IN-DEPTH CASE STUDY OF A PARTNERED PROJECT DELIVERY

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ABSTRACT

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There has been a lot of research done on the concept of partnering in the Architecture, Engineering and Construction (AEC) industry. Partnering literature provides research on the synthesis of key partnering drivers and performance outcomes in the AEC industry. Research on the barriers to partnering in the AEC industry has also been accomplished. However, an evidence based guide developed based on a case study of a partnered construction project is missing. There is a gap in the literature in empirical and rigorous studies for project partnering in the AEC industry, especially focusing on and documenting its immediate implications, that is: the mediating effects on project performance via improvements in team performance.

To respond to this gap, this study aims at exploring the team dynamics and project progress during the delivery of an AEC project via an in-depth case study. To accomplish this, influence of the partnering process on team performance, team interactions and project outcomes were examined. An aviation construction project was selected as the case study and the collected data was analyzed in a retrospective and longitudinal manner. Using methods such as qualitative analysis of project documents and social network analysis (SNA), the results of the research obtained emphasize on the use of effective system of issue resolution and open communication to achieve a successfully partnered project. The research shows the link between the implementation of partnering practices, change in team interaction, and project performance outcomes. In the end, the researcher combined all the findings and documented lessons learned and recommendations for the industry.

“My research is dedicated to my parents who have given me positivity and confidence to achieve any goal in life”

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Chapter-1. INTRODUCTION

1.1 Overview

Issue of lack of communication has always affected project performance across industries. Same is evident in the Architecture, Engineering, and Construction (AEC) industry projects. Specific contractors for different trades help in getting the needed expertise for the project. However, the increased number of contractors coupled with lack of practices during project delivery to enable open information sharing on a single project gives rise to lack of collaboration within project teams. Moreover, there is a lack of communication between the owner, designer, consultant and the contractor. Mostly subcontracted work also gives rise to the lack of collaboration amongst the contractors. In the AEC industry, there are few types of collaborative project delivery systems such as design-build, integrated project delivery (IPD), lean construction, construction management (CM) as risk and partnering. The focus of this study is project partnering. Project partnering in construction can be adopted under any contractual agreements. Especially with design-bid-build projects where due to low bid requirements with government funded projects, it is difficult to adopt collaborative delivery methods such as design-build, CM at risk and IPD, project partnering provides a good alternative.

Project partnering addresses common interests of owner, designer and contractor. In order to ensure safety and quality with minimum rework, project partnering encourages early involvement of participants at the time of procurement (Eriksson, 2010; Nystrom, 2012; Manley, 2002; Lahdenpera, 2012). Project partnering promotes equal power, resource sharing and open books at the contractual level. Project partnering also encourages open communication of mutual goals & objectives through value engineering, joint problem solving strategies, joint project office, benchmarking, joint project charter, workshops, integrated information sharing system and supply

chain partnering. Inclusion of third party as the facilitator helps in getting unbiased feedback during the workshops. Partnering promotes promise keeping, positive attitude, cooperation, mutual trust, team commitment and team work at individual and team level. Reduced cost and meeting budget cost targets are attributed to measure cost performance. While, better productivity and meeting scheduled targets are attributed to measure schedule performance. In the end, increased client satisfaction, quality improvement and increased safety performance defines high quality and safety performance of a partnered project.

Research on the concept of project partnering in construction has been going on since the last two decades, mostly reporting the benefits and barriers to partnering (Sparkling, 2014). There has been a lot of discussion on different types of boundary conditions, drivers, and team characteristics affecting project performance outcomes within and across partnered versus non-partnered construction projects. However, there is lack of research to create an evidence based guide to successful partnering practice. This research aims to fill the gap via conducting content analysis of project document to understand the effects of partnering on the project performance.

The aim of this research is to respond to the above-mentioned gap via an in-depth case study of partnered project in the AEC industry. First, researcher performed content analysis on the project documents such as partnering session documents, partnering charter, partnering score cards and weekly project meeting minutes. Second, the researcher performed qualitative analysis using the recently developed partnering framework (Mollaoglu and Sparkling, 2015; Sparkling, 2014) and categorized the content from the project documents under the partnering framework. Researcher analyzed the project performance by assessing the six project goals: safety and security, time, budget, quality, public perception, minimize operational disruption and have fun. Third, researcher also developed a process map (Klotz et al., 2009; Lapinski et al., 2006) of the partnering case study

that documents the project performance, key issues, and team interactions and performance during project delivery. Then a reliability check was performed. Fourth, in order to understand the change in team interaction throughout the project, researcher performed Social Network Analysis (SNA). SNA aims at understanding the structure of the organization and the way interactions happened within that organization. Last, results were evaluated and compared and inferences were drawn to understand if and how partnering practices affected project performance outcomes in the case study project.

1.2 Need Statement

The research aims to study a complex construction project where partnering is implemented. Airport construction is one of the most complex construction due to its large scale and high number of stakeholders involved. Moreover, it becomes difficult for the airport authorities to carry out an improvement construction while the airport is fully functional. This is a challenge for both the owner and the contractors as well. For airport facility owners, construction claims remain common and cost and schedule overruns occur frequently, particularly for large, complex projects. When implemented successfully, partnering provides a great opportunity to improve project performance by improving collaboration among key project stakeholders.

Certain airports have achieved outstanding outcomes from the implementation of collaborative partnering. Since 2006, San Francisco International Airport (SFO) has completed more than $1.6B in total installed costs and has experienced no construction claims. They have also optimized the planning, design and construction process, delivering projects 20-30% below industry average while simultaneously including internal stakeholders (e.g. Airlines, Concessions, Maintenance and Operations, etc.) and external stakeholders (e.g. TSA, FAA, Fire, Police, etc.) (Neumayr, 2014). In 2012, Sacramento International Airport used structured partnering to deliver the $687M “Big

Build" Program, which was delivered $12M under budget and 119 days early without claims (Reaugh, 2014).

Despite individual outstanding outcomes on specific projects and on a program-level by several Airports and Departments of Transportation, billions of taxpayer dollars continue to be spent on construction litigation every year. Aviation construction projects in particular are incredibly complex. The vast majority of aviation projects rely on multiple funding sources, take place in highly regulated and secure environments, must allow for ongoing operations where the travelling public walks adjacent to or through ongoing projects and yet no studies on the implementation of partnering for aviation projects exist.

To respond to this gap in the literature, this study builds up on recent meta-analytic synthesis of partnering literature (Mollaoglu et al., 2015; Sparkling, 2014) with the motivation to develop an evidence-based guide to successful partnering practices for implementation in the aviation sector.

1.3 Research Goals and Objectives

The goals of this study are to: (1) Explore the team dynamics and project progress during the delivery of an aviation construction project via an in-depth case study; (2) Examine the influence of the partnering process on team performance, team interactions and project outcomes in this case study; and (3) Build the foundation for a large-scale future study to develop evidence-based documents for partnering in construction projects in the aviation industry. Specific objectives of the study are as follows:

- Develop a process map (Klotz et al., 2009; Lapinski et al., 2006) through qualitative analysis of the partnering case study of a construction project in the aviation industry that

documents the project performance, key issues, and project goals achieved during project delivery;

- Using Social Network Analysis (SNA) techniques, graph team interactions in the form of sociograms on a monthly basis (i.e., time interval for analysis is determined as one month on this project marked by the occurrence of partnering workshops each month) and evaluate them to understand if and how team characteristics and team member interactions change during partnered-project delivery;
- Study project delivery documents and analyze the process map and team interaction models to understand if and how partnering practices affect:
    - The way project teams perform;
    - The way individuals interact in project teams; and
    - Project performance (e.g., cost, RFIs, schedule, quality) during and at the end of the project delivery process.
- Compare SNA results with the qualitative analysis results to understand:
    - If changes in SNA and qualitative results of this study show any links, in other words if the changes in team interactions are associated with the partnering process interventions (e.g., partnering workshops, team meetings, etc.); and
    - Evaluate the links among partnering drivers, team characteristics, and performance outcomes during partnered-project delivery.

To achieve these objectives, the researcher selected a construction case study of a partnered project from the aviation industry with the support of the International Partnering Institute (IPI). The main research question that guides this study is as follows:

"Do project partnering affect team and project performance during AEC project delivery process? If so, how?"

1.4 Research Scope

The unit of analysis in this research project is a case study which is a partnered aviation project in the AEC industry. The scope of the case study project was to provide a special safety zone at the end of the two runways of one of the busiest airports in the United States of America (USA). It included the installation of Engineered Material Arresting Systems (EMAS) to capture the aircraft's landing gear in case it overshoots the runway strip. The project scope also included relocation of landing lights, navigation systems, and other related equipment. The original budget was between $ 50-100 million and the original project schedule was about eight months. Within the scope of this project, partnering session documents, partnering charter, partnering score cards and weekly project meeting minutes were evaluated and analyzed following methods that include: content analysis, qualitative analysis, development of process maps (Klotz et al., 2009; Lapinski et al., 2006) , and social network analysis.

Qualitative analysis helps in producing a systematic categorization of data that can be achieved by studying the team communication (Krippendorff, 2012; Kassarjian, 1977). Whereas, SNA is a method that helps to analyze the social structure by studying the interactions and relationships between the team participants both quantitatively and qualitatively (Hu and Rachera 2008, De Nooy et al. 2005). This research will examine team and project performance along with information exchange patterns, frequency and nature of communications among project team members and stakeholders during project delivery. Qualitative and SNA will be employed to further refine the data at hand, shed light on the changes in team interaction during project delivery

and explore the links between these changes and partnering practices. Section 1.5 gives the overview of methods employed for the research.

1.5 Overview of Methods

A visit to the project site of the case study was organized to kick off the research. Researchers interacted with the team leaders including the owner's representatives, general contractor, consultants and partnering facilitators. Researchers conducted the semi-structured interviews in order to understand the project in a better way. The researchers then collected all the project related documents of the case study.

Content analysis was performed on the project documents. Then the content was qualitatively categorized under the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014). First, process map #1 was developed showing the analysis results of the project documents showing the evidence for partnering drivers and team characteristics categories throughout the project timeline. Second, researchers developed a process map #2 that was the limited version of the process map #1 where only the key issues were reported. Third, process map #3 was developed to illustrate project performance outcomes.

Following the qualitative analysis, SNA was performed to understand the ties (type of communication) that occurred between the nodes (people) and helped in better understanding the flow of information and team interactions within a project network. Teams were categorized under inter-organizational tiers of operation. Tools used to perform SNA are sociogram, network density, degree centrality, betweeness, geodesic distance and closeness. Then the results from qualitative analysis and SNA were compared to conclude with the results.

1.6 Results and Deliverables

Results and deliverables of the research are as follows:

1) Response to the gap in the literature with the motivation to develop an *evidence-based guide to successful partnering practices* for implementation in the aviation sector;
2) Understand the *implications of partnering in an aviation construction project* and *show evidence to if and how the concept of partnering improves project performance*;
3) Verified *partnering framework and suggested changes (if any) in the partnering framework; and*
4) Future guidance to the *use of partnering framework developed through meta-analytical synthesis of partnering literature in qualitatively analyzing the construction project documents.*

1.7 Reader's Guide

Chapter-2 talks about the literature review performed for the study. Methods to perform the research are discussed in Chapter-3 which is then followed by Chapter-4 giving description about the case study project. Results and comparative analysis is conducted in Chaptet-5. Chapter-6 concludes the research.

Chapter-2. LITERATURE REVIEW

2.1 Introduction

This chapter presents the background and types of partnering in the AEC industry. Through this literature review, the researcher provides an in-depth study of project partnering and presents the characteristics of partnering in construction, benefits of partnering, and the barriers to its successful implementation. This chapter also explains the partnered-project delivery framework (Mollaoglu et al., 2015; Sparkling, 2014) that is used for the qualitative analysis in this research. The researcher concludes the literature review section by stating the gaps in the literature and how this research will help in filling that gap.

2.2 Background

Partnering was born with a perspective to provide better performance. Partnering has occurred in different forms depending on the type of industry it is associated with. The concept of partnering was spawn to control project goals such as cost, schedule and quality (Mentzer et al., 2000; Hagedoorn, 1996; Lambert et al., 1996). Total Quality Management (TQM) gave birth to the concept of partnering in the construction industry (Army Corps of Engineers, 2010).

Partnering is mostly evident in the form of joint problem solving, resource sharing and information sharing. Automobile companies such as General Motors (GM) and Toyota incorporated partnering into their supply chain by collaborating with the suppliers to improve project performance. Project performance was improved by delivering better quality with improved cost and procedure of production (Brennan, 1997). However, there are barriers to such collaborations in the form of mutual trust, initial financial investment and lack of team commitment (Brennan, 1997). Similarly, partnering is evident in the telecommunication industry in the form of contractually formulated

joint venture. Mostly it is the larger company that develops a contract while dominating the smaller collaborator. Research and development (R&D) is the main motive for both the companies to agree for the partnering in the contract. Telecommunication company like Microsoft went under a formulated contract with a Japanese company Mitsui to develop microprocessors (Hagedoorn, 1996).

Partnering is a defined process that is designed to overcome the cultural, legislative and organizational barriers at the team level. It encourages teams to work to improve the overall project performance over their individual performance (Mollaoglu et al., 2014). Partnering may occur at the contractual level followed by the partnered procurement of other teams into the project. Partnering practices are the most crucial drivers for the success of any partnered project. Better implementation of partnering practices helps in overcoming the boundary conditions at cultural, legislative and organizational level. Better team characteristics and proper implementation of the partnering drivers can improve cost performance, schedule performance and quality & safety performance. Strategic alliance, public private partnerships and project partnering are the most common types of partnering evident in any industry. Section 2.3 gives the overview about the types of partnering.

2.3 Types of Partnering in the AEC Industry

2.3.1 Strategic Alliance

A formal partnership between two participating companies bound together by one or two contracts can be called as strategic alliance. Usually the partners are not legally bound before a strategic alliance contract is in place, which restricts them to form an agency or a corporation (Lahdenperä, 2012; Loraine, 1993). Advantages of such ventures are shared risks, shared knowledge, opportunities for growth, better cost performance, and assistance in overcoming the complexities associated with large scale projects. Companies prefer to incorporate strategic alliance when they want access to new technology, to improve R&D, to reduce administrative cost and to learn from

the partners (Anderson & Polkinghorn, 2011). Such strategies help in diversification that allows each partner to concentrate on their expertise to achieve competitive advantage. There are disadvantages when one company has to share its business secrets with another company which may not want to pursue a contract agreeing to keep those business secrets classified. Partnering can also create a competitor if the strategic partner grows enough to separate itself from the alliance and perform alone.

2.3.2 Public Private Partnerships

In public-private partnerships (also called PPPs), the project is funded by the government along with one or more private sector companies working as a partner for that project. There is increase in the implementation of public private partnership because this kind of alliance helps state and local government to set up non-profit organizations to provide government services to the people (Smith, 2008). It is really important that the partnership is balanced for it to be successful. There should be continuous involvement from both the parties to maintain the service provided by the partnership. There are often failures if the partnership is taken lightly (Babiak and Thibault, 2008).

Most of the non-profit organizations have long-term goals to be achieved. Usually, the timeline to achieve the goals is defined by the governments depending on the election tenures (Ferris and Williams, 2013). There is a disadvantage when the parties are unable to decide the direction for the flow of the funding. This might result in project losing its time and resources (Babiak et al, 2008). Communication plays a huge role in the success of such projects. It is mostly a cross-sector partnership where it cannot be easy to collaborate due to different spoken languages and cultural differences (Babiak et al, 2008).

For a successful PPP, there should be a program defining the milestones of the partnerships. Partnership termination causing issues such as lack of trust and cooperation can be avoided with a properly drafted agreement between the participants (Bloomfield, 2006). There should be a defined conflict resolution strategy that should be in the agreement. This results in committed teams for issue resolution to make project successful.

2.3.3 Project Partnering

Project partnering (also referred to as partnered-projects or partnered-project delivery within this thesis) can be defined as a commitment of team participants to achieve mutual goals and objectives (CII, 2011). Project partnering can be delivered through design-build, IPD, lean construction, CM at risk and partnering. Specifically, partnering is carried forward with a neutral facilitator who conducts workshops. All the project participants who can affect the project performance are required to attend these workshops. Such workshops act as platform for everyone to discuss their problems with others. This creates respect for each other's problems. Workshops allow facilitator to give feedbacks to the team participants to strengthen the collaboration.

The three main aspects that are discussed during such workshops are: (1) Mutual goals and objectives; (2) Issue resolution and decision making procedure; and (3) Specifications to gauge and improve the overall project performance. In short, focus of partnering workshops is to improve the project performance by strengthening the collaboration amongst all the participants and stakeholders (Mollaoglu, Sparkling, & Thomas 2015). Therefore, feedbacks via workshops ensure that a project is actually receiving the advantages of project partnering (Bennett and Peace 2006). Sections 2.4, 2.5, 2.6 and 2.7 discuss specifically about project partnering in the AEC industry as the focus of this research study.

