Management and Overall Satisfaction) and to what extent these factors lead to create effective project teams.

This questionnaire should take about 10 minutes of your time to complete. The information collected will be kept confidential and will be stored on a password-protected computer with limited access to only this researcher. When completing this survey no identifying information will be collected with your responses. Your participation in this survey is completely voluntary.

For questions or concerns, please contact Hida Azmy at *hida@iastate.edu*

Thank you for your time.

1- Company/Agency name: _____

2- Project name: _____

3- What is your current job position?
- ❍ Project Manager
- ❍ Engineer
- ❍ Architect
- ❍ Subcontractor
- ❍ Contractor
- ❍ Others, please specify _____

4- Years of experience in the construction industry
- ☐ 0-5 years
- ☐ 5-10 years
- ☐ 10-15 years
- ☐ More than 15 years

5- Please check the answers below which most closely match your **overall satisfaction** regarding your team's performance.

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Project team successfully achieved the project objectives.	☐	☐	☐	☐	☐
b. As owner, I am satisfied with the final product of the project.	☐	☐	☐	☐	☐
c. Project team exercise effective documentation system.	☐	☐	☐	☐	☐
d. Project completed met the quality standard specified during the earlier phase.	☐	☐	☐	☐	☐

e. Project site is kept clean and organized at all time.	☐	☐	☐	☐	☐

6- Please check the answers below which most closely match your opinion regarding your team's performance on the **project phases and tasks aspects:**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Project planning has been achieved correctly.	☐	☐	☐	☐	☐
b. Project construction has been completed correctly.	☐	☐	☐	☐	☐
c. Project has quality designs.	☐	☐	☐	☐	☐
d. As the owner, I am satisfied with the time taken to issue design information.	☐	☐	☐	☐	☐
e. Construction activities during the project were inspected to ensure quality work.	☐	☐	☐	☐	☐
f. Procedures adopted by the project team ensured that the level of quality remains constant throughout the life of the project.	☐	☐	☐	☐	☐

7- Please check the answers below which most closely match your opinion regarding your team's performance on the **project schedule aspect:**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. The project was completed on time.	☐	☐	☐	☐	☐
b. Unforeseen physical and weather conditions have been considered in project schedule.	☐	☐	☐	☐	☐
c. The team established a sense of urgency and adjustments were promptly made to maintain or improve the schedule.	☐	☐	☐	☐	☐
d. The master schedule was up to date.	☐	☐	☐	☐	☐
e. Critical milestones were well-monitored.	☐	☐	☐	☐	☐
f. Reports and documentation were prepared within the time given.	☐	☐	☐	☐	☐

8- Please select the duration of the overall project (From contract start date to contract completion date):

☐0-6 months
☐6-12 months
☐12-18 months

☐ More than 24 month

9- Please check the answers below which most closely match your opinion regarding your team's performance on the **project cost aspect:**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Project was completed/maybe completed within budget.	☐	☐	☐	☐	☐
b. Contractor did seek alternative solutions with less emphasis on cost.	☐	☐	☐	☐	☐
c. Project costs were continuously monitored.	☐	☐	☐	☐	☐
d. Overall project costs were continuously monitored.	☐	☐	☐	☐	☐

10- Please select the actual overall cost of the project:
☐ Less than $100,000
☐ $100,001 - $250,000
☐ $250,001 - $500,000
☐ $500,001- $750,000
☐ More than $750,001

11- Please select the budgeted cost of the project (including contingency):
☐ Less than $100,000
☐ $100,001 - $250,000
☐ $250,001 - $500,000
☐ $500,001- $750,000
☐ More than $750,001

12- Please check the answers below which most closely match your opinion regarding your team's performance on the **change management aspect:**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Project has no deficiencies during construction.	☐	☐	☐	☐	☐
b. Decisions to rework were based on cost not value of work.	☐	☐	☐	☐	☐
c. A defined change control system was used for the project.	☐	☐	☐	☐	☐
d. Project is flexible to accommodate the changes I requested at any time.	☐	☐	☐	☐	☐

e. Change control systems was well-managed by the project team.	☐	☐	☐	☐	☐

13- Please select the number of change orders occurred within the project:
- ☐ None
- ☐ 1 - 5
- ☐ 6 - 10
- ☐ 11 - 15
- ☐ More than 15

14- Please select the most common causes of variations on the project:
- ☐ Inadequate project objectives
- ☐ Design errors and omissions
- ☐ Conflicts between contract documents
- ☐ Ambiguous design details
- ☐ Lack of contractor's involvement in design
- ☐ Other, please specify _____

15- Please check the answers below which most closely match your opinion regarding your team's performance on the **project safety aspect:**

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Safety is clearly a priority in this project.	☐	☐	☐	☐	☐
b. Exceptional efforts were made to establish effective safety procedures.	☐	☐	☐	☐	☐
c. Safety record keeping and reporting are well-managed and documented.	☐	☐	☐	☐	☐
d. Project safety inspections are well-managed.	☐	☐	☐	☐	☐
e. Project team reports accident statistics to me on a regular basis.	☐	☐	☐	☐	☐
f. As owner, I establish specific safety goals for the team performing this project.	☐	☐	☐	☐	☐

16- Please select all types of incidents that has been recorded on this project:
- ☐ Near misses
- ☐ OSHA recordable
- ☐ First aid cases
- ☐ Workers compensation cases
- ☐ Lost workdays
- ☐ Not applicable
- ☐ Other, please specify _____

17- Please check the answers below which most closely match your opinion regarding your **project team members' performance** on the project:

	Strongly Agree	Disagree	Neutral	Agree	Strongly Agree
a. Good service of the contractor was demonstrated during the project.	☐	☐	☐	☐	☐
b. Contractor demonstrated good technical ability on the project.	☐	☐	☐	☐	☐
c. Professional and skilled people were hired for the project.	☐	☐	☐	☐	☐
d. Contract team had a friendly atmosphere and trust.	☐	☐	☐	☐	☐
e. Project team members demonstrated expertise necessary for the project.	☐	☐	☐	☐	☐
f. Project team communicates with the owner in an effective manner.	☐	☐	☐	☐	☐
g. Project team responds quickly to my needs with professional service.	☐	☐	☐	☐	☐
h. As owner, I would like to work together again with the team members in future projects.	☐	☐	☐	☐	☐

Thank you for completing the questionnaire.

APPENDIX B. INTERVIEW GUIDE AND PROTOCOL

INTERVIEW PROTOCOL

A semi-structured interview protocol was developed with open-ended questions to provide ample opportunities for interviewees to elaborate. The interview questions provided multiple probes into the descriptive and theoretical questions posed below. They were designed to elicit how individuals made sense of their experiences as an award-winning construction team member and his actions within the team.

A 30-minute interview session is set-up by the researcher (interviewer). A phone interview is chosen for this purpose as it is convenient for both parties. Prior to the interview process, an interview guide was developed to ensure the objectives of the interview are achieved. Once the interview is over, the researcher should thank the interviewee for spending some time being interviewed.

INTERVIEW GUIDE

Interviewee: Mr. John Doe
Project name: Project ABC at City D
Company name: XYZ
Phone number: xxx-xxx-xxxx
Date: 2/28/2011
Time: 3pm

Introduction:
(Personal background)
Who am I? How far along am I in the program? Ask if it is okay to record the interview?

(Explaining the purpose of the research)
My Ph.D. research is entitled "The Role of Team Effectiveness in Construction Team and Project Performance". This study determines the team effectiveness factors that are use for assessing the project teams, and identifies the project performance aspects to be evaluated by the owner. The relationship between the team effectiveness factors and the project performance aspects are also examined.

Purpose of the interview: (Why the interview is conducted)
This interview is conducted as means to validate the findings from this study. Additionally, it is the intention of this interview to get some perspectives on construction team effectiveness from an award-winning construction team.

Confidentiality policy:

Interview content will be transcribed and reported in a manner that the identity of participants will not be revealed. If extracts from interviews are quoted in research reports, the names of interviewees and of people they have mentioned will be changed into pseudonyms. The same procedure will be used for the names of organizations/institutions and place names. When the research is completed, digital interview files and contact information to participants will be destroyed. Interview transcriptions will be archived permanently by the researcher for scientific research and teaching purposes.

Questions:

A. Interviewee background
    1. What is your job title and responsibilities?
    2. How many years of construction experience do you have?
    3. How long have you been working with this company?
    4. How any projects have you been involved since you started at this company? (Estimate number)
    5. What are the types of projects that you've been involved since you started at this company? What are the sizes (estimate in $)

B. Team/Project-related
    1. Can you provide further information about this project?
        - Location
        - Project owner
        - Duration
        - Total project cost and construction cost
        - Type of procurement
        - Project delivery approach
        - Number of team members (core team)
        - Main key team members (core team)
    2. I know that your team received an award for being the best project team from DBIA. Why do you think your project/team was chosen?
    3. What percent of the design has been completed when the project was awarded? At what point in the design that the construction begins?
    4. What do you considered to be the most important factor in being an effective team?
    5. Can you describe some of the examples that your team did that leads to being an effective team?
    6. Are there any issues or problems that your team faced throughout the course of the project?
        - How did you overcome? Measures taken?

7. From the study that I conducted, I found out that there are 6 team effectiveness factors that are considered to be the most relevant and important to construction teams (Team goals and objectives, Team relationship, Team leadership, Team communication, Trust and values and Team roles and responsibilities).
    - What would be your opinion regarding these factors?
    - Would you say that these factors are the factors that contribute to your team being an effective team?
    - What other factors that might be the main contributors to your team being an effective team?
8. In your opinion, what is your definition of team effectiveness in construction teams?
9. Do you conduct team assessment/evaluation throughout the course of the project?
    - If yes, how frequent? What type of assessment tool that you used?
    - If no, would you think it would be a good idea to assess the team throughout the construction process?
10. In the study, I also include an assessment from the owner, looking into the project performance aspects such as overall owner's satisfaction, project cost, schedule, quality, project-related tasks, project safety, project change management and the owner's opinion on the project team. During the data analysis process, looking into the relationship of the team effectiveness factors and the project performance aspects, it was found that project change management has the strongest relationship with the team effectiveness factors.
    - Based on your experience working with the team, how would you describe the change management process (coordinating change orders, addition, variations, modifications throughout the project) practiced by the team?
    - In your opinion, would you say team effectiveness factors do have some impact on the change management aspect of the project?
    - Could you describe how your team deals with change orders?
11. How many change orders did your team have? What were the costs of the change orders? What droves the number of change orders?
12. I also found out that team leadership plays an important role in project change management from the perspective of the construction team members.
    - What would be your thoughts regarding that matter?
    - (If interviewee agrees with the statement) Any specific example on how leadership effect changes management process on your team?
    - What do you think would be the other important factor(s) (aside from the 6 factors) that would have an impact on the change management process (in general and within your team)?

13. From the assessment and evaluation provided by the owner's representatives, and with regards to project change management, it was found that Team Roles and Responsibilities have the strongest relationship with project change management.
    - What would be your thoughts regarding that matter?
    - (If interviewee agrees with the statement) Any specific example on team roles and responsibilities effect changes management process on your team?
    - As part of an award-winning team, what do you think would be the other important factor(s) (aside from the 6 factors) that would have an impact on the change management process from the owner's point of view?
14. Is there anything else you'd like to share with me on how to be an effective team?

Closing remark:

That's all the questions I have. Thank you for participating in this interview. I would like to thank you (both of you) for your time today, and I will certainly get back to you if I have some questions during the transcription process of this interview. Before I go, do you have any additional comments or questions?

APPENDIX C. DESCRIPTIVE STATISTICS OF ANOVA

Project team	Team Roles and Responsibility				Team Goals and Objectives				Team Leadership				Team Communication			
	Mean	Std Dev	95% CI		Mean	Std Dev	95% CI		Mean	Std Dev	95% CI		Mean	Std Dev	95% CI	
			Lower	Upper			Lower	Upper			Lower	Upper			Lower	Upper
1	4.740	0.261	4.416	5.064	4.600	0.365	4.147	5.053	4.950	0.112	4.811	5.089	4.444	0.157	4.249	4.640
2	4.720	0.476	4.128	5.312	4.633	0.650	3.827	5.440	4.400	0.555	3.711	5.089	4.089	0.355	3.648	4.530
3	4.975	0.050	4.895	5.055	4.917	0.167	4.651	5.182	4.688	0.331	4.161	5.214	4.389	0.556	3.505	5.273
4	4.457	0.469	4.024	4.890	4.357	0.353	4.031	4.683	4.518	0.459	4.093	4.942	4.476	0.438	4.071	4.882
5	4.520	0.502	3.897	5.143	4.233	0.703	3.360	5.106	4.350	0.627	3.571	5.129	4.133	0.288	3.776	4.490
6	3.933	0.383	3.531	4.335	3.861	0.488	3.349	4.373	3.917	0.574	3.315	4.519	4.093	0.447	3.624	4.561
7	4.400	0.784	3.426	5.374	4.467	0.767	3.514	5.420	4.400	0.634	3.613	5.187	4.333	0.593	3.597	5.070
8	4.473	0.413	4.196	4.750	4.606	0.634	4.180	5.032	4.307	0.600	3.903	4.710	4.172	0.572	3.788	4.556
9	3.350	0.173	3.074	3.626	3.417	0.289	2.957	3.876	2.875	0.577	1.956	3.794	3.556	0.000	3.556	3.556
10	4.250	0.545	3.383	5.117	4.375	0.459	3.645	5.105	4.031	0.780	2.790	5.272	4.111	0.521	3.282	4.940
11	4.900	0.141	4.675	5.125	5.000	0.000	5.000	5.000	4.750	0.204	4.425	5.075	4.694	0.246	4.302	5.086
12	4.317	0.458	3.836	4.797	4.194	0.552	3.615	4.774	4.396	0.421	3.954	4.838	4.278	0.288	3.976	4.580
13	4.275	0.320	3.766	4.784	4.167	0.471	3.417	4.917	4.219	0.544	3.354	5.084	4.139	0.319	3.631	4.647
14	4.700	0.187	4.468	4.932	4.800	0.139	4.627	4.973	4.650	0.056	4.581	4.719	4.578	0.241	4.279	4.877
15	4.300	0.462	3.565	5.035	3.833	0.577	2.915	4.752	4.125	0.722	2.977	5.273	3.833	0.834	2.506	5.160
16	4.375	0.608	3.408	5.342	4.625	0.750	3.432	5.818	4.469	0.237	4.092	4.845	4.472	0.611	3.500	5.445

Project team	Team Relationship				Trust and Values			
	Mean	Std Dev	95% CI		Mean	Std Dev	95% CI	
			Lower	Upper			Lower	Upper
1	4.778	0.324	4.376	5.180	4.911	0.093	4.796	5.027
2	4.333	0.377	3.865	4.801	4.556	0.451	3.995	5.116
3	4.556	0.351	3.996	5.115	4.694	0.306	4.208	5.181
4	4.381	0.362	4.046	4.716	4.429	0.482	3.983	4.874
5	4.244	0.183	4.018	4.471	4.489	0.469	3.907	5.071
6	3.833	0.587	3.217	4.449	4.056	0.515	3.515	4.596
7	4.133	0.964	2.937	5.330	4.356	0.755	3.418	5.293
8	4.333	0.447	4.033	4.634	4.333	0.577	3.945	4.721
9	2.944	0.064	2.842	3.047	3.111	0.128	2.907	3.315
10	4.000	0.240	3.618	4.382	4.056	0.345	3.506	4.605
11	4.694	0.246	4.302	5.086	4.972	0.056	4.884	5.061
12	4.278	0.470	3.784	4.771	4.407	0.443	3.943	4.872
13	4.222	0.272	3.789	4.655	4.194	0.419	3.527	4.862
14	4.356	0.298	3.985	4.726	4.422	0.363	3.971	4.874
15	3.833	0.577	2.915	4.752	4.111	0.257	3.703	4.519
16	4.639	0.439	3.941	5.337	4.278	0.321	3.767	4.788

APPENDIX D. RESPONSES ON OPEN-ENDED QUESTIONS FOR OWNERS AND TEAMS

Owner (Q14): Team effectiveness is said based on team performance, the ability of the team to meet the approval of its client, interdependent functioning and the extent to which the team is satisfied with team membership. Based on the above statement, do you consider your team "effective"? Please justify your answer.