2.4 Project Partnering

Project partnering can be implemented in any design and construction project and under any contractual arrangement. Partnering helps in resolving the issues without no loss of time and money. International Partnering Institute (IPI) defines partnering as a tool to keep construction project 'on-time, on-budget' (Dyer, 2014).

2.4.1 Characteristics of Project Partnering

Project partnering is about addressing the common interests of owner, designer and contractor. Partnering provides safety and quality with minimum re-work while project execution. Partnering encourages the use of partnering drivers at contractual, procurement and execution level. These drivers should be implemented with better team characteristics at individual level and team level. Then the project performance outcome can be defined by gauging cost, schedule, quality and safety throughout the project timeline.

Procurement drivers like the early involvement of participants in design process, joint contractor selection and broad partnering teams with prior partnering experience offers successful partnered project at the procurement level (Eriksson, 2010; Nystrom, 2012; Manley, 2002; Lahdenpera, 2012). Partnering contractual drivers encourage equal power, resource sharing and open books. It is also required to establish and communicate the conflict resolution strategy in the contract. Adoption of alternative dispute resolution (ADR) strategy at the contractual level is preferred (Eriksson, 2010; Nystrom, 2012; Lahdenpera, 2012). Partnering practices identified in the literature includes value engineering, joint problem solving, benchmarking (monitoring of partnering), joint project charter, workshops, integrated information sharing system and supply chain partnering. Inclusion of third party as the facilitator helps in getting unbiased feedback

during the workshops. Partnering practice like determining clear definition and lines of responsibilities helps in communicating mutual goals and objectives. Joint project office is a practice that helps in open communication within all the project participants (Rogge, Griffith, & Hutchins, 2002).

Team characteristics at the individual level should include promise keeping and positive attitude. Literature also states that cooperation, mutual trust, team commitment and team work are the team characteristics at the team level (Black, Akintoye, & Fitsgerald, 2000; Cheng, Li, & Love, 2000).

Factors that measure project performance outcomes are cost, schedule, quality and safety. Reduced cost, value engineering savings and meeting budget cost targets are attributed to measuring cost performance. Better productivity, reduced time in delivering the project and meeting scheduled targets are attributed to measure schedule performance. Increased client satisfaction, better workmanship, quality improvement, reduced re-work and increased safety performance defines high quality and safety performance.

2.4.2 A Guide to Project Partnering

In 2014, IPI developed an owner's guide, 'On-Time, On-Budget', to assist owners in setting up partnering for their construction projects (Dyer, 2014). This guide was prepared based on feedback from the pioneers in the field who have already implemented partnering successfully for many years. It provides a matrix for vertical, horizontal, and aviation (i.e., combination of vertical and horizontal) construction projects defining the methodologies to be followed in AEC projects to successfully implement partnering throughout project delivery. The matrix considers parameters such as project value, complexity, political significance and relationships in outlining the required methodologies to be followed for successful execution of partnering. Level 5 is the most stringent

while level 1 is the most lenient in following the set of partnering requirements given in the project matrix. Once the project is classified under a particular level based on the above mentioned parameters, matrix lists the expected benefits of partnering and the approximate cost to owner to implement partnering. Matrix also lists the partnering elements that must be implemented in the project.

2.5 Benefits of Partnering

Not all the benefits of partnering are measurable directly in traditional means of performance. Most of the benefits, although have mediating effects on performance via team performance, are unnoticeable. Some of the measurable benefits of partnering can be categorized under cost, schedule, safety, quality, claims, and job satisfaction (Chan, Chan, Chiang, Tang, Chan, & Ho, 2004; Black et al., 2000; Grajek, Gibson, & Tucker, 2000; Granberg, Dillon, Reynolds, & Boyd, 1999).

Partnering helps in lowering the total project cost by increasing profitability through value engineering. There is a huge reduction in the number of claims that results in reduced cost and delays due litigations. Partnering promotes quality by reducing the rework and change orders which help in cost reduction and reduces derailment of project from its overall schedule (Sparkling, 2014). Open communication also helps in reducing the number of accidents which in turn reduces the number of hours lost due to such incidents. With minimal or no accidents, partnering also helps in maintaining high safety rating. Partnering helps in increasing the job satisfaction for all the team participants by encouraging mutual trust and communication.

All the above mentioned benefits of partnering are the results of partnering practices such as establishing & clearly communicating conflict resolution strategies, working with win-win

attitudes, feedback through regular monitoring of partnering process, clear definitions of lines and responsibilities for the participants, and willingness & openness to share resource among project participants (Sparkling, 2014). In a nutshell, partnering helps in keeping project on time and within budget with no claims and utmost job satisfaction (Dyer, 2014).

2.6 Barriers to Partnering

Barriers to partnering can be categorized under four main categories: (1) Organizational/Program level barriers; (2) Legislative/Governance barriers; (3) Cultural barriers; and, (4) Project team barriers (Sparkling, 2014; Mollaoglu et al., 2015). The above mentioned categories of barriers are further classified under: (1) Barriers to adoption of partnering; and, (2) Barriers to partnering success during project delivery (Sparkling, 2014; Mollaoglu et al., 2015). Table 1 and Table 2 defines the barrier to partnering in the architecture, engineering and construction industry. Table 1 and Table 2 specifically defines the list of barriers to adoption of partnering on project and the list of barriers to partnering success during project delivery, respectively.

Table 1: Barriers to Adoption of Partnering on Projects (Sparkling, 2014; Mollaoglu et al., 2015)

Organizational/Program Level Barriers	• The perception of unfair risk sharing • Perceived cost of partnering • People feel that partnering means giving up something • Not willing to invest time for partnering development
Legislative/Governance Barriers	• Public project legislation requires award to the lowest bidder • Competitive bidding creates an adversarial relationship • Organizations' policies provide inadequate support
Cultural Barriers	• Misunderstanding of partnering • Adversarial mentality within the construction industry • Concerns with over-dependency on others • Open exchange of information among partnering participants • Past negative relationships with team members

Table 2: Barriers to Partnering Success during Project Delivery (Sparkling, 2014; Mollaoglu et al., 2015)

Organizational/Program Level Barriers	• Not willing to invest time for partnering development
Cultural Barriers	• Open exchange of information among partnering participants • Past negative relationships with team members • Lack of trust among partnering participants • Communication problems between team members • One party committing to partnering process more than other • Cultural differences in negotiation styles
Project Team Related Barriers	• Lack of support from company management • Resistance from project team members • Major partnering organization influencing decisions • Misaligned goals and priorities among companies • Responsibilities tend to overlap among team members • Lack of partnering training workshops early on in the project • Pre-partnering training fades over the course of the project • Parties fear to share too much information outside companies • Companies/Managers inability to relinquish decision-making

2.7 Partnered-Project Delivery Framework

Partnered-project delivery framework used for the qualitative analysis in this research was developed through an in-depth study on the partnering literature to collect the frequently occurring measures and outcomes related to the concept of project partnering in construction (Mollaoglu et al., 2015; Sparkling, 2014). While gathering these measures, researchers could also observe the emerging categories that resulted in the formation of the partnered project delivery framework. Categories are as follow:

- **Boundary Conditions:** These conditions can be cultural, legislative or organizational.
- **Drivers:** They are partnering features at procurement, contractual and practice level.

- **Team Characteristics:** These are the characteristics of participants at team level and individual level.
- **Project Outcomes:** These are categorized as project performance outcomes and organizational outcomes.

The Figure 1 below shows the relationships of the above mentioned partnering framework categories.

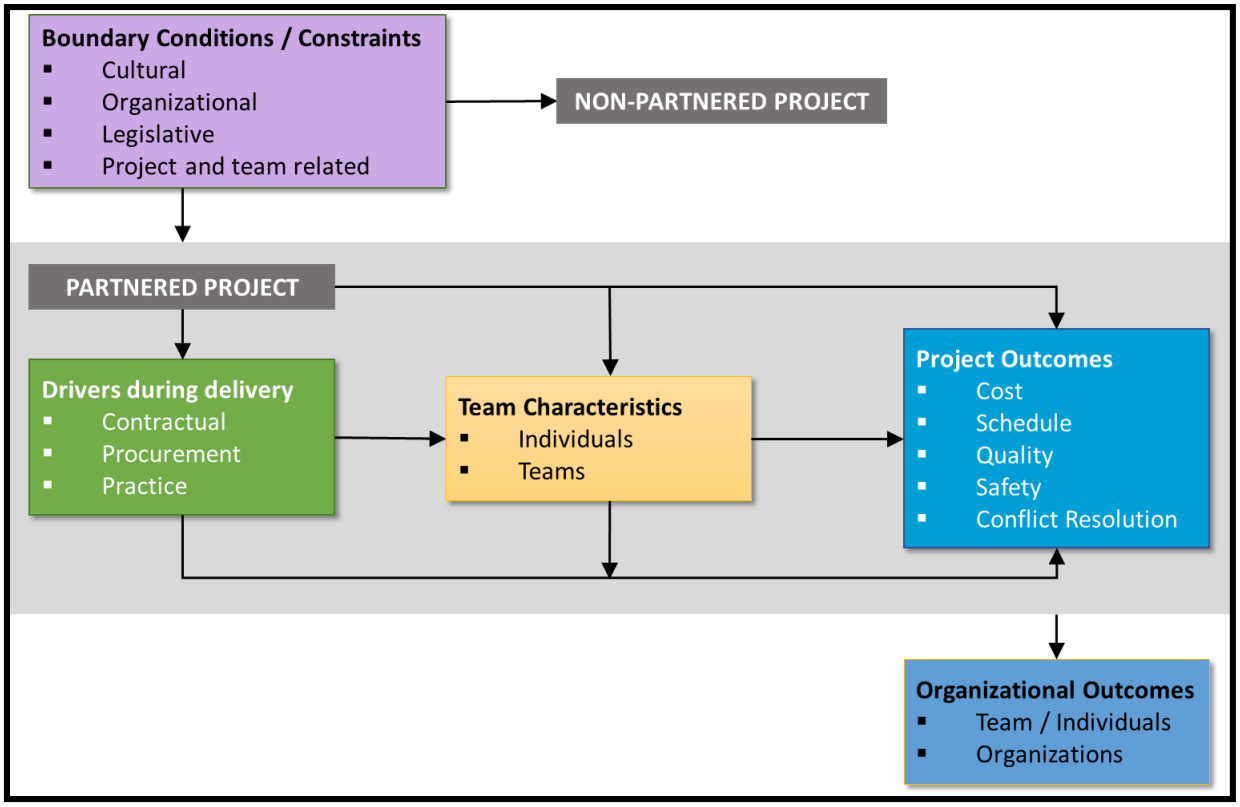


Figure 1: Partnered project delivery framework categories and their relationships (Mollaoglu et al., 2015; Sparkling, 2014)

2.7.1 Boundary Conditions

Boundary condition is a category that defines the conditions that resists the implementation of partnering in project delivery. There conditions can be further divided into cultural, legislative and organizational (Mollaoglu et al., 2015; Sparkling, 2014):

- *Cultural:* Boundary conditions results in the lack of effective communication and dialogue within the inter-organizational project participants.
- *Legislative:* Factors like stringent public rules & regulations and bureaucratic organizations become hurdles in partnering.
- *Organizational:* Availability of resources, initial cost of partnering, lack of long term relationship and staff continuity & availability are identified under organizational boundary conditions.

2.7.2 Drivers

Drivers is a category that states the factors that are implemented at the procurement, contractual and practice level to get better project performance outcomes with partnering (Mollaoglu et al., 2015; Sparkling, 2014):

- *Procurement:* Drivers at the procurement level help adopting partnering practices early in the project.
- *Contractual:* Partnering drivers incorporated at the contractual level helps in defining strategy at the early stage through everyone's consent.
- *Practices:* Partnering practices are workshops, feedback survey, joint project charter, third party facilitator, joint problem solving,

2.7.3 Team Characteristics

Team characteristics can be good as well as bad for partnering. Team characteristics affect boundary conditions and the implementation of the partnering drivers and vice versa. Team characteristics can be categorized at team level and individual level (Mollaoglu et al., 2015; Sparkling, 2014):

- *Team-Level Characteristics:* Mutual trust, team commitment, mutual interest, cooperation, ego and personality differences can affect the team work considerably.
- *Individuals' Characteristics:* Unenthusiastic participation can hinder partnering. On the other hand, positive attitude, integrity, promise keeping and reliability are the positive characteristics for partnering.

2.7.4 Project Outcomes

Partnering outcomes can be further divided in to project performance outcomes and organizational outcomes (Mollaoglu et al., 2015; Sparkling, 2014):

- *Project Performance Outcomes:* Performance outcomes can be further divided into cost, schedule, safety, quality, and conflict resolution. Partnering outcomes are reduced cost, project on time, increased safety, owner satisfaction and adaption of conflict resolution strategy.
- *Organizational Outcomes:* Outcomes aims at improved relationships for project participants and maintaining long-term relationship with enhanced reputation. This results in better team work with the same participants on the future projects.

2.8 Summary

The partnering literature presents the evolution of partnering to control cost, schedule and quality (Army Corps of Engineers, 2010). Partnering was evident in the automobile industry to improve the quality of supply chain (Brennan, 1997). Whereas, telecommunication industry required partnerships in R&D in order to share resources and expertise (Hagedoorn, 1996). Strategic alliance came into existence to get the advantages of sharing risk and knowledge that can help in overcoming the poor cost performance and large scale complex projects (Anderson et al, 2011). Public-private partnership was government venture with one or more public entities to support its non-profit programs for the public welfare.

Project partnering was similar to strategic alliance but also had mutual goals and objectives, issue resolution process and project performance outcomes defined contractually at the time of team procurement. Project partnering included IPD, CM at risk, lean construction and partnering. Later researcher specifically talks about the partnering literature focusing on the characteristics of partnering including boundary condition, partnering drivers, team characteristics and project performance outcomes that were defined by the partnered project delivery framework. Literature also discusses about the benefits of partnering in terms of cost, schedule, safety and quality along with the barriers to successful partnering (Mollaoglu et al., 2015; Mollaoglu et al., 2015; Sparkling, 2014). Researcher also presented the IPI's matrix defining the norms for the successful partnering of vertical, horizontal and aviation construction projects depending on the project scale as a recent and practice-based guide to project partnering.

The researcher found extensive literature in the field of partnering in construction project delivery. However, there is a gap in the literature in empirical and rigorous studies for project partnering in the AEC industry, especially focusing on and documenting its immediate implications, that is: the

mediating effects on project performance via improvements in team performance. To fill this gap in the literature, researcher performed an in-depth case study to understand and illustrate if partnering actually improves the project performance outcomes or not. Researcher also aims to identify the key factors that are interdependent on each other for the success of a partnered project delivery.

Chapter-3. METHODS

3.1 Introduction

This chapter defines research goals and objectives along with the research approach to meet them. Data collection procedures such as Institutional Review Board (IRB) approval, visit to the case study site, semi-structured interviews, and access to project documents through information sharing platform are discussed. This chapter also presents the data analysis procedure such as content analysis through qualitatively analyzing the project documents, SNA, comparative analysis and maintaining data quality through reliability check.

3.2 Research Goals and Objectives

The goals of this study are to: (1) Explore the team dynamics and project progress during the delivery of an aviation construction project via an in-depth case study; (2) Examine the influence of the partnering process on team performance, team interactions and project outcomes in this case study; and (3) Build the foundation for a large-scale future study to develop evidence-based documents for partnering in construction projects in the aviation industry. Specific objectives of the study are as follows:

- Develop a process map (Klotz et al., 2009; Lapinski et al., 2006) through qualitative analysis of the partnering case study of a construction project in the aviation industry that documents the project performance, key issues, and project goals achieved during project delivery;
- Using SNA techniques, graph team interactions in the form of sociograms on a monthly basis (i.e., time interval for analysis is determined as one month on this project marked by the occurrence of partnering workshops each month) and evaluate them to understand if

and how team characteristics and team member interactions change during partnered-project delivery;

- Study project delivery documents and analyze the process map and team interaction models to understand if and how partnering practices affect:
    - The way project teams perform;
    - The way individuals interact in project teams; and
    - Project performance (e.g., cost, RFIs, schedule, quality) during and at the end of the project delivery process.
- Compare SNA results with the qualitative analysis results to understand:
    - If changes in SNA and qualitative results of this study show any correlations. For example, if the changes in team interactions are associated with the partnering process interventions (e.g., partnering workshops, team meetings, etc.); and
    - Evaluate the correlations among partnering drivers, team characteristics, and performance outcomes during partnered-project delivery.

To achieve these objectives, the researcher selected a case study of a partnered project from the aviation industry with the support of the International Partnering Institute (IPI). Figure 2 shows the overall goals and objectives of the research.