Team No	Coding categories	Themes	Step 1: List Out Responses	Is team effective overall ?	Step 2: Cluster the Responses
1	Goals and Objectives	Team Goals and Objectives	Everyone on the project team knows and understands the project goals, and strives to meet them at all times.	Yes	* Team members understand project goals, trust each other and work look out for each others' interest
	Working Relationship	Team Relationship	Teamwork is paramount and has worked well here through familiarity (second project the team has worked together) and trust.		
	Trust	Trust and Values	Everyone on the team trusts each other that they will be professional, do their best, and look out for each others' interests.		
2	Design & Construction, Time, Budget	Project Phases & Tasks, Project Schedule, Project Cost	The result was quality design and construction delivered on time and on budget.	Yes	* Members contribute to produce quality design and construction on time and within budget.
	Team contribution	Project Team	All team members contributed to that success.		
3	Communication	Team Communication	There are some communication issues; sometimes getting answers back from the engineers can be a problem.	No	* Team seemed to experience delays and communication issues
	Communication	Team Communication	Team members often do not get answers to questions in a timely manner		
	Communication	Team Communication	Delayed responses/decisions		
	Project cost	Project Cost	Increases costs due to delays		
4				Yes	

Team No	Coding categories	Themes	Step 1: List Out Responses	Is team effective overall ?	Step 2: Cluster the Responses
5	Roles and Responsibility	Team Roles and Responsibility	Everyone on site knows their roles and duties	Yes	*Team members know their roles and responsibilities and willing to help out each other to find cost-effective solution
	Team contribution, Working relationship	Project Team, Team Relationship	Everyone is ready, willing, and able to effectively contribute to another team members need if a problem arises to find the most cost and schedule effective solution.		
6	Team contribution	Project Team	Effectiveness has been tremendous because each member of the team brings to the table their own experience and knowledge	Yes	*Members' experience and knowledge contributes to team being effective
7	Communication and responsibility	Team Communication, Team Roles and Responsibility	The breakdown of work responsibilities was great, communication was great, and follow through was great.	Yes	* Team members understand their roles and responsibilities and practice effective communication
8	Roles and Responsibility	Team Roles and Responsibility	Each member of the team has specific responsibilities and must complete his/her tasks in a effective and efficient manner or another team member may be delayed in the completion of their respective tasks.	Yes	*Team members has specific responsibilities and must complete his/her tasks in a effective and efficient manner
10	Roles and Responsibility	Team Roles and Responsibility	The team was effective, we all worked well together knowing the roles of all parties and desired outcomes on the project.	Yes	* Team members understand their roles and responsibilities in thr project
11	Schedule and costs	Project Schedule, Project Cost	Project come in under budget and on-time	Yes	*Project come in under budget and on-time

Team No	Coding categories	Themes	Step 1: List Out Responses	Is team effective overall ?	Step 2: Cluster the Responses
12	Schedule and costs	Project Change Management, Project Schedule, Project Cost	Any changes were quickly followed up, project in on time and under budget.	Yes	*Any changes were quickly followed up, project in on time and under budget.
13			They are absolutely effective.	Yes	
14	Strength and Weaknesses	Project Team	We struggled to understand the strengths and weaknesses quickly so we could adapt. Our effectiveness was affected by this. Managed to finish the project within the time given.	Yes	*Team struggled to understand the strengths and weaknesses quickly, but managed to complete the project on time.

Owner (Q15): How would you define team effectiveness within a construction project team?

Team	Coding Categories	Themes	Step 1: List out responses	Step 2: Cluster responses	Frequency
1	Communication	Team Communication	Open and honest communication	*Team should have open, honest and constant communication among themselves and with the owner	3
10	Communication	Team Communication	Communication is key to any construction project		
11	Communication	Team Communication	Constant communication with the owner		
2	Goals and Objectives	Team Goals and Objectives	Establishing clear objectives	* Team should established clear objectives and common goals	4
5	Goals and Objectives	Team Goals and Objectives	Achieve common goals		
7	Goals and Objectives	Team Goals and Objectives	Meet common goals of quality work		
9	Goals and Objectives	Team Goals and Objectives	Have common goals		
4	Project outcome	Project Phases and Tasks	Deliver project safely	* The ability to efficiently complete and deliver a top quality project safely and in compliance with contract requirements	4
4	Project outcome	Project Phases and Tasks	Provide quality workmanship		
4	Project outcome	Project Phases and Tasks	In compliance with contract requirements.		
13	Project outcome	Project Phases and Tasks	The ability to efficiently complete tasks safe, right and fast.		

Team	Coding Categories	Themes	Step 1: List out responses	Step 2: Cluster responses	Frequency
1	Project Scheduling	Project Schedule	Meeting project milestones	* The ability to complete the project within the time given, being cost effective and on budget as possible.	7
3	Project Scheduling	Project Schedule	Complete a project in the most time		
7	Project Scheduling	Project Schedule	Complete project on schedule		
9	Project Scheduling	Project Schedule	Complete project on schedule		
4	Project Scheduling, Project Cost	Project Schedule & Project Cost	Completing the project on time and under budget		
12	Project Scheduling, Project Cost	Project Schedule & Project Cost	On budget, on time, on brand		
3	Project cost	Project Cost	Being cost effective as possible		
5	Team relationship	Team Relationship	Everyone working together	* The team members willingly work together in a flexible manner and functions well as a team to overcome obstacles throughout the project.	6
7	Team relationship	Team Relationship	The team work in a cooperative and flexible manner		
8	Team relationship	Team Relationship	Work together as a team to overcome obstacles		
9	Team relationship	Team Relationship	Work together as a team		
11	Team relationship	Team Relationship	The ability to function as a team		
12	Team relationship	Team Relationship	Willingness by all parties to want to work together on another project.		

Team	Coding Categories	Themes	Step 1: List out responses	Step 2: Cluster responses	Frequency
2	Team/individual performance	Project Team	Sense of achievement and pride in work	*Team that has knowledgeable and experienced members helping each other put in effort as a team and take pride in the work accomplished.	6
3	Team/individual performance	Project Team	The ability to work together		
3	Team/individual performance	Project Team	Assist team members to keep the flow		
5	Team/individual performance	Project Team	The effort put in as a team		
6	Team/individual performance	Project Team	Experienced and knowledgable team members		
7	Team/individual performance	Project Team	Team members are knowledgable		
11	Leadership	Team Leadership	The importance of good leadership	The importance of good leadership	3
2	Managing Conflicts	Team Leadership	No conflict/disagreement	No conflict/disagreement	
3	Problem solving	Team Leadership	Resolve issues as soon as possible	Resolve issues as soon as possible	
1	Owners satisfaction	Owners Satisfaction	Owner's expectations are met	Owner's expectations are met	1
2	Roles and Responsibility	Team Roles and Responsibilities	Define roles and responsibilities for team members	Define roles and responsibilities for team members	1

Team: (Q14) Team effectiveness is said based on team performance, the ability of the team to meet the approval of its client, interdependent functioning and the extent to which the team is satisfied with team membership. Based on the above statement, do you consider your team "effective"? Please justify your answer.

Team No	Coding categories	Themes	Step 1: List Out Responses	Team Member	Is team effective overall ?	Step 2: Cluster the Responses
1	Team relationship	Team Relationship	Working together	2	Yes	* Previous working relationship helps members working together as a team
1	Team relationship	Team Relationship	Previous working relationship helped to become successful team	4		
1	Team relationship	Team Relationship	Work together as a team	5		
1	Owner Satisfaction	Owner Satisfaction	Owner is satisfied	1		*Owner is satisfied with the outcome of the project
1	Owner Satisfaction	Owner Satisfaction	Owner is satisfied	3		
1	Owner Satisfaction	Owner Satisfaction	Met owner's expectation	5		
1	Goals and Objectives	Team goals and objectives	Project goals achieved	1		*Team performance were based on project goals and successfully achieved
1	Goals and Objectives	Team goals and objectives	Perform with end goal in mind	2		
1	Communication	Team Communication	Utilized multiple communication methods in multiple settings	4		Utilized multiple communication methods in multiple settings
1	Decision making	Team Leadership	Includes owner's input during decision making process	3		Includes owner's input during decision making process
1	Leadership	Team Leadership	Have a strong leadership from management	5		Have a strong leadership from management
1	Project cost	Project Cost	Provide cost effective and multiple solutions	5		Provide cost effective and multiple solutions
1	Project tasks	Project Phases & Tasks	Effective and efficient construction process	2		Effective and efficient construction process
1	Respect, trust and honesty	Trust and Values	High mutual respect	1		High mutual respect
1	Roles and Responsibility	Team Roles and Responsibility	Understand roles	5		Understand roles

Team No	Coding categories	Themes	Step 1: List Out Responses	Team Member	Is team effective overall ?	Step 2: Cluster the Responses
2	Owner Satisfaction	Owner Satisfaction	Performing to the satisfaction of the client	2		
2	Owner Satisfaction	Owner Satisfaction	Ensure that the goals of client satisfaction	2		
2	Owner Satisfaction	Owner Satisfaction	Owner is satisfied	2		*Owner's expectation were met and owner was satisfied
2	Owner Satisfaction	Owner Satisfaction	Met owner's expectation	2		
2	Owner Satisfaction	Owner Satisfaction	Meet the approval of our client	3		
2	Project Scheduling	Project Schedule	On time schedule performance	4		*Project was completed on time
2	Project Scheduling	Project Schedule	Project is on schedule	4		
2	Roles and Responsibility	Team Roles and Responsibility	Understand roles	4		*All team members understand their roles and responsibilities
2	Roles and Responsibility	Team Roles and Responsibility	Everyone knows their roles and responsibilities	1	Yes	
2	Communication	Team Communication	Communicate frequently	1		Communicate frequently
2	Information management	Team Communication	Manage the flow of information effectively	2		Manage the flow of information effectively
2	Leadership	Team Leadership	Have a strong leadership from management	2		Have a strong leadership from management
2	Problem solving	Team Leadership	Provide cost effective and multiple solutions	3		Provide cost effective and multiple solutions
2	Project cost	Project Cost	Budget are met	4		Budget were met
2	Team relationship	Team Relationship	Work together as a team	4		Worked together as a team
2	Team/individual performance	Project Team	Help out the other team members	5		Helped out the other team members