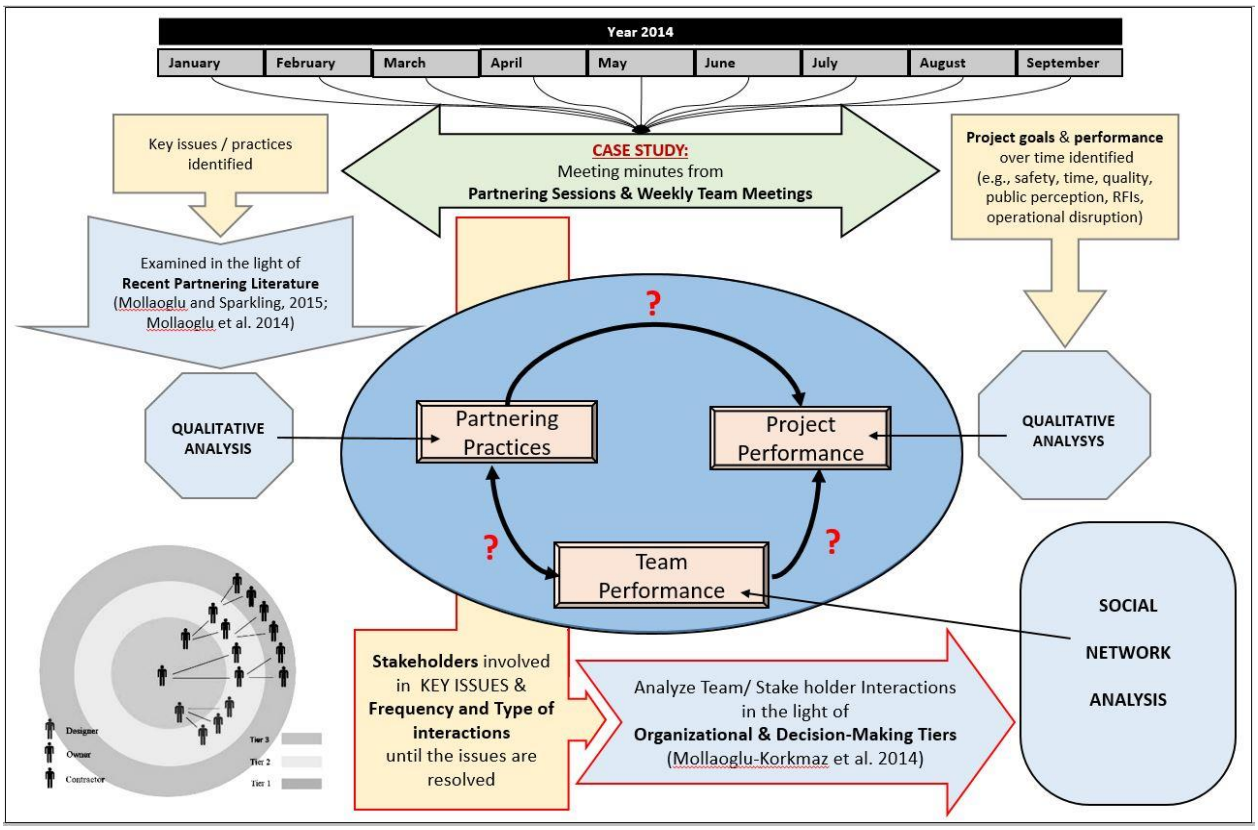


Figure 2: Proposed Methodology

The main research question that guides this study is as follows:

> *"Do project partnering affect team and project performance during project delivery process in aviation construction projects? If so, how?"*

3.3 Research Approach

The unit of analysis in this research project is a case study which is a partnered aviation project in the AEC industry. The scope of the case study project was to provide a special safety zone at the end of the two runways of one of the busiest airports in the United States of America (USA). It included the installation of Engineered Material Arresting Systems (EMAS) to capture the aircraft's landing gear in case it overshoots the runway strip. The project scope also included relocation of landing lights, navigation systems, and other related equipment. The original budget

was between $ 50-100 million and the original project schedule was about eight months. Within the scope of this project, partnering session documents, partnering charter, partnering score cards and weekly project meeting minutes were evaluated and analyzed following methods that include: content analysis, qualitative analysis, development of process maps, and SNA.

The data coding and analysis were performed via following methods:

- A content analysis was performed on the project documents including partnering session documents, partnering charter, partnering score cards, and weekly project meeting minutes. Partnering session documents and partnering charter included project goals, dispute resolution ladder and partnering maintenance.
- Qualitative analysis was conducted using the categories defined in the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014). The researcher also categorized project goals such as, safety and security, time, budget, quality, public perception, minimize operational disruption and have fun. Project performance was then measured using the score cards.
- Project documents were analyzed to develop process maps (Klotz et al., 2009; Lapinski et al., 2006) and explore team dynamics and performance over project delivery.
- A reliability check was done to maintain data quality.
- SNA was performed that helped the researcher further refine the data at hand, shedding light on the change in team interaction during project delivery; and exploring the correlations between these changes and partnering practices.

- Finally the data coded via the steps above were compared to respond to the research question and develop data collection tool and procedures for future large scale research project.

3.4 Data Collection

This section presents the data collection procedures followed to conduct this research. Mandatory procedure such as taking approval from the International Review Board (IRB) is discussed. Overview of the procedures to conduct interviews and the collection of project documents through web based sharing platform is also discussed in this section.

3.4.1 Institutional Review Board Approval

Institutional Review Board (IRB) states that the research involving human participation has to obtain their approval before any data collection starts. Appendix A show the approval letter from IRB for the research. Two consent forms were also developed for the research. Consent form – A can be found in Appendix A which specifically asks team participants their permission to collect and analyze project delivery documents, project meeting minutes and any type of information exchange among project participants. Consent form – B can also be found in Appendix A which asks team participants their permission to conduct telephonic interviews where voice may be recorded.

3.4.2 Site Visit

Case study selection was kicked off by a visit to the selected airport to meet and interact with the case study project team leaders. The researcher met key project participants during this visit and conducted a round table meeting with them to define the perimeters of this research study. The

meeting helped in collecting participant's perceptions about partnering in the AEC industry and how it helped in the case study project.

3.4.3 Semi-Structured Interviews

During the site visit, the researcher met the project manager in-person to further learn about the case study, the parties involved and the timeline of the case study. Researchers also met the major project participants during this visit, explained about the research and got their verbal consent for the research. The researcher also conducted phone interviews and email communication with the key participants as and when required during the analysis of project documents. The objective of these phone calls and emails was to verify the information gathered in project documents and the researcher's interpretation for those. The phone interviews were recorded based on the participants' consents.

3.4.4 Project Web-Based Information Sharing Platform for Collection of Key Documents

The researcher was given access to the web-based information sharing platform for the case study project that was used by the project participants to store partnering session documents, partnering charter, partnering score cards, and weekly project meeting minutes. The information sharing system was managed by owner's representatives and other team participants had password protected access to this system. Following is the brief description of the project documents accessed via the project's web-based information sharing platform and analyzed:

- *Partnering charters / Partnering session meeting minutes:* Partnering charter was analyzed to understand the key issues, project goals, dispute resolution ladder, team interactions and partnering maintenance strategies. Partnering sessions were held monthly where all the team participants discuss their problems with each other. The main participants of these

sessions were the executive team members representing the owner and the general contractor. Also, there were sessions held after these executive's meeting, where representatives of all the consultants and subcontractors also joined in along with the owner's and general contractor's representatives. These sessions were facilitated by a third party facilitator. The purpose of these sessions was to discuss the key issues affecting the project performance. Participants also discussed the team performance towards achieving project goals such as safety, security, schedule control, cost control, quality control, good public perception, minimizing operational disruption, and having fun. These sessions also helped in getting feedbacks from the facilitators and other team participants as well.

- *Partnering score cards:* Each key issue and project goal was scored on the scale of 1 to 5, with 1 being poor and 5 being excellent. Items were scored by the team members and then the average of these scores was calculated to be the score for that issue. Scores describes the agreement of team members over an issue. These scores were collected via web based survey conducted by the partnering facilitator after each monthly partnering sessions and were given to the teams as a feedback during next month's partnering session.
- *Weekly project meeting minutes:* Weekly meetings were held every Wednesday throughout the project timeline. These meeting minutes were extensively analyzed to understand the team interactions on weekly basis.

3.5 Data Analysis

This section describes the data analysis procedure. Via the data analysis, researchers tracked key issues and project goals addressed during project delivery. The researcher measured the practices followed during project delivery, change in team performance and change in project performance.

In the end, researcher reported the project outcomes by analyzing the project goals achieved. Data Analysis was performed using two methods, i.e. Qualitative Analysis and SNA. First, data analysis was performed via qualitatively analyzing the project documents, i.e. qualitative analysis. Following qualitative analysis, SNA was performed to understand the team interactions. Data quality was maintained through reliability check. Then comparative analysis was performed to get the results.

3.5.1 Qualitative Analysis: Introduction

Qualitative analysis aims at understanding why a decision was made and the effect of that decision on the project performance. It also aims at understanding the circumstances that led teams to make that decision. The researcher used the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014) to categorize the key issues, practices and project goals. To accomplish this, the researcher used the methodology of creating process maps (Klotz et al., 2009; Lapinski et al., 2006) to list the key issues and practices the occurred over the timeline of the project delivery. Section 3.5.2 present the use of partnering framework in qualitative analysis. Also, section 3.5.3 focuses on the methodology followed to develop the process maps as a part of the qualitative analysis.

3.5.2 Qualitative Analysis: Use of Partnered-Project Delivery Framework

Recently developed framework (Mollaoglu et al., 2015; Sparkling, 2014) of partnering constructs were used to conduct qualitative analysis of the collected project documents.

Issues and items in the partnering session documents were categorized according to the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014) broadly defined under boundary conditions, partnering drivers, project team characteristics, project outcomes and organizational outcomes.

Then based on the relationships of the categories defined in Figure 3, research was limited to partnering drivers, team characteristics and project outcomes.

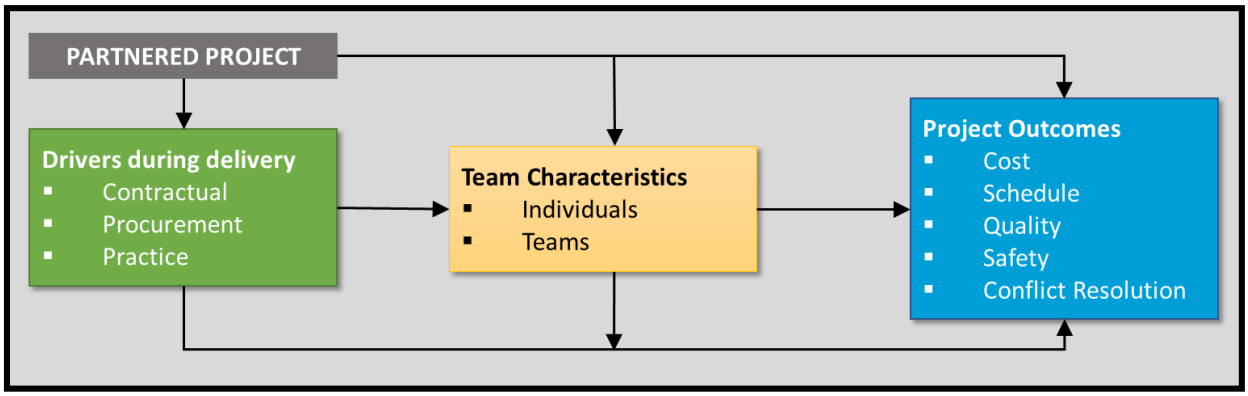


Figure 3: Limited version of Partnering Framework followed in the data analysis (Mollaoglu et al., 2015; Sparkling, 2014)

The key issues in the meeting minutes of the partnering session documents contained all the information regarding major communications that took place between all the project teams. There were problems and agendas which were also discussed during these sessions. Lot of major information was communicated to the project team members at that time. Particular work items and their deadlines were also mentioned during these sessions. Key issues discussed during the sessions of March, April, May, June and July were then scored on the scale of 0 to 5, with 1 being poor and 5 being excellent. For example, performance of the team on a particular issues was self-scored by the team members and then the average of these scores was calculated to be the score for the overall team performance for that particular issue. Scores also describes the agreement of team members over an issue. These scores were mostly given to the teams during the succeeding partnering sessions in the form of Score Cards by the facilitator for the partnering sessions. This process was a part of the practice of giving feedback to the participants.

Figure 4 gives a summary of an example of how an issue was resolved over a period of time. Identity of the owner, contractor and supplier involved in this issue has not been disclosed.

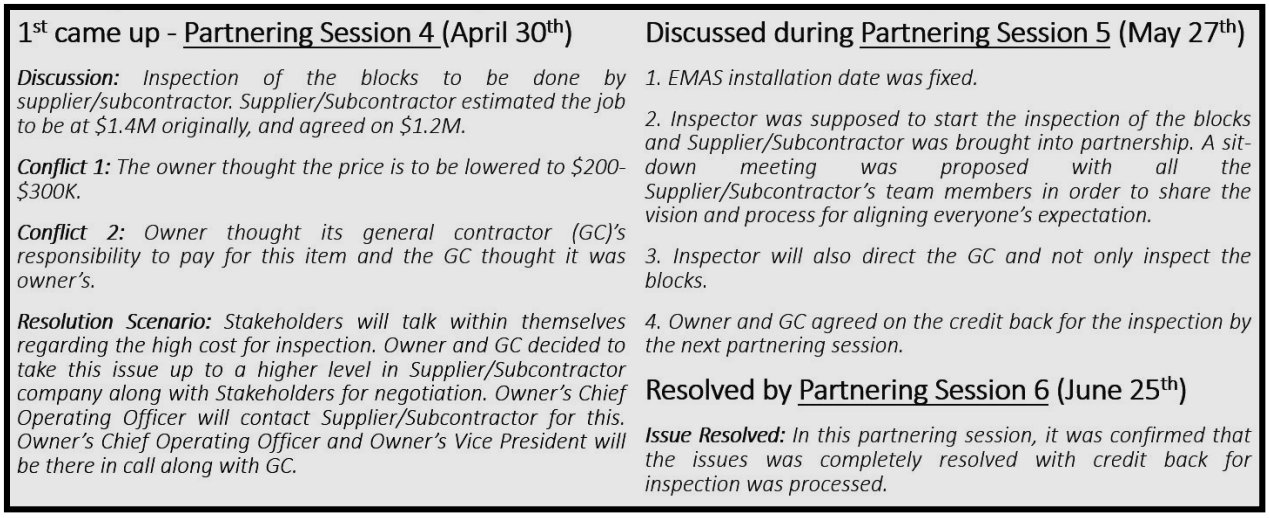
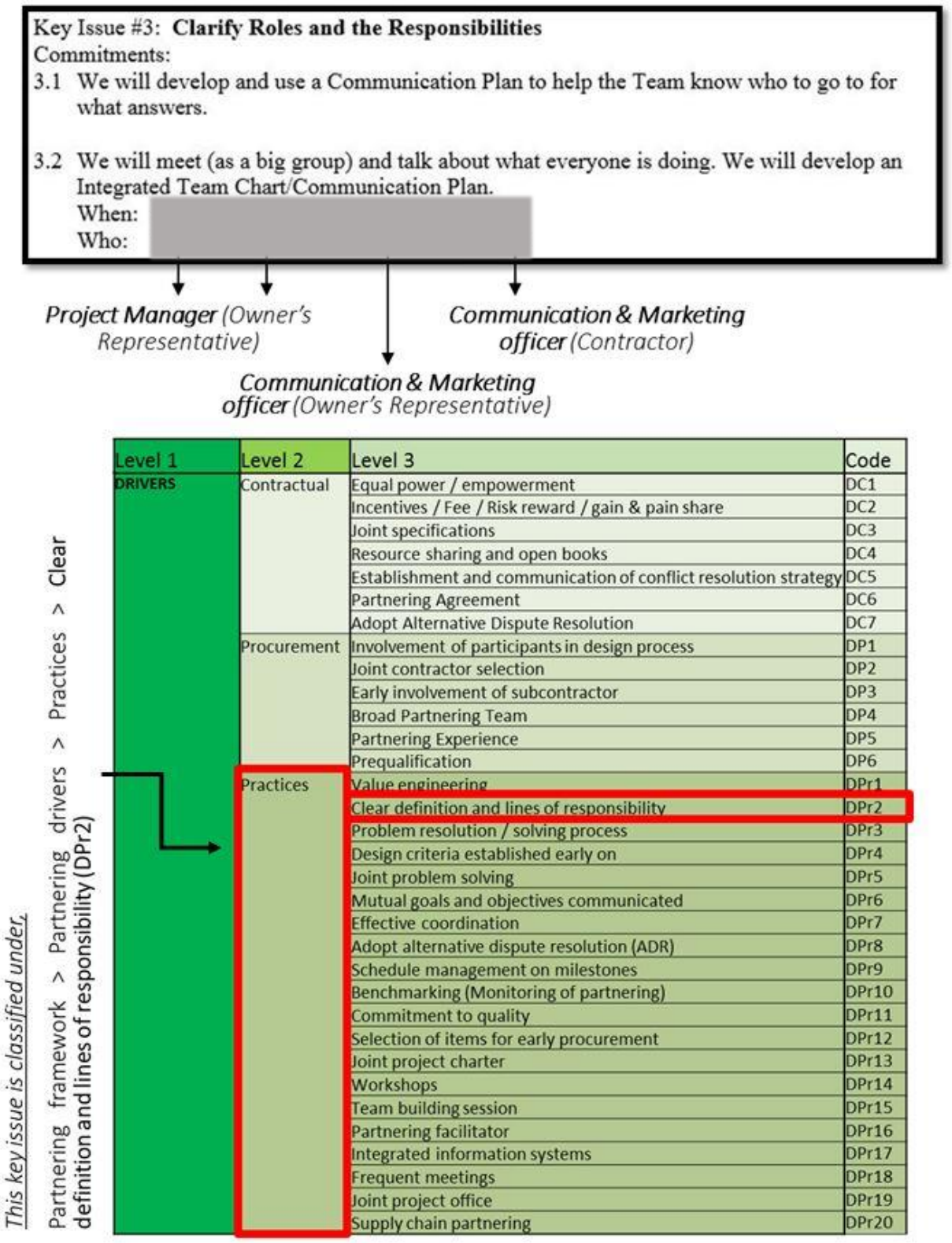


Figure 4: Sample Issue Resolution: Issue of Runway Block Installation

The researcher used Atlas.ti software to categorize such content under the partnering framework. Figure 5 shows the sample of the content analysis for the partnering drivers. Similarly, content analysis for team characteristics and project outcomes was also performed.