Team No	Coding categories	Themes	Step 1: List Out Responses	Team Member	Is team effective overall ?	Step 2: Cluster the Responses
3	Communication	Team Communication	Team members often do not get answers to questions in a timely manner	1		* Delayed responses resulted in not getting answers in timely manner
3	Communication	Team Communication	Delayed responses/decisions	2		
3	Project cost	Project Cost	Increases costs due to delays	3		*Delays occurred which increase costs for the contractor and owner
3	Project cost	Project Cost	Extra costs for the owner and contractor.	3		
3	Goals and Objectives	Team goals and objectives	Individual goals of the design team and construction team are different	2	No	Individual goals of the design team and construction team are different.
3	Project Scheduling	Project Schedule	Challenge to get all parties of the team to look at each condition and respond (schedules, other projects)	3		Challenge to get all parties of the team to look at each condition and respond (schedules, other projects)
3	Project tasks	Project Phases & Tasks	Unexpected conditions have been uncovered	1		Unexpected conditions have been uncovered
3	Team/individual performance	Project Team	Struggled to get consultant to participate in meetings	4		Struggled to get consultant to participate in meetings
4	Communication	Team Communication	Spending a lot of time having open discussions	3		*Effective communication such as open discussions help resolve issues
4	Communication	Team Communication	Effective communication and resolution of issues.	5		
4	Goals and Objectives	Team goals and objectives	Make sure all team members understand each others goals for the project	3		*Everyone on the team understand each other goals and overall goals
4	Goals and Objectives	Team goals and objectives	Team understands the overall goals	6		
4	Owner Satisfaction	Owner Satisfaction	Satisfied client	2		*Owner is happy and satisfied with the end result
4	Owner Satisfaction	Owner Satisfaction	Happy owner	4	Yes	
4	Team relationship	Team Relationship	Work together with our Client	1		*Team members work well together and with the owner.
4	Team relationship	Team Relationship	Works well with others	6		
4	Project Scheduling	Project Schedule	Ahead of schedule	1		Ahead of schedule
4	Respect, trust and honesty	Trust and Values	Trust the contractor	4		Trust the contractor
4	Team/individual performance	Project Team	Have a structure and delegation of authority	5		Have a structure and delegation of authority

Team No	Coding categories	Themes	Step 1: List Out Responses	Team Member	Is team effective overall ?	Step 2: Cluster the Responses
6	Communication	Team Communication	Owner limits the scope individual team member activities and communication	1	Yes	*Owner limits communication and is the only source of project information
6	Communication	Team Communication	Owner is the only entity with significant broad-based information	1		
6	Goals and Objectives	Team goals and objectives	Achieved our team and owner's goals	2		Achieved our team and owner's goals
6	Team relationship	Team Relationship	Owner is very controlling	1		Owner is very controlling
7	Goals and Objectives	Team goals and objectives	Team works well together to accomplish our goals.	3	Yes	*Project goals were set and the team worked well together to achieved the goals.
7	Goals and Objectives	Team goals and objectives	The goals were set and achieved.	5		
7	Team/individual performance	Project Team	CM has made the project delivery more complicated and cumbersone	1		*Eventhough the team has highly effective people, the CM did not fully utilized their strength and abilities thus make things complicated. Team tried their best to accomplish the project as efficiently as they can.
7	Team/individual performance	Project Team	CM team and the design team each have highly effective, top quality people	1		
7	Team/individual performance	Project Team	CM/design team not fully actualized these individual strengths.	1		
7	Team/individual performance	Project Team	Performed our taks as promised to the best of our abilities and as efficiently as possible.	4		
7	Communication	Team Communication	Communication is key	2		Communication is key
7	Team relationship	Team Relationship	Relationship between the CM and the design team has never been adequately defined for CM delivery projects	1		Relationship between the CM and the design team has never been adequately defined for CM delivery projects

Team No	Coding categories	Themes	Step 1: List Out Responses	Team Member	Is team effective overall ?	Step 2: Cluster the Responses
8	Team/individual performance	Project Team	Getting the job done is most important for everyone	1	Yes	*The team managed to meet the job requirements, getting the job completed and successfully addressed all obstacles. Team members care about each other work and established good working relationship
8	Team/individual performance	Project Team	Successfully addressed all roadblocks along the way	4		
8	Team/individual performance	Project Team	Meet the requirements of each job	5		
8	Team/individual performance	Project Team	Paying close attention to each member of the team and how everyone is working in relation to one another	5		
8	Owner Satisfaction	Owner Satisfaction	The team has always worked with the client in mind	3		*Owner satisfaction is the team's priority
8	Owner Satisfaction	Owner Satisfaction	Negotiated on behalf of the client.	3		
8	Goals and Objectives	Team goals and objectives	All work to achieve a goal.	2		All work to achieve a goal.
8	Others	Project Safety	Safety and profitability are some major issues	1		Safety and profitability are some major issues
8	Team relationship	Team Relationship	Worked together with the general contractor on some important decision an issues.	4		Worked together with the general contractor on some important decision an issues.
9	Owner Satisfaction	Owner Satisfaction	Owner says he wants to be a team but in reality dictates	1	No	*Owner dictates the team and does not understand how to successfully operate as a team.
9	Owner Satisfaction	Owner Satisfaction	Owner does not agree with the Team concept for himself	2		
10	Team/individual performance	Project Team	The team has the required expertise and experience	1	Yes	*Team has experienced and knowledgeable members but need to learn the right way to be more effective.
10	Team/individual performance	Project Team	Could be better if not for one person who continues to think that ruffling one's feathers will lead to more effectiveness.	2		
10	Project tasks	Project Phases & Tasks	Effective on some of the basic project requirements but not others	3		Effective on some of the basic project requirements but not others