Level 1	Level 2	Level 3	Code
DRIVERS	Contractual	Equal power / empowerment	DC1
		Incentives / Fee / Risk reward / gain & pain share	DC2
		Joint specifications	DC3
		Resource sharing and open books	DC4
		Establishment and communication of conflict resolution strategy	DC5
		Partnering Agreement	DC6
		Adopt Alternative Dispute Resolution	DC7
	Procurement	Involvement of participants in design process	DP1
		Joint contractor selection	DP2
		Early involvement of subcontractor	DP3
		Broad Partnering Team	DP4
		Partnering Experience	DP5
		Prequalification	DP6
	Practices	Value engineering	DPr1
		Clear definition and lines of responsibility	DPr2
		Problem resolution / solving process	DPr3
		Design criteria established early on	DPr4
		Joint problem solving	DPr5
		Mutual goals and objectives communicated	DPr6
		Effective coordination	DPr7
		Adopt alternative dispute resolution (ADR)	DPr8
		Schedule management on milestones	DPr9
		Benchmarking (Monitoring of partnering)	DPr10
		Commitment to quality	DPr11
		Selection of items for early procurement	DPr12
		Joint project charter	DPr13
		Workshops	DPr14
		Team building session	DPr15
		Partnering facilitator	DPr16
		Integrated information systems	DPr17
		Frequent meetings	DPr18
		Joint project office	DPr19
		Supply chain partnering	DPr20

Figure 5: Sample Content Analysis using Partnering Framework (Mollaoglu et al., 2015; Sparkling, 2014). Snapshot is from the Meeting Minutes of Partnering Session 3

3.5.3 Qualitative Analysis: Development of Process Maps

Process map methodology is capable of analyzing the whole process and not just the part and phase of the project (Klotz et al., 2009; Lapinski et al., 2006). It is the pictorial way of showing the process and helps in visualizing the whole process at a glance. Process map helps in showing the activities and issues that took place throughout the project timeline (Klotz et al., 2009; Lapinski et al., 2006). Partnering charter & partnering session meeting minutes, weekly meeting minutes, and project score cards were analyzed to create process maps. First, process map #1 (Figure 6) was developed showing the analysis results of the project documents showing the evidence for partnering drivers and team characteristics categories throughout the project timeline. Second, the researcher developed a process map #2 (Figure 6) that was the limited version of the process map #1 where only the key issues were reported. Third, process map #3 (Figure 6) was developed to illustrate project performance outcomes. Full size process maps are attached in Appendix D. Below are the snapshots of the process maps. Using the results from the process maps, researchers developed graphs for the comparative analysis.

Following the development of the process maps, the researcher prepared graphs describing the occurrence of partnering drivers, different team characteristics and project outcomes over the project timeline. These graphs were then compared to analyze their effects on the project performance. Chapter-5 presents graphs and their comparative analysis.

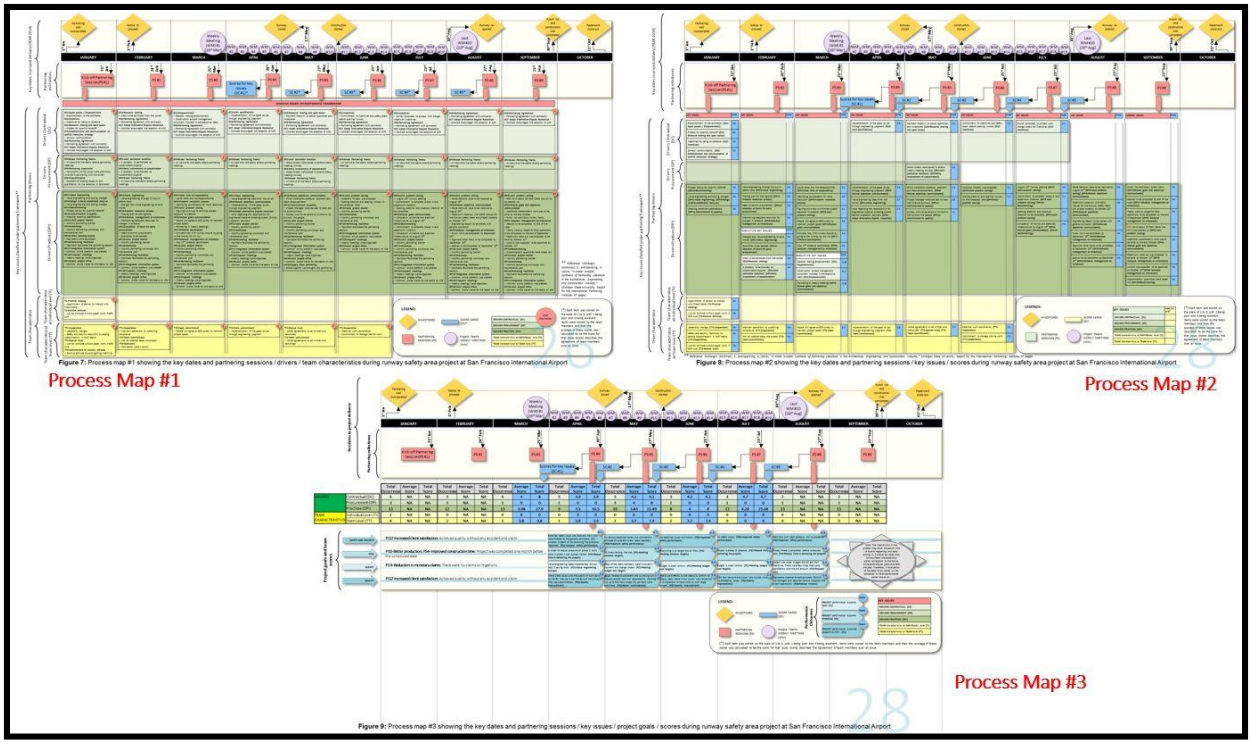


Figure 6: Snapshots of the Process Map #1, #2 and #3

3.5.4 Social Network Analysis: Introduction

Project team integration and team communication have always been the matter of interest to the researchers studying the concept of project delivery in the AEC industry (Gultekin et al., 2013). To improve the quality of project delivery, coordination between the modes of operations, engineering and construction longitudinally (i.e., across the time) is really important. To achieve better productivity and quality, team integration between design and construction is really important (Gultekin et al., 2013). Pocock (1996) measured people interaction and duration of interaction, and introduced the method as the measure of "the degree of interaction". The study helped in measuring the coordination of design and construction process.

In 1934, Moreno introduced a tool for the researcher and named it as Social Network Analysis (SNA). SNA provides the formal representation of the team interaction through sociograms (Chinowsky et al., 2008). Social network analysis is a process that helps in understanding the

factors like formal communication, informal communication, information exchange and exchange of project technical information longitudinally (Chinowsky et al., 2008). SNA helps in understanding the ties (type of communication) that occurred between the nodes (people) and helps in better understanding the flow of information and team interactions within a project network. Therefore, the researcher chose to perform SNA for studying the change in team interaction longitudinally for the case study project.

Inter-organizational AEC project teams constitute of complex contractual, organizational, and hierarchical boundaries which influence how project teams interact, function, and perform. Mollaoglu-Korkmaz, et al (2014), classified such tiers of operation as (Figure 7):

- **Tier 1:** Tier 1 includes team members (i.e., majority of the time project managers) from main project participant teams (e.g., owner, designer, and contractor) that represent their home organizations within an inter-organizational AEC project team;
- **Tier 2:** Team members working on the associated inter-organizational AEC project at the home organizations of Tier 1 representatives; and
- **Tier 3:** Organizations working on the associated inter-organizational AEC project that are subcontracted to Tier 2 organizations on the project team (e.g., subcontractors, trades, consultants, stakeholders).

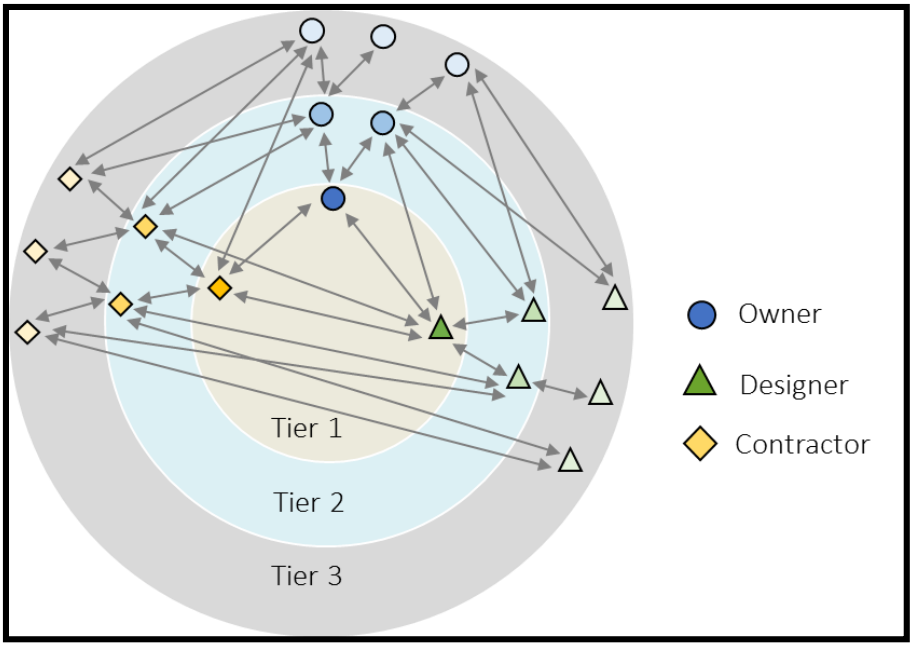


Figure 7: Tiers of operation in inter-organizational architectural, engineering, and construction (AEC) project teams (Mollaoglu- Korkmaz et al. 2014)

Sections 3.5.5 presents the SNA measures used in the research. Section 3.5.6 states the limitations faced by the researcher in performing SNA. Section 3.5.6 also states the process followed in the research to perform SNA.

3.5.5 Social Network Analysis: SNA Measures used in the Research

This sections presents the SNA measures used in this research to analyze the change in team interaction:

1) **Sociogram:** Sociograms were developed using monthly time intervals on the case study project, sociograms assisted in visually representing and studying the tiers of operations in the project network and the interaction of different project parties (Cross et al. 2002; Cross, Parker, & Borgatti, 2002). Refer Figure 8.

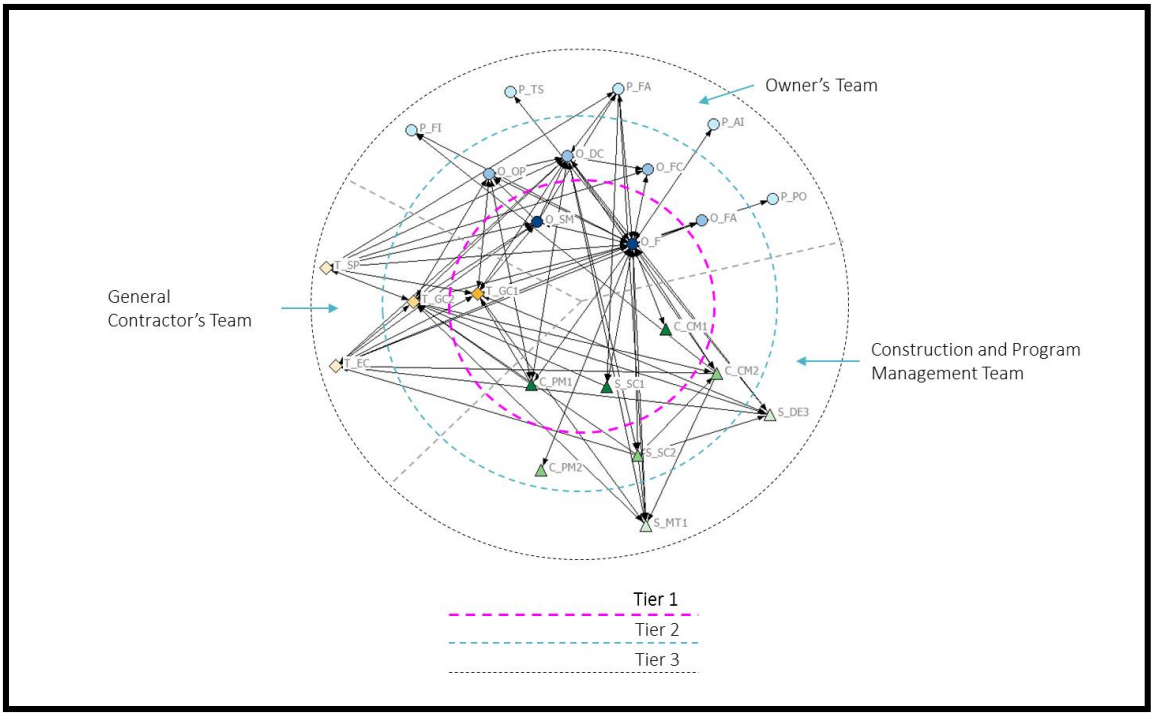


Figure 8: Sample sociogram illustrating team interactions during April

2) **Network Density:** It was calculated by dividing the actual number of interactions by the total number of possible interactions that happened within a network. Range of the network density lies between 0 to 1 where 0 describing no interactions at all and 1 describing the most efficient network (Hanneman and Riddle, 2005; Park, Han, Rojas, Son, & Jung, 2011).
3) **Degree Centrality:** It helped in defining the number of incoming and outgoing ties for a node (e.g., a person, a team, an organization). The higher the number of incoming and outgoing ties to a node, the higher was the centrality for that node.
4) **Betweeness:** It helped in defining the number of nodes that were required to go through another node to interact with other nodes.
5) **Geodesic Distance:** It is a measure used to study the direction of information flow from one node to another. For example, if A is communicating with B directly, then the geodesic

distance between nodes A and B is 1. However, if a message from A is communicated to C via B, then the geodesic distance between nodes A and C is 2 (Hanneman & Riddle, 2005).

6) **Closeness:** It is a function of geodesic distance and centrality. Nodes with low geodesic distance and high centrality were found closer to each other. The lower the value for closeness was, the closer the nodes were to each other.

3.5.6 Social Network Analysis: Limitations and Process

In the documents analyzed, 90% of the issues did not have the names of the individual participants involved in the interactions. Instead, the documents analyzed listed the teams / organizations that are called for a task or an action item, in most instances. Therefore, nodes in the SNA of this study are assigned to:

- Individuals, only when they are clearly identified in the analyzed documents (e.g., the facilitator); and
- Participating tier members that attended the meeting which the document was analyzed for, where their team/organization is called out for a task/action item.

The distinction between Tier 1 and 2 members from the same organization in the study coding was accomplished via following the list of attendees in a given document (i.e., executive meeting minutes included mostly Tier 1 members and stakeholders, while weekly meeting minutes included Tier 1-3 members)

Based on the above mentioned limitations and the methodology followed, researcher categorized the project participants according to the tiers of operation as follows (Refer Appendix B for the full list of participants):

1) **Tier 1:**
    - Owner's senior management (O_SM), construction and program management team's executives (C_PM1, C_CM1, S_SC1), contractor team's executives (T_GC1) and partnering facilitator (F) are at Tier 1 as they were the members of the core executive partnering meeting.
    - These are the representatives from the main project participant organizations.
2) **Tier 2:**
    - Team members from home organizations of Tier 1 members such as design and construction (O_DC), facilities (O_FC), finance and accounting (O_FA) and airport operation (O_OP).
    - Similarly their counterparts who were in the construction and program management team like C_PM2, C_CM2 and S_SC2 are also at Tier 2.
    - Construction managers and superintendents (T_GC2) from the contractor's home organization were at Tier 2.
3) **Tier 3:**
    - All the stakeholders (P_FA, P_TS, P_FI, P_PO and P_AI) from the owner's team are at Tier 3.
    - S_DE3 and S_MT1 are the engineers and inspectors that consult for the construction and program management organizations; therefore, are at Tier 3 in the project team.
    - Sub-contractor T_EC and T_SP for the general contractor are at Tier 3 in the project team.