Team No	Coding categories	Themes	Step 1: List Out Responses	Team Member	Is team effective overall ?	Step 2: Cluster the Responses
11	Managing Conflicts	Team Leadership	Minimal amount of conflicts	1	Yes	Minimal amount of conflicts
11	Project Scheduling	Project Schedule	Project was completed ahead of schedule and well under budget.	1		Project was completed ahead of schedule and well under budget.
11	Respect, trust and honesty	Trust and Values	There is honesty among team members (we are all in this together)	2		There is honesty among team members (we are all in this together)
11	Communication	Team Communication	There is a reasonable amount of listening and hearing out of all ideas and options, constructive discussion and eventually resolution.	2		There is a reasonable amount of listening and hearing out of all ideas and options, constructive discussion and eventually resolution.
12	Team/individual performance	Project Team	We are all willing to help out where needed.	1	Yes	We are all willing to help out where needed.
12	Owner Satisfaction	Owner Satisfaction	Completed the project to the satisfaction of the owner with 85% of the information from the start.	2		Completed the project to the satisfaction of the owner with 85% of the information from the start.
12	Communication	Team Communication	Effective with communication	3		Effective with communication
12	Project Scheduling	Project Schedule	Meeting the Owner's Schedule	3		Meeting the Owner's Schedule
12	Team relationship, Roles and Responsibility	Team Roles and Responsibility	Work together and delegate work	3		Work together and delegate work
13	Owner Satisfaction	Owner Satisfaction	We have the vision producing a great project for the Owner	1	Yes	*Team has clear idea on owner's expectation and is committed to produce a great project and gauge owner's satisfaction on a regular basis
13	Owner Satisfaction	Owner Satisfaction	This project has been a spotlight for the Owner	2		
13	Owner Satisfaction	Owner Satisfaction	Producing a great project for the Owner	2		
13	Owner Satisfaction	Owner Satisfaction	We gauge client satisfaction on a regular basis	3		
13	Problem solving	Team Leadership	If there is a problem or concern - we react to it quickly.	3		If there is a problem or concern - we react to it quickly.

Team No	Coding categories	Themes	Step 1: List Out Responses	Team Member	Is team effective overall ?	Step 2: Cluster the Responses
14	Project tasks	Project Phases & Tasks	Struggle with keeping the Architect engaged in providing clearly defined scope in terms of finalizing design/scope for project allowances	1	Yes	* Project scope is not clearly defined by architect, but meetings are continuously conducted to resolve issues and maintain coordination of project
14	Project tasks	Project Phases & Tasks	Good job of holding weekly meetings to discuss issues, changes, progress, schedule and coordination	2		
14	Communication	Team Communication	The use of mostly email/paperless communication	2		The use of mostly email/paperless communication
14	Problem solving	Team Leadership	Do not compromise our high professional standards when issues need to be resolved.	3		Do not compromise our high professional standards when issues need to be resolved.
14	Project Scheduling	Project Schedule	Project is currently well ahead of schedule and will come in on budget.	2		Project is currently well ahead of schedule and will come in on budget.
14	Respect, trust and honesty	Trust and Values	Trust the quality of each person's work and their contribution to the whole.	3		Trust the quality of each person's work and their contribution to the whole.
14	Team relationship	Team Relationship	Worked well together for this client in the past	3		Worked well together for this client in the past
14	Team/individual performance	Project Team	Sense of urgency can be difficult to convey.	1		Sense of urgency can be difficult to convey.
15	Team/individual performance	Project Team	Making sure to be a team player	1	Yes	*Team members are team plyers and completed their portion of project effectively
15	Team/individual performance	Project Team	Each member of team completed their portion of the project effectively	2		
15	Project Scheduling	Project Schedule	Racing the clock to get our part completed	1		Racing the clock to get our part completed
15	Project tasks	Project Phases & Tasks	Our work has many coordination opportunities	1		Our work has many coordination opportunities
16	Goals and Objectives	Team goals and objectives	Effective in satisfying common interests	1	Yes	*The project goals are clear and satisfy common interests
16	Goals and Objectives	Team goals and objectives	Our clients advise our required outcome as clear as possible	2		
16	Team/individual performance	Project Team	Interdependent functioning were successful	3		* Team functioning were successful and members were satisfied with team performance
16	Team/individual performance	Project Team	Satisfaction with team membership could use significant improvements.	3		
16	Owner Satisfaction	Owner Satisfaction	Meeting the approval of the Client	3		Meeting the approval of the Client
16	Problem solving	Team Leadership	Trying to find a “best fits solution” to all interests.	1		Trying to find a “best fits solution” to all interests.

Team: (Q15) How would you define team effectiveness within a construction project team?

No	Themes	Step 1: List out responses	Frequency	Step 2: Cluster the responses	Frequency
1	Team Roles and Responsibility	Take personal and team responsibility seriously	2	*Roles are clearly defined, agreed and understood by all team members to minimize overlapping responsibilities	15
		Ability to define roles within all design or management disciplines	2		
		Agree with roles assigned	2		
		Members understand their roles	1		
		Understand each others roles	3		
		Operate within their framework and assigned responsibilities	1		
		Understanding the expertise of each person	1		
		Sharing the workload	1	*Members perform assigned responsibilities and take it seriously, shared/distribute team workload	5
		Everyone is on the same page	1		
		Each person on the team recognizing their responsibilities	1		
		Ability to distribute responsibilities to all team-members	1		
		Minimal overlap of responsibilities	1		
		Organized roles	2		
		Need to understand each other's needs over oneself needs	1		
		Members understand their level of decision making authority	1	Members understand their level of decision making authority	1
		Efficient use of the human resources	1	Efficient use of the human resources	1

No	Themes	Step 1: List out responses	Frequency	Step 2: Cluster the responses	Frequency
2	Team Communication	Good communication	4	* The ability to have good, clear, active and effective communication that produces results	18
		Communication is key in all aspects of a construction project	3		
		Clear communication between team members	2		
		Active communication	1		
		Communicating	1		
		Freedom of speech	1		
		A group of individuals that can communicate (speaking and listening)	1		
		Communication produce results	1		
		Communication effectiveness	2		
		Ability to communicate your intent accurately and clearly	2		
		Sharing information	1	*The importance of having effective record keeping and information management	4
		Management project information	1		
		Record keeping	2		
3	Project Schedule	Effectively maintain project schedule	1	*Clearly defined and effectively maintain project scheduling through focusing on critical path helps deliver the project on time	16
		Scheduling priorities	1		
		On time	5		
		Clearly defined project schedule	4		
		Focusing on the critical path	1		
		Bring the project in on time	1		
		Ability to make project deadline	1		
		Delivered within the schedule	2		

No	Themes	Step 1: List out responses	Frequency	Step 2: Cluster the responses	Frequency
4	Owner Satisfaction	Owner Satisfaction	1	*The ability to effectively embrace owner's expectation during the entire project and keep their best interests' resulted in owners satisfaction	15
		Achieved owners expectation	1		
		Client satisfaction	1		
		Focusing on the owner as the end user of the project	1		
		Ensuring a finished product that the owners will be happy with	1		
		Fully meet the owners expectations during design and construction	1		
		The ability to deliver a built product that meets the client requirements	1		
		Satisfied owner	1		
		Keeping the owners best interests' out front	1		
		Effectively embracing the Owner's expectations	3		
		Keeping the interest of the owner priority	2		
		Meets commitments to the Owner	1		
5	Team Goals and Objectives	Team goals and objectives	1	*Team managed to achieve well-defined, clear and consistent common goals that are understood by all members	12
		Have clear goals	3		
		Achieve common goal	4		
		Vision is clear and consistent	1		
		Achieve the overall goals on the project	1		
		Achieve a well-defined, common goal	1		
		Understand project goals	1		

No	Themes	Step 1: List out responses	Frequency	Step 2: Cluster the responses	Frequency
6	Project Phases and Tasks	Project gets completed safely	2	*The ability of team members to accomplish assigned tasks and deliver a completed and well-built project that is compliant, functions as intended, with the highest quality	12
		Striving for top quality	2		
		Project that is compliant	1		
		Achieving a successful outcome - a well-built building	1		
		Quality of work	2		
		Successful outcome in the eyes of the owner, team and contractor	1		
		Project that functions as intended	1		
		Accomplishes tasks with the least amount of work	1		
		The ability for individual construction entities completing their contracted work	1		
		Provide concise and timely designs	2	*The project has clearly defined scope of work, concise designs and properly supervised	8
		Staying on task	1		
		Clearly defined scope of work	2		
		Minimal surprises are met during construction.	2		
		Adequate project supervision	1		
7	Project cost	Effectively maintain project budget	1	*The ability to clearly defined project budget and ensure that the project is cost efficient, maintained and delivered within allocated budget	9
		Under budget	1		
		Clearly defined project cost	2		
		Within budget	3		
		Cost efficient	1		
		Delivered within the budget	1		

No	Themes	Step 1: List out responses	Frequency	Step 2: Cluster the responses	Frequency
8	Project Team	Overcome all challenges gracefully and productively	1	*The team work effectively and efficiently as a team, support and care for each other, managed to overcome challenges and productive which resulted in individual and team satisfaction on the effort well spent.	9
		Team feeling good about the effort that was spent	1		
		Individual performance is key	1		
		Efficiency of work	1		
		Team members satisfaction	1		
		Generates profit for the team members.	1		
		Work together and need each other to accomplish project	1		
		Entire team is on board with the project and really cares about what they are doing	1		
		Strong team support, experience, dedication, reliability	1		
		Willingness to be flexible with your team mates and your individual roles.	1	Willingness to be flexible with your team mates and your individual roles.	1
9	Trust and Values	Respect	2	*Respect and trust each other, as well as work together honestly and fair to get the job done	8
		Show respect to one another along the way	1		
		Trust	1		
		Trust produce results	1		
		Trusting in each person to get the job done	1		
		Honesty and straightforward discussions	1		
		Work together fairly and honestly in all areas	1		

No	Themes	Step 1: List out responses	Frequency	Step 2: Cluster the responses	Frequency
10	Team Leadership	Problem solving	3	*Discuss and work together in teams to provide creative solutions and solve issues as quickly as possible	7
		Allowing creative solutions for issues	1		
		Solve issues that arise as quickly as possible.	1		
		Willingness to discuss the options	1		
		Work together to solve problems	1		
		Conflict resolution	1	*Conflict management should be practiced to in an open and fair manner to avoid finger pointing and disagreements	4
		Finger pointing would not solve conflicts	1		
		Resolve diagreements	1		
		Resolves inevitable issues in an open and fair mannner	1		
		Team leader is organized	1	Team leader is organized	1
11	Team relationship	They work well together as a team	1	*Team willing to work together as a unit and maintain relationship with all members of the team	7
		Willingness to work together	1		
		Ability to unite a group of individuals into one team	1		
		Team members working together daily	1		
		The ability to work as one unit	2		
		Preserve and maintain relationships with all members of the project team	1		
12	Project Change Management	The team ability to manage changes	1	The team ability to manage changes	1