Based on the tiers of operation and the main project participants (e.g., owner, contractor, construction manager), sociograms were developed (using UCINET software) on a monthly basis. The interactions were observed at the multi-tiered level of the participating teams and following methods were used:

- Using the data from the sociograms like geodesic distances and network density, the researchers compiled data in the form of individual tier's degree centrality, betweeness and closeness using UCINET software (Figure 9) (Refer Appendix C to view sociogram for each month).
- Each sociogram was evaluated using SNA team mechanics measures (e.g., degree centrality, betweeness & closeness) to detect the change in team characteristics and interactions.

Following this analysis, results were studied using three different graphs (for each SNA measure) showing measurements of: (1) Different tiers (e.g., tier 1, tier 2, and tier 3); (2) Project parties (e.g., owner, stakeholders, consultants, sub-consultants, and trades); and (3) Whole project team. The graphs were developed on a monthly basis to detect changes that happen over time during partnered-project delivery. Then the change in team interaction (if any) were compared with the results of the qualitative analysis where the data was categorized under partnered project delivery framework.

APR	Degree	Betweeness	Closeness
O_SM	8	1.744	36
O_DC	14	14.311	30
O_FC	3	0.000	41
O_FA	2	0.000	42
O_OP	6	0.311	38
P_FA	6	1.733	38
P_TS	1	0.000	43
P_FI	2	0.000	42
P_PO	1	0.000	43
P_AI	1	0.000	43
C_PM1	5	0.111	39
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	7	2.667	37
S_SC1	3	0.167	41
S_SC2	7	0.567	37
S_DE3	6	0.311	38
S_MT1	7	1.594	37
T_GC1	9	3.517	35
T_GC2	12	10.550	32
T_EC	9	4.961	35
T_SP	7	1.811	37
O_F	22	138.644	22

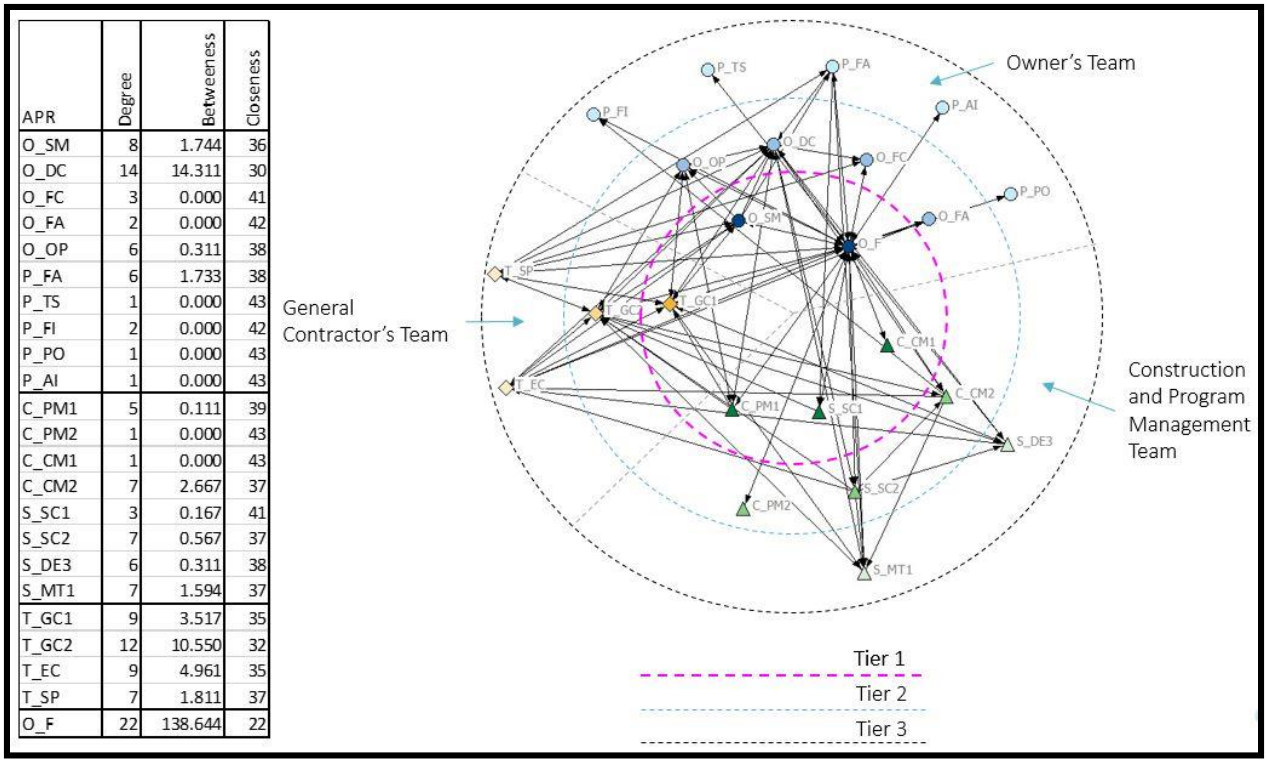


Figure 9: Sample sociogram illustrating team interactions along with SNA measures (degree centrality, betweeness and closeness) during April (Refer Appendix C for sociograms for each month)

3.5.7 Comparative Analyses via Qualitative Methods

Comparative analyses was performed via qualitative methods. Separate graphs were developed showing the frequency of occurrence of issues categorized under partnering drivers, team characteristics and project outcome respectively. Then the separate graphs showing the scores of the key issues falling under these categories were developed. There graphs were compared to each other. The researcher tracked the peaks and dips in the graphs and tried to identify the factors affecting such fluctuations for each of the graphs.

Similarly, researchers developed graphs through SNA and compared them to identify the factors affecting the peaks and dips in those graphs. Lastly, researchers compared the results of SNA with the results of qualitative analysis.

3.6 Data Quality

To maintain data quality, the researcher analyzed data in the following six steps:

1. Researcher classified the key issues identified in partnering sessions according to the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014).
2. A second researcher that worked as the primary researcher in the partnered project delivery framework development then repeated the process in step #1 above independently.
3. The results from the two researchers' analyses were compared, resulting in approximately 90% agreement.
4. The disagreements were resolved through team discussions for consistent results.
5. A senior researcher checked the final classifications and revisions were made accordingly.
6. Industry feedback was taken on the results of the analysis. Corrections were made afterwards to finalize the results.

3.7 Summary

Data collection procedures including the IRB review and approval, visit to the case study site, semi-structured interviews and access to the project information sharing platform were discussed in this section. Data analysis methods such as the development of process maps and use of partnered-project delivery framework in qualitative analysis methods; social network analysis; and data quality measures taken in this research were also presented in this section.

Chapter-4. CASE STUDY - RUNWAY SAFETY AREA (RSA) IMPROVEMENT PROJECT

The scope of this project was to provide a special safety zone at the ends of two runways of one of the busiest airports in the United States. This safety zone included the installation of Engineered Material Arresting Systems (EMAS) that incorporated honeycombed energy absorbing material to capture the aircraft's landing gear in case it overshoots the runway strip. The project scope also included relocation of landing lights, navigation systems, and other related equipment. The original budget was between $ 50-100 million and the original project schedule was about eight months.

4.1 Project Timeline

Figure 10 describes the project timeline. The starting and finishing date of the major processes in the project are shown in the figure. Major event such as runway shutdown, distribution of score cards, inclusion of partnering, notice to proceed, and project end dates are presented in the figure.

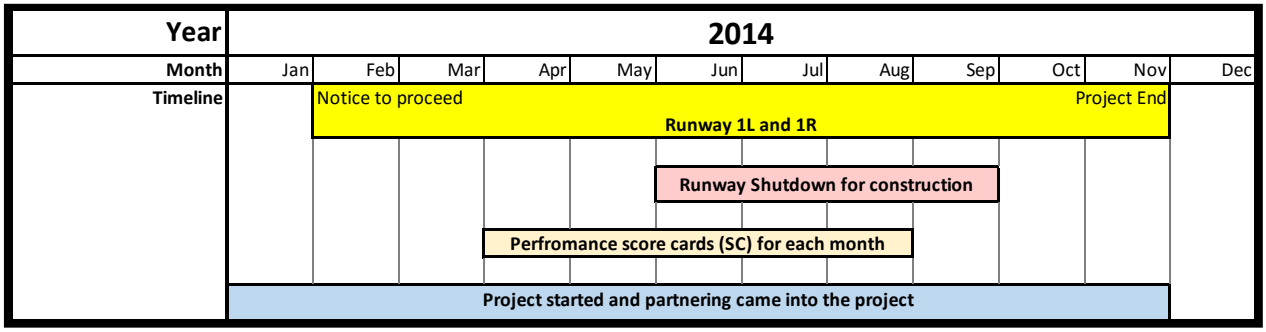


Figure 10: Timeline indicating the start and end dates of the project

4.2 Team Procurement Method and Payment Terms

The project was funded by Federal Aviation Administration (FAA). Due to FAA's rules for contractor selection, a competitive bidding process was followed in team procurement. A joint-venture formed for this project won the bid. Airport's team had no prior working experience with

the winning contractor team. However, design and program support consultant was competitively selected through request for qualification/proposal (RFQ/P) process and was awarded the contract in April 2011 to support all RSA projects. Similarly, construction management consultant was awarded the contract in 2012 for all the RSA projects. Unit cost price payment method was followed in the project. Figure 11 shows the participants involved in the project. Figure 11 shows the engagement of these participants in the monthly partnering meetings.

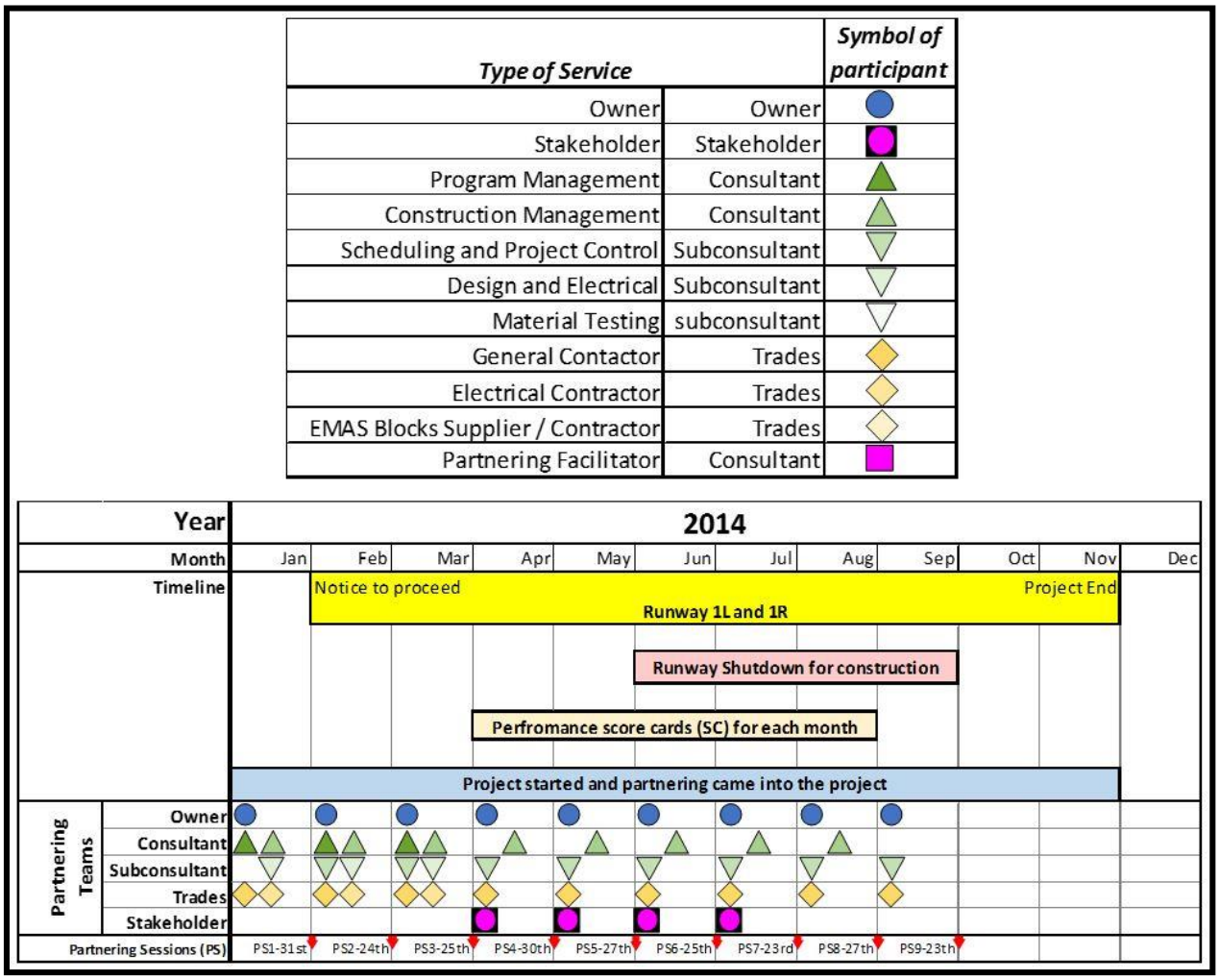


Figure 11: Timeline indicating the start and end dates of the project

4.3 Project Partnering Practices and Procedures Followed

Due to the complexity (e.g., high number of stakeholders involved and interference of the construction with on-going airport operations), tight schedule, intentions of the owner to avoid litigation despite negative historical data in this area, and high costs involved in the case study, the airport's team, representing the owner, opted for adoption of 'project partnering' in the delivery process. Project partnering has been regularly practiced at prior construction projects at this airport. For example, Phase I of the RSA Improvement Project had an in-house project partnering facilitator appointed by the airport. Due to the added complexity and higher budget in the Phase II project, an external partnering facilitator that the general contractor and the owner jointly agreed on was brought on board.

The case study project falls under the level 5 category of the vertical project matrix that was earlier discussed in section 2.4.2. The project was considered very large due to high technical and complex design and construction. New project relationships included contractor, consultants, and subcontractor having no prior experience of working with each other in past. As this situation had high potential for conflict, litigations and claims, the project was considered to be of level 5.

The following project partnering practices were followed in the project:

- Weekly team meetings;
- Inclusion of partnering facilitator and stakeholders;
- Monthly partnering sessions and partnering charter;
- Formation of issue resolution ladder;
- Setting up common project goals;

- Cohabitation (i.e., all teams work in the same trailer on the jobsite including owner representatives to minimize disruption to the workflow and encourage the 'open door' policy in team communication);
- Based on the dynamic needs of the project, formation of empowered focused strategic teams (FAST); and
- Respect for each other's issues and time (i.e., an hourglass was setup in the center of the conference room table to address the time issue) and effective communication.

The following partnering goals were established during the kick-off partnering session:

- **Safety & Security:** Project will have zero incidents related to construction, operations, field, electrical and environment;
- **Schedule:** Contract included penalties for late delivery or missed milestones. Contract also included incentives for early runway opening;
- **Cost:** Teams will complete the project under budget and the contractor will earn their full incentives and help airport save money;
- **Quality:** Project will not have any rework and meet all the specification requirements;
- **Public Perception:** No negative press about the project and minimize complaints from neighbors;
- **Minimize Operational Disruption**; and
- **Fun:** Teams will have fun!

Chapter-5. RESULTS

5.1 Qualitative Analysis

As discussed in section 3.5.1, issues and items in the partnering session documents were categorized according to the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014) broadly defined under boundary conditions, partnering drivers, project team characteristics, project outcomes and organizational outcomes. Based on the relationships of the categories defined in Figure 12, research was limited to partnering drivers, team characteristics and project outcomes.

Separate graphs were developed showing the frequency of occurrence of issues categorized under partnering drivers, team characteristics and project outcomes respectively. Following that the separate graphs showing the scores of the key issues falling under these categories were also developed. These graphs were compared to each other to identify the factors affecting fluctuations in each graphs.

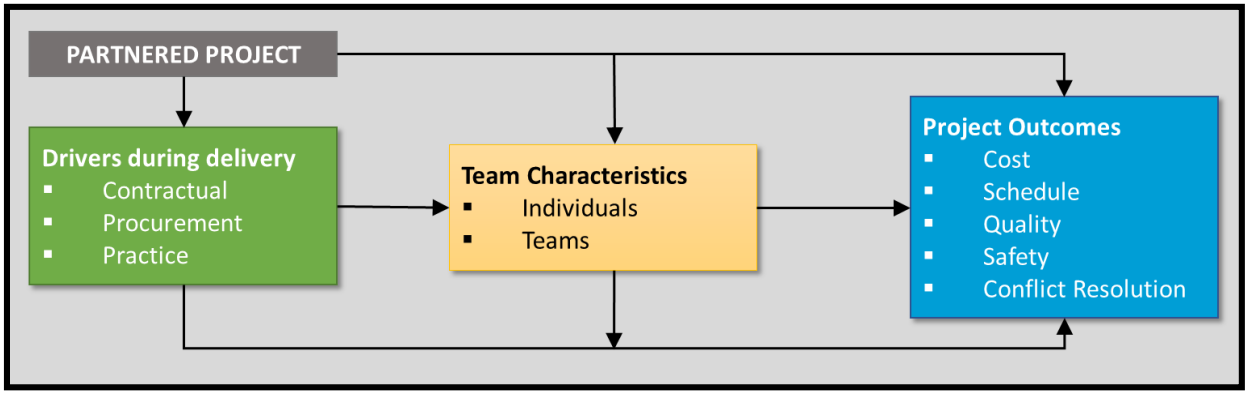


Figure 12: Limited version of Partnering Framework followed in the data analysis (Mollaoglu et al., 2015; Sparkling, 2014)

5.1.1 Drivers

While categorizing issues and items obtained by analyzing partnering session documents, researcher was able to identify the partnering drivers mentioned in Table 3.

Table 3: Partnering Drivers identified in the Case Study Project

LEVEL 1	LEVEL 2	LEVEL 3	Code
DRIVERS	Contractual	Equal power / empowerment	DC1
		Incentives / Fee / Risk reward / gain & pain share	DC2
		Joint specifications	DC3
		Resource sharing and open books	DC4
		Establishment and communication of conflict resolution strategy	DC5
		Partnering Agreement	DC6
		Adopt Alternative Dispute Resolution	DC7
	Procurement	Involvement of participants in design process	DP1
		Joint contractor selection	DP2
		Early involvement of subcontractor	DP3
		Broad Partnering Team	DP4
		Partnering Experience	DP5
		Prequalification	DP6
	Practices	Value engineering	DPr1
		Clear definition and lines of responsibility	DPr2
		Problem resolution / solving process	DPr3
		Design criteria established early on	DPr4
		Joint problem solving	DPr5
		Mutual goals and objectives communicated	DPr6
		Effective coordination	DPr7
		Adopt alternative dispute resolution (ADR)	DPr8
		Schedule management on milestones	DPr9
		Benchmarking (Monitoring of partnering)	DPr10
		Commitment to quality	DPr11
		Selection of items for early procurement	DPr12
		Joint project charter	DPr13
		Workshops	DPr14
		Team building session	DPr15
		Partnering facilitator	DPr16
		Integrated information systems	DPr17
		Frequent meetings	DPr18
		Joint project office	DPr19
		Supply chain partnering	DPr20

Based on these categories, graph-A (Figure 13) was developed showing the total occurrences of partnering drivers during each partnering session conducted on a monthly basis. Each monthly partnering sessions is named as PS1, PS2, PS3, and so on. This graph was developed using the information from the process map #1.

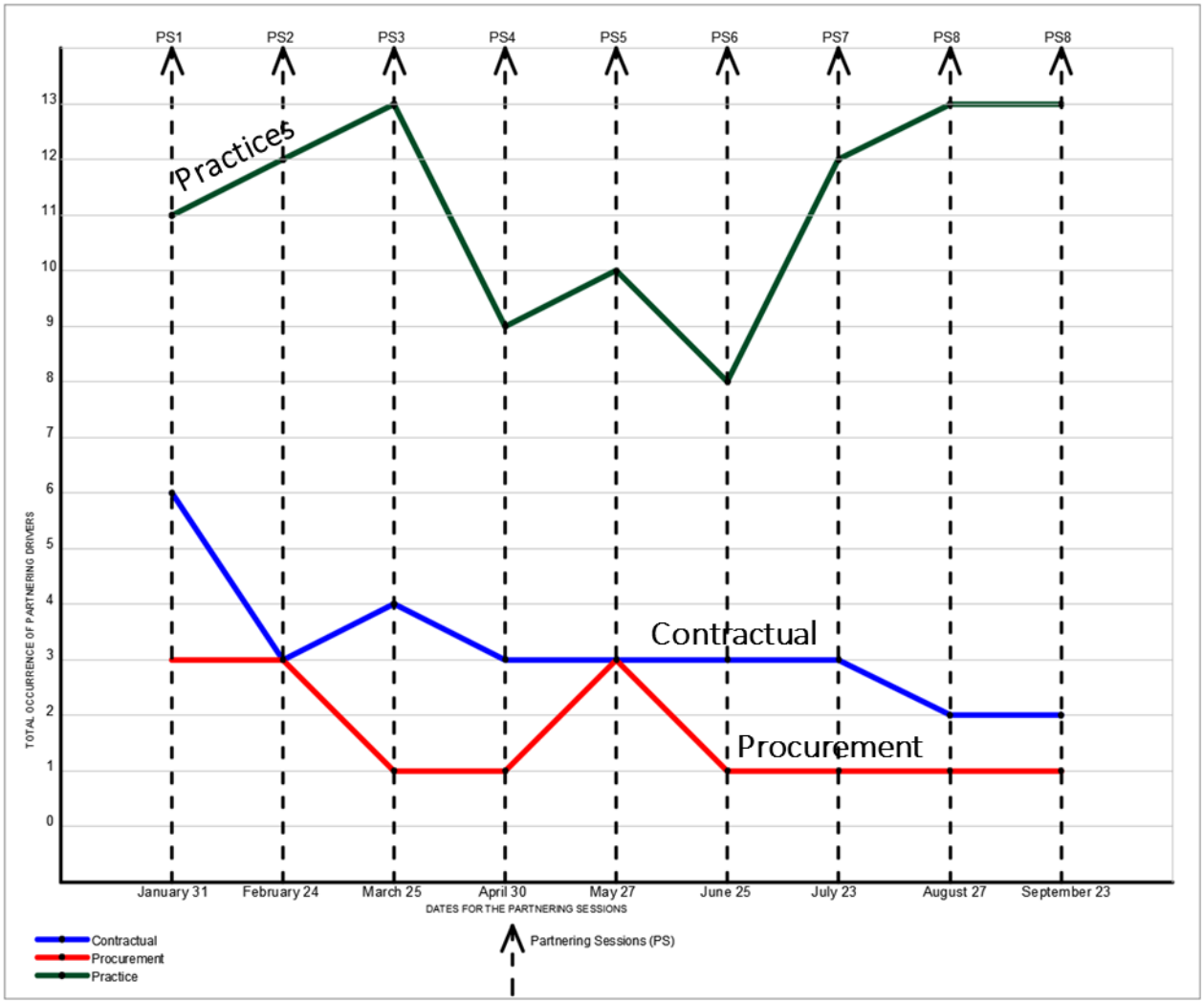


Figure 13: Graph-A, Total occurrences of partnering drivers during each partnering session

Similarly, graph-B (Figure 14) was developed showing the total scores for partnering drivers during each monthly partnering session. This graph was developed using the information from the process map #2.

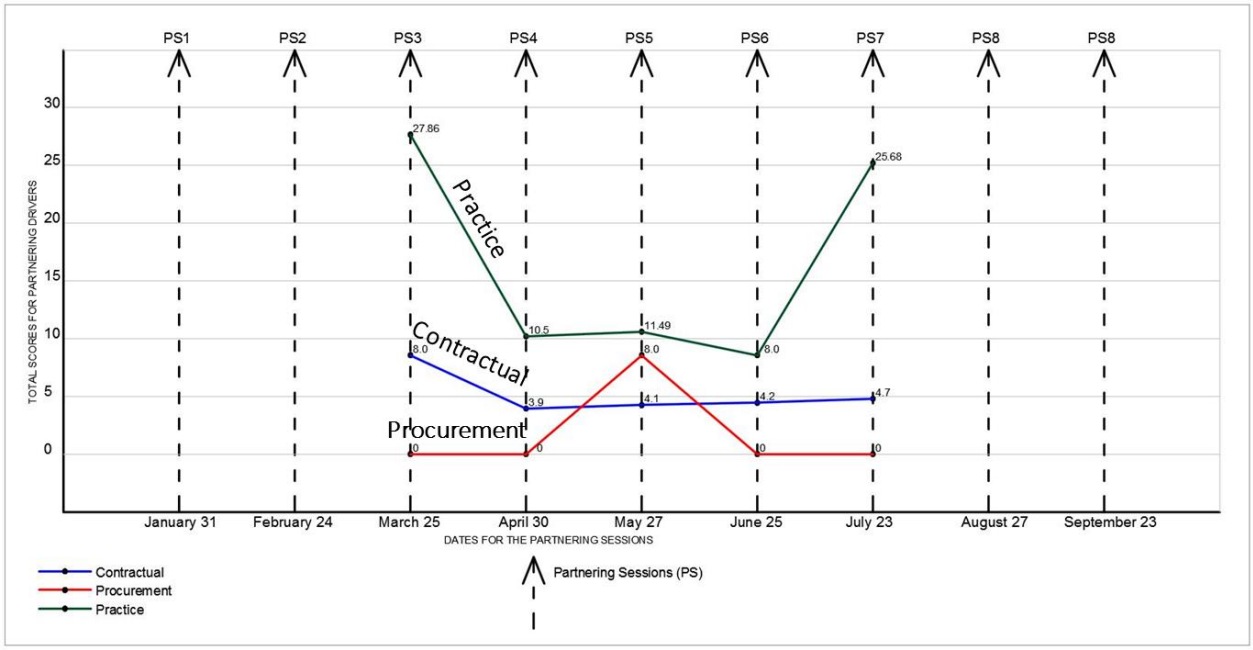


Figure 14: Graph-B, Total scores for partnering drivers during each partnering session

Among all partnering drivers, partnering practices showed high occurrence and a high total score during each partnering session. Table 4 shows each item that was scored on the scale of 1 to 5, with 1 being poor and 5 being excellent. These items were scored by the team members. Scores in Table 4 are the addition of the scores achieved by all the issues falling under respective level-3 partnering driver. Further, researcher prepared Graph-C (Figure 15) to document the sum of scores of the level-3 partnering practices during each partnering sessions.

Table 4: Partnering practices classified according to partnering framework

Level-2	Level-3		Mar		Apr		May		Jun		Jul	
		Code	# Occ	Total	# Occ	Total	# Occ	Total	# Occ	Total	# Occ	Total
Partnering Practices	Value engineering	DPr1			1	3.7						
	Clear definition and lines of responsibility	DPr2	1	4.0								
	Problem resolution / solving process	DPr3	1	4.0								
	Design criteria established early on	DPr4										
	Joint problem solving	DPr5	1	4.1					2	8	3	13.2
	Mutual goals and objectives communicated	DPr6	2	7.6	1	3.9	1	3.8			1	4.2
	Effective coordination	DPr7	1	4.2								
	Adopt alternative dispute resolution (ADR)	DPr8			1	3.0						
	Schedule management on milestones	DPr9	1	4.0								
	Benchmarking	DPr10									2	8.3
	Commitment to quality	DPr11					2	7.7				
	Selection of items for early procurement	DPr12										

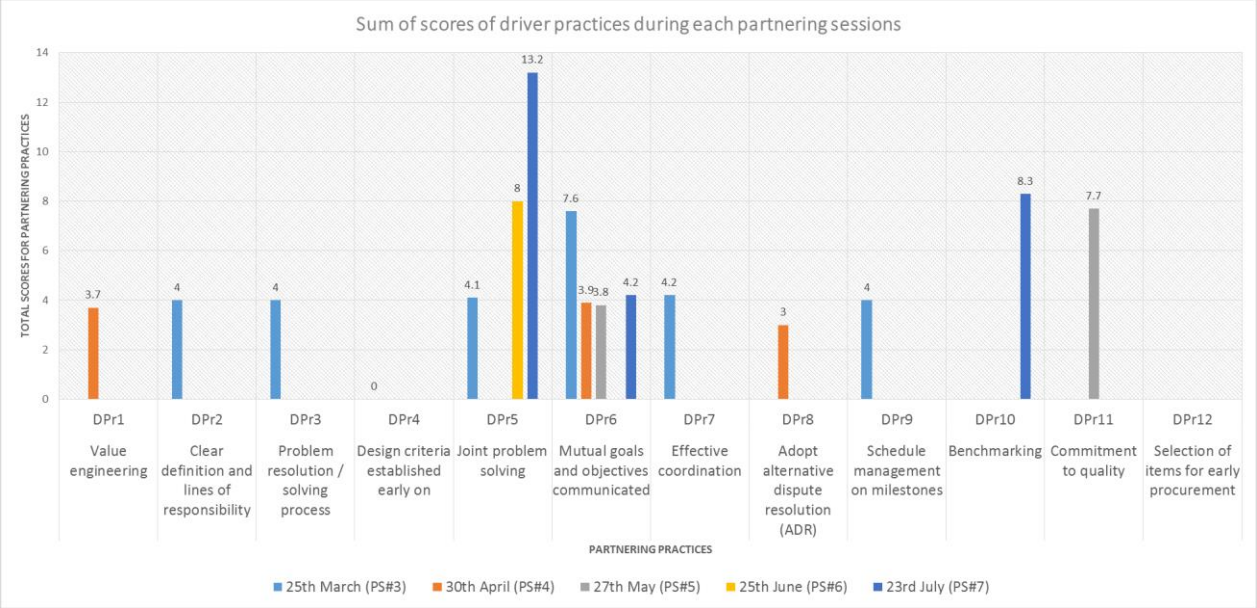


Figure 15: Graph-C, Sum of scores of partnering practices (one of the partnering drivers) during each partnering session

From graph-C (Figure 15), it is evident that among all partnering practices, joint problem solving showed high occurrence and a high total score during each partnering session.

5.1.2 Team Characteristics

While categorizing issues and items obtained by analyzing partnering session documents, researcher was able to identify the team characteristics mentioned in Table 5.

Table 5: Team Characteristics identified in the Case Study Project

LEVEL 1	LEVEL 2	LEVEL 3	Code
TEAM CHARACTERISTICS	Individual Level	Promise keeping	TI1
		Positive attitude	TI2
	Team Level	Cooperation	TT1
		Mutual trust	TT2
		Team commitment	TT3
		Commitment to win/win attitude	TT4
		Teamwork	TT5

Based on these categories, graph-D (Figure 16) was developed showing the total occurrences of team characteristics during each partnering session. This graph was developed using the information from the process map #1.

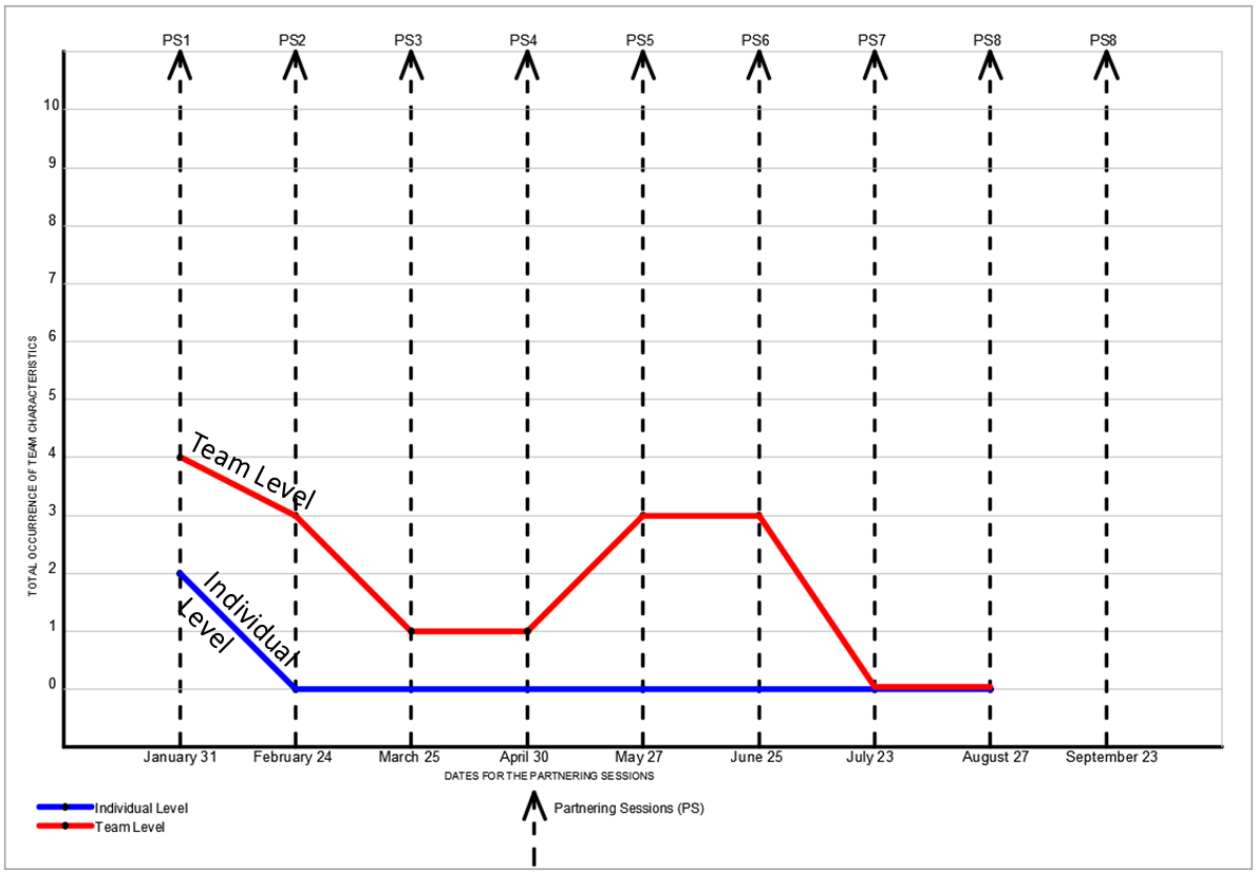


Figure 16: Graph-D, Total occurrences of team characteristics during each partnering session

Similarly, graph-E (Figure 17) was developed showing the total scores for team characteristics during each partnering session. This graph was developed using the information from the process map #2.

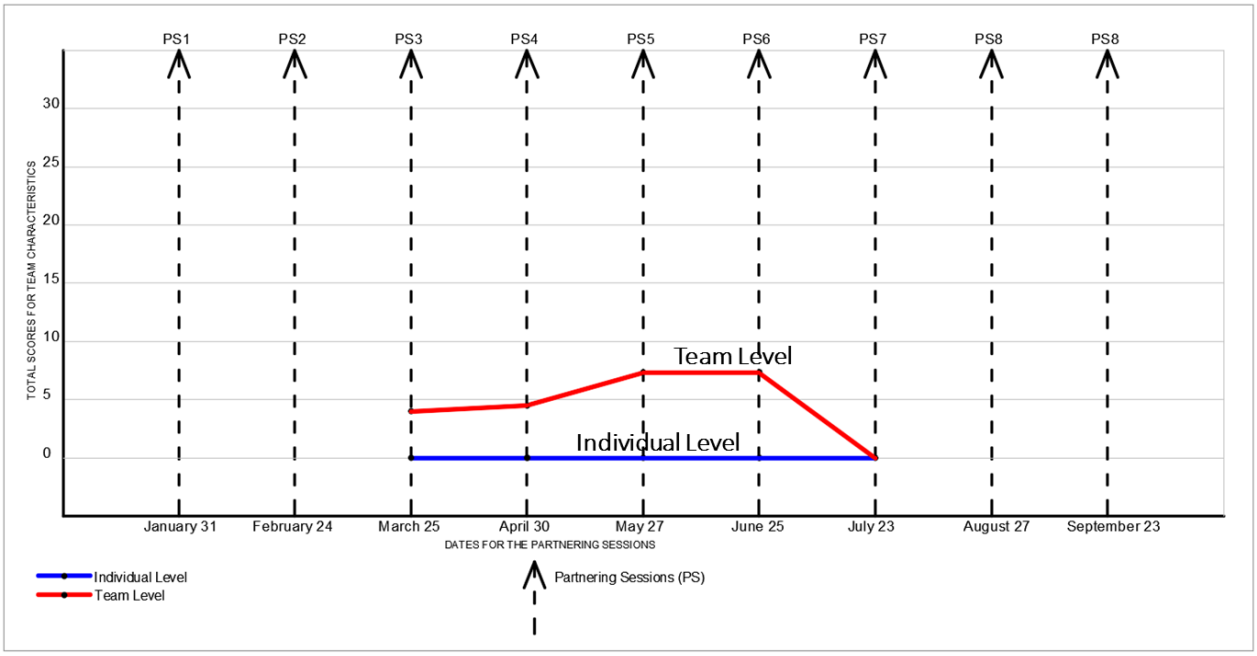


Figure 17: Graph-E, Total scores for team characteristics during each partnering session

The method used in this section to assess team characteristics is limiting because this method is unable to track changes in the team interaction. In order to understand the change in the team interaction, the researcher used SNA for the better representation of team characteristics.

5.1.3 Project Performance Outcomes

The researcher was able to identify the project outcomes mentioned in Table 6.

Table 6: Project Outcomes identified in the Case Study Project

LEVEL 1	LEVEL 2	LEVEL 3	Code
PROJECT PERFPORMANCE OUTCOMES	Cost	Value engineering savings	PC1
		Meeting budget cost targets	PC2
		Reduced cost	PC3
		Reduction in monetary	PC4
	Schedule	Meeting schedule targets	PS1
		Reduce time in delivering the project	PS2
		Better productivity	PS3
		Improved construction time	PS4
	Quality/Safety	Increased safety performance	PQ1
		Quality Improvement	PQ2
		Better workmanship	PQ3
		Improved safety performance	PQ5
		Reduce re-work	PQ6
		Increase client satisfaction	PQ7

Project outcomes were identified by analyzing the project goals achieved. Based on these categories, graph-F (Figure 18) was developed to show the total scores for project performance outcomes and organizational outcomes during each partnering session. This graph was developed using the information from the process map #3. The highlighted red line in Figure 18 is the average score line depicting the overall performance of the project using self-scores for each of the project goals.

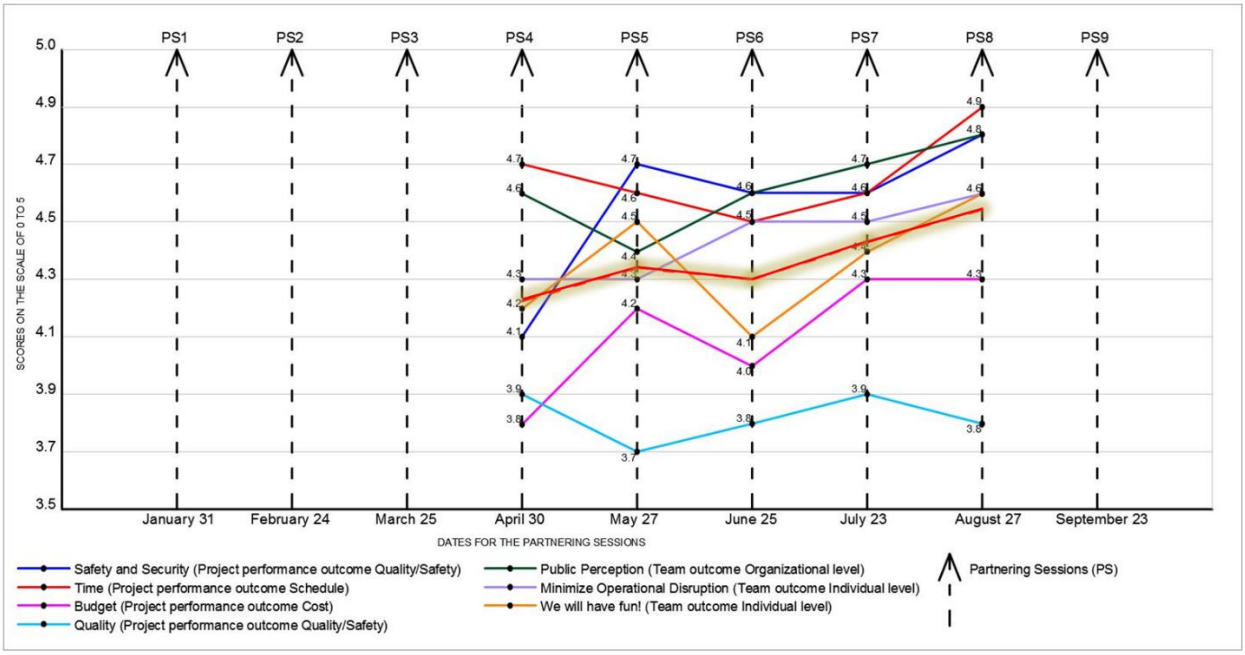


Figure 18: Graph-F, Scores for different project goals during each partnering session showing project performance outcomes

5.1.4 Comparative Analysis: Partnering Drivers vs. Team Characteristics

Comparing graph-B (Figure 14) and graph-E (Figure 17), the following observations were made:

1) Better team characteristics at team level were observed when partnering drivers at procurement level were highest.
2) PS5 is the only partnering session where all three partnering drivers (procurement, contractual, and practices) were observed. Observation of highest team level characteristics can be attributed to the occurrence of all three partnering drivers in the same partnering session.
3) Based on the observations made during PS5, a positive relation between procurement partnering drivers and team characteristics can be proposed.
4) It can be seen that when partnering practices were high during PS3, its effect in the form of high team characteristics could be seen in the succeeding sessions PS5 and PS6.

5) Similarly, due to low team characteristics observed during PS7, high partnering practices were incorporated to maintain better team characteristics in the succeeding sessions.

5.1.5 Comparative Analysis: Team Characteristics vs. Project Performance Outcomes

Comparing graph-E (Figure 17) and graph-F (Figure 18), following observations were made:

1) On an average, project performance has increased during PS5 and PS6 as compared to PS4. Better team characteristics led to better overall team performance.
2) Performance outcomes in project quality, operational disruption, and public perception improved with better team characteristics. This shows how project performance outcome for quality and team outcomes at organizational and individual level are connected to better team characteristics.
3) Project goals like time, we will have fun, and budget showed improvement during PS6. This improvement can be attributed to the high team characteristics observed during the preceding session (PS5). This shows how project performance outcome for schedule and cost are related to the high team characteristics with a time lapse of at least a month.

5.1.6 Comparative Analysis: Partnering Drivers vs. Project Performance Outcomes

Comparing graph-B (Figure 14) and graph-F (Figure 18), the following observations were made:

1) It can be seen that the graph lines for time and public perception line up with partnering practices. This shows how project performance outcome for schedule and team outcome at organizational level correlates with high and low partnering practices.
2) There is a time lapse of almost a month between partnering practices and project goal of safety and security. This shows that better results for performance outcomes for quality and safety show up after a month when partnering practices are practiced.

3) Low performance outcomes for quality and safety can be attributed to low contractual and procurement drivers.

5.1.7 Summary

This section presents the summary of the results of the qualitative analysis. To perform qualitative analysis, the researcher used the methodology of creating process maps (Klotz et al., 2009; Lapinski et al., 2006) to list the key issues and practices the occurred over the timeline of the project delivery. The process maps helped in developing graphs depicting the occurrences and the scores of the partnering drivers, team characteristics and project performance outcomes over the project timeline.

The researcher then performed comparative analysis to compare the effects of the results of use of partnering drivers on team characteristics, changing team characteristics on project performance outcomes, and use of partnering drivers on project performance outcomes. It was observed that the partnering practice of joint problem solving showed the highest occurrence. It was also observed that in order to achieve better team characteristics over long term of time, it is important to implement partnering drivers at the time of procurement. The researcher also observed that implementation of partnering drivers helps in achieving better team characteristics in the succeeding month.

The researcher while analyzing the effects of better team characteristics on project outcomes, observed that project performance outcomes for project quality, operational disruption, and public perception improved with better team characteristics. While comparing the effect of partnering drivers on project performance outcomes, researcher observed that project performance outcomes for schedule, cost, safety, and security depends on the implementation of partnering drivers.

Even though the researcher was able to identify some team characteristics, it was not possible to identify the change in team interaction over the period of timeline. Lack of data on the change in team interaction became a barrier in studying team performance. Therefore, SNA was performed and its results identified in the following sections were used to understand the team performance.

Team outcome at the organizational level was low during a particular month. It was a result of bad public perception as there were some complains from the neighbors regarding construction noise. The issue was taken care in the later month and public perception was good. A local newspaper journal also quoted, "…a major airfield construction that took place non-eventfully".

Overall project performance outcomes were high throughout the project timeline except for the quality. Quality of the project could have been even better if the implementation of even more partnering practices were included in the contract. An issue related to the inspection and warranty of the installed EMAS blocks was raised in April end. Teams forgot to account for the money required for the scope of warranty and inspection. The owner thought that it was included in the scope of the general contractor's work package and the general contractor had a perception that the owner was responsible for this work item. When the supplier of the EMAS blocks was contacted, the supplier suggested an exorbitant cost for inspection and warranty. To resolve this issue, the supplier was brought into partnering in May, 2014. Project executives representing owner, general contractor, and supplier met during the partnering sessions from May onwards to resolve the issue. Issue was resolved by June end where supplier agreed to lower the price, and general contractor and owner decided to share the cost of inspection and warranty. If partnering was properly implemented at the contractual level, supplier would be attending the partnering sessions from the beginning of the project and this would have prevented the issue.

5.2 Social Network Analysis

The researcher developed the sociograms showing the team interactions for each month. Using the data from the sociograms like geodesic distances and network density, the researchers compiled data in the form of individual tier's degree centrality, betweeness and closeness using UCINET software (Refer Appendix C to view sociogram for each month). Results for SNA were then studied using three different graphs (for each SNA measure) showing measurements of: (1) Different tier (e.g., tier 1, tier 2, and tier 3); (2) Project parties (e.g., owner, stakeholders, consultants, sub-consultants, and trades); and (3) Whole project team. The graphs were developed on a monthly basis to detect changes that happen over time during partnered-project delivery. The change in team interaction (if any) were then compared with the results of the qualitative analysis where the data was categorized under the partnered project delivery framework.

5.2.1 Network Density

Graph-G (Figure 19) shows network density of the sociogram for each month. The researcher made the following observations about the change in team interaction through network density:

1) Network density is seen to be highest in April because runway was shut down and construction had begun which needed high coordination between all the teams.
2) Network density is also found to be high during August. This can be attributed to the project controlling process in order to finish the construction and reopen the runways.

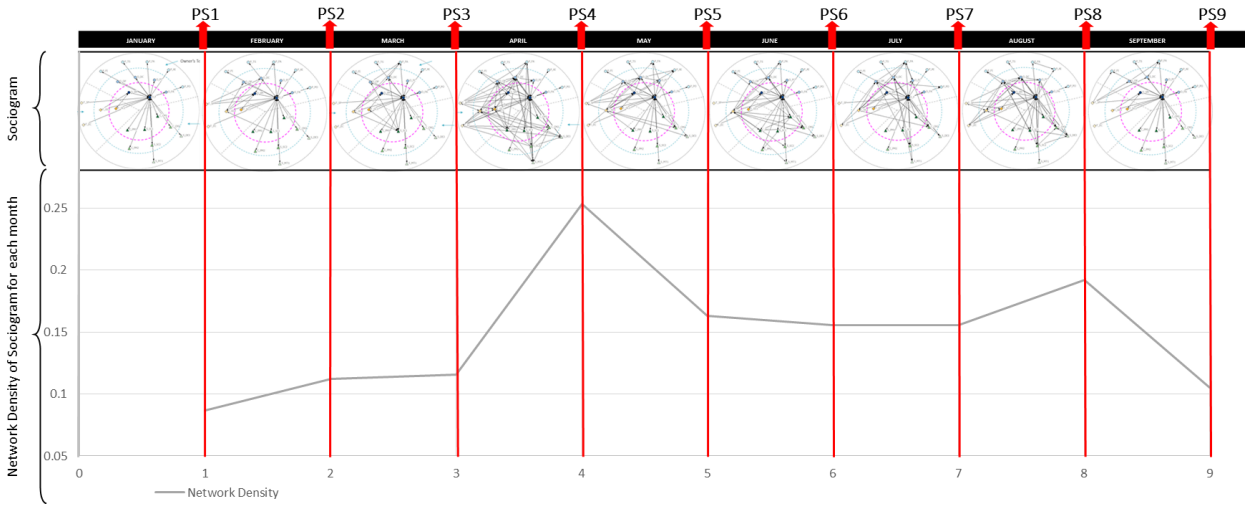


Figure 19: Graph-G, Showing Network Density of Sociogram for each month (Refer Appendix C for sociograms)

5.2.2 Degree Centrality

Graph-H (Figure 20) shows degree centrality of the sociogram for each month. The researcher made the following observations about the change in team interaction through degree centrality:

1) In January, tier 1 had the highest degree centrality as compared to other tiers. This was attributed to the involvement of senior management to kick off the project.
2) Degree centrality of tier 2 was highest followed by tier 1 and tier 3. This shows that tier 2 acted as a bridge between tier 1 and 3.
3) Degree centrality was highest for tier 2, especially from April through August end due to runway closure and ongoing construction at that time.
4) Degree centrality of the construction manager's team was high during April and August to coordinate the construction start and finish, respectively.

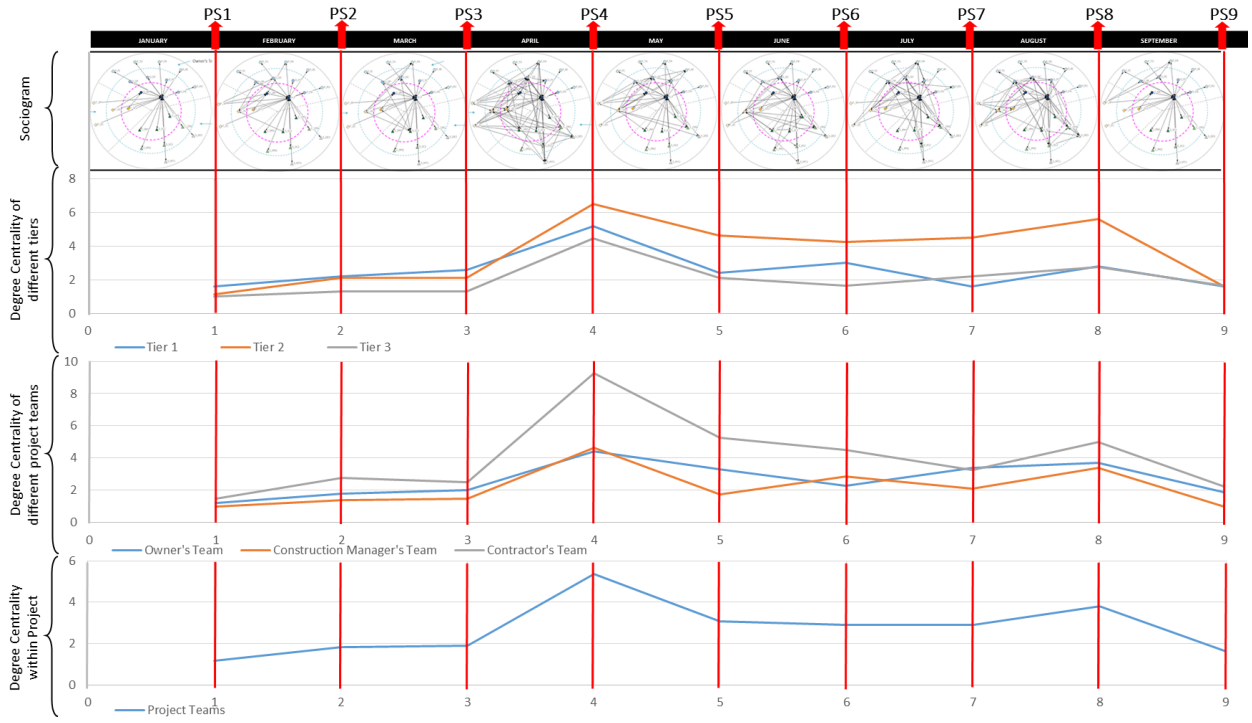


Figure 20: Graph-H, Showing Degree Centrality of individual tiers, individual project teams and overall project teams (Refer Appendix C for sociograms)

5.2.3 Betweeness

Graph-I (Figure 21) shows betweeness of the sociogram for each month. The researcher made the following observations about the change in team interaction through betweeness:

1) Tier 2 that mostly comprises of people from general contractor's team had high betweeness, especially from April through August due to runway closure and ongoing construction at that time. This was due to high interactions among operations people on the field from all teams.
2) High betweeness of the owner's team can be seen in the end of July. This observation can be attributed to the task of opening the runway during the beginning of August that needed a lot of coordination within the owner's team.

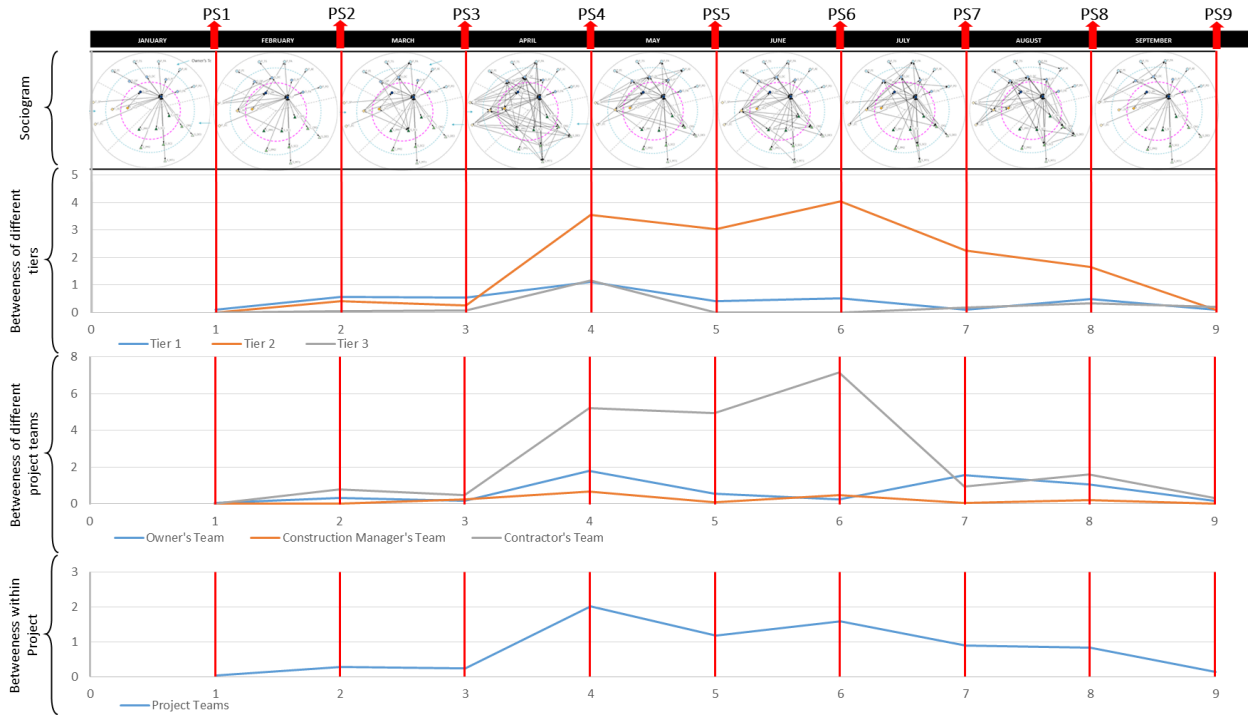


Figure 21: Graph-I, Showing Betweeness of individual tiers, individual project teams and overall project teams (Refer Appendix C for sociograms)

5.2.4 Closeness

Graph-J (Figure 22) shows closeness of the sociogram for each month. The researcher made following observations about the change in team interaction through closeness:

1) In January, tier 1 had the closest nodes as compared to the other tiers. This is attributed to the involvement of senior management to kick off the project.
2) Tier 2 members had closest of interactions, especially from April through August. This observation can be attributed to runway closure and construction going on at that time, thus the high number of and close interactions among tier 2 members that include operation teams from owner, contractor, and construction manager teams.

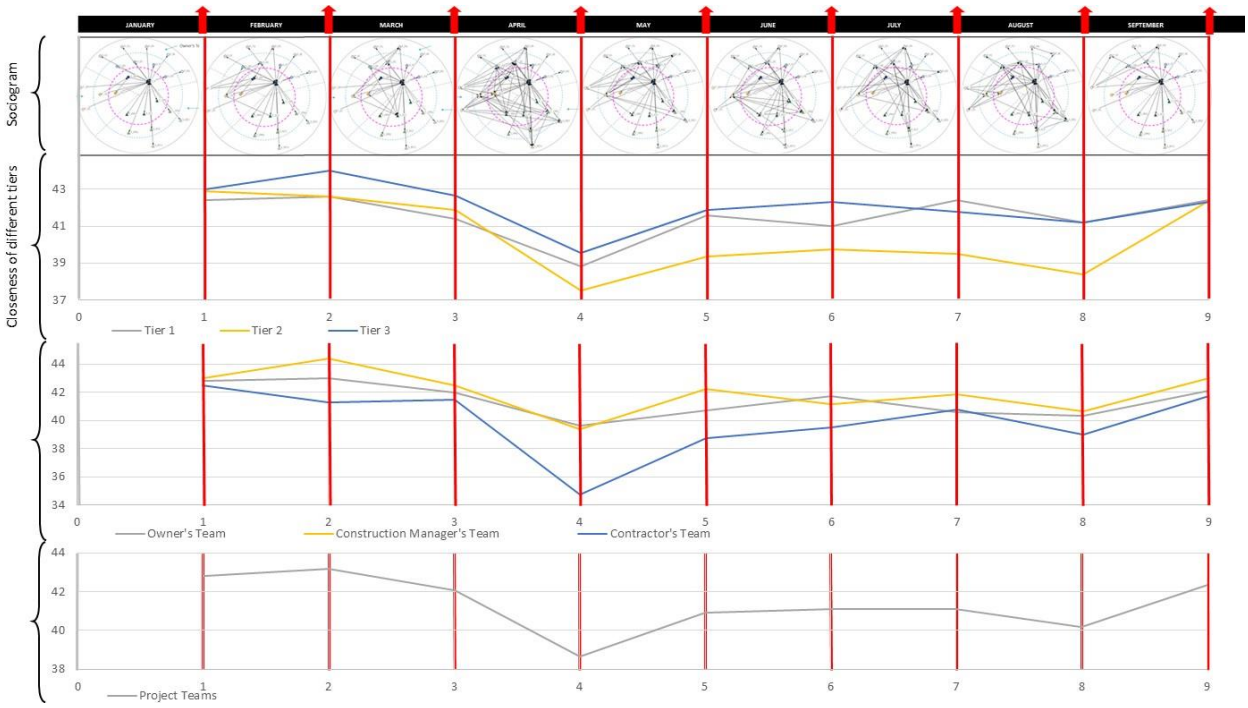


Figure 22: Graph-J, Showing Closeness of individual tiers, individual project teams and overall project teams (Refer Appendix C for sociograms)

5.2.5 Summary

This section summarizes the results of the SNA. To study the change in the team interactions, SNA was performed. Results of SNA helped in understanding the performance of the team. Graphs presenting the change in network density, degree centrality, betweeness, and closeness over the project timeline were developed. It was observed that network density was highest during the time when construction began and was completed. It was also observed that the degree centrality of tier 2 was highest as it acted as a bridge between tier 1 and tier 3 for communication. Also, the betweeness of the tier 2 (general contractor's team) was highest during the actual construction. The researcher observed that the closeness for tier 1 (senior management) was high during the project kick-off. But when the actual construction started, tier 2 was closest to other tiers.

5.3 Comparative Analysis of Results

This section outlines the comparative analysis of the results and observations made through qualitative analysis and SNA to shed light onto relations among:

- Partnering practices (namely drivers in the partnered project delivery framework (Mollaoglu et al., 2015; Sparkling, 2014) , determined through qualitative analysis;
- Team characteristics, determined via SNA; and
- Project performance outcomes, detected via the change during project delivery.

Changes in time for each of the metric presented above during project delivery of the case study was measured.

5.3.1 Partnering Drivers, Project Performance Outcomes, Network Density and Degree Centrality

The researcher made following observations while comparing partnering drivers (Graph-A, Figure 13), project performance outcomes (Graph-F, Figure 18), network density (Graph-G, Figure 19) and degree centrality (Graph-H, Figure 20):

1) Due to high partnering practices during March, overall degree centrality and network density were high in April, which resulted in high project performance in May.
2) High degree centrality of the contractor's team (Tier 2) throughout the project timeline shows the implementation of partnering practice of open communication. Contractor's Tier 2 team, people mostly working on the field, was at the center of team communications.

5.3.2 Partnering Drivers, Performance Outcomes and Betweeness

The researcher made following observations while comparing partnering drivers (Graph-A, Figure 13), project performance outcomes (Graph-F, Figure 18) and betweeness (Graph-I, Figure 21):

1) High partnering practices in the month of March resulted in high betweeness of the contractor's team in the following months until construction was completed.
2) High partnering practices in the month of July resulted in high betweeness of the owner's team in August in order to coordinate the timely opening of the runways.
3) Tier 2 that mostly comprises of people from general contractor's team had high betweeness, especially from April to August end due to runway closure and construction going on at that time. That also resulted in high project performance during that period.

5.3.3 Partnering Drivers, Project Performance Outcomes and Closeness

The researcher made following observations while comparing partnering drivers (Graph-A, Figure 16), project performance outcomes (Graph-F, Figure 18) and closeness (Graph-J, Figure 22):

1) Due to lowest average geodesic distance of tier 2, its closeness was the least. This observation is the result of partnering practice of empowering participants in tier 2 to make decisions.
2) Due to high partnering practices during March end, overall geodesic distance was less in April, which resulted in high project performance in May.
3) Low closeness of the contractor's team throughout the project timeline shows the implementation of partnering practice to involve contractor in close and open communication.

5.3.4 Summary

This section summarizes the observations of the comparative analysis of the results of qualitative analysis and SNA. Due to the high implementation of partnering practices, overall communication and interaction increased in the succeeding month. Following the increase in the interaction, project performance was high in the next succeeding month. This observation shows the link between the implementation of partnering practices, change in the team interaction and project performance outcomes.

Participants from the Tier-2, i.e. people mostly from the general contractor's and owner's team were at the center of the communication. Tier-2 participants are the people who are actually working on the field, for example, project engineers, superintendents, resident engineers, project managers, etc. These people had the highest interaction when construction was going on. Also, tier-2 participants representing owner had high interaction when construction was about to finish. Airport operations team (tier-2) were constantly communicating with the general contractor's team (at tier-2) to close the construction and open new runways on time. This process helped teams in opening runways a month prior to the scheduled date. Opening runways before the scheduled date helped contractor's team in earning $2 million as incentives.

5.4 Reported Results by the Owner's Representative

- **Safety & Security:** Total 130,000 working hours were completed without any accidents on the job site.
- **Schedule:** Through partnering, teams were able to open the runways a month before the scheduled date. Project teams earned the full incentives of $2 Million in total for their performance in managing the project schedule. Project also had the liquidated damages

(LD) clause tied to the certain milestones and the late opening of the runways. There were no LDs assessed at the end of the project.

- **Cost:** Original contract price was $87,429,594 and the cost of the contract was $95,829,594 due to change orders during the delivery process. Thanks to partnering, increased cost went down to $95,002,454.06 as the final cost of the project that ended up saving $827,139.94 for the owner. The final cost of the project went up for about 8.66% of the original cost. With $2,000,000 as incentives, actual increase in cost was only $5,527,860.06, i.e. 6.37% only. This shows how partnering helped in bringing down 3% of the final cost. According to the owner, this is outstanding as both the major runways were shut down for the construction and project was very complex.
- **Quality:** Involvement of the stakeholders in the partnering meetings helped in communicating the quality expectations and the goals throughout the projects. This resulted in no re-work or follow up later on because the stakeholders would be inspecting the as-built throughout the project timeline.
- **Public Perception:** Airport communication team was very prompt in communicating with the city officials and public regarding the project schedule, flight pattern changes, noise or any disruptions throughout the project timeline. This resulted in no inconvenience and one of the local newspaper quoted, "…a major airfield construction that took place non-eventfully".
- **Minimize Operational Disruption:** Airport used a Departure Metering System (DMS) to avoid runway waiting in long lines for take-off. DMS was first used at JFK Airport for their 2010 runways construction project.

- **Fun:** Teams were asked to report their scores if they had fun or not. Teams were consistent on the fact that they had fun working together and the project was a great success.

5.5 Recommendation for the Partnering Framework

This section lists the changes in the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014) that were identified while performing qualitative analysis. The researcher with the help of a senior researcher and the industry feedback developed a list of suggestions and changes that can be incorporated in the earlier developed partnering framework. Following that, the primary researcher who developed the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014) made the following changes in it:

- ✓ Contractual Driver:
    - *Establishment and communication of conflict resolution strategy:* Combined with conflict identification and resolution strategy.
- ✓ Procurement Driver:
    - *Involvement of participants in design process:* Combined with early involvement of designer / contractor / subcontractor.
- ✓ Practice Drivers:
    - *Establishing a conflict resolution process:* Moved to contractual drivers.
    - *Previous work experience with other members:* Moved to procurement drivers.
- ✓ Team Characteristics at Team Level:
    - *Unity:* Combined with integrated team.
    - *Dedicated team:* Combined with individual commitment to team.

- *Teamwork:* Combined with integrated team.

✓ Project Performance Outcome (Schedule):

- *Improved productivity:* Combined with better productivity.

✓ Project Performance Outcomes (Quality):

- *Achieve better safety performance:* Combined with improved safety performance.
- *Customer needs:* Combined with increase client satisfaction.
- *Increased customer satisfaction:* Combined with increase client satisfaction.
- *Increased safety performance:* Combined with improved safety performance.
- *Safety:* Combined with improved safety performance.
- *Better quality design:* Combined with improved design.

The above mentioned changes in the partnering framework were suggested to avoid the repetition of categories under different names. The suggested changes made the partnering framework even more reliable tool to perform such studies. Please refer Appendix-E to view the revised version of the partnering framework (Mollaoglu et al., 2015; Sparkling, 2014).

Chapter-6. CONCLUSION AND DISCUSSION

This section states the key factors that led to the smooth and successful implementation of partnering in the case study project. In the end, section concludes with the discussion and recommendations for the future research.

6.1 Summary of the Results

This is the first time an empirical rigorous study is performed in a retrospective manner evaluating the case study data longitudinally during the partnered project delivery. The study also demonstrates the links among partnering practices, team performance, and project outcomes. This study also demonstrated the change in team interaction during partnered project delivery. Researcher noted the high implementation of partnering drivers during practice as compared to the partnering drivers implemented at contractual and procurement level. It can be inferred that proper implementation of partnering practices is important for successful partnering. The researcher went into further detail to identify the partnering practices that were mostly evident during the project timeline. It was clearly evident that among all partnering practices, joint problem solving showed high occurrence and high total scores during each partnering session. Following joint problem solving, researcher also noted the considerable use of the practice of communicating mutual goals and objectives, benchmarking, and committing to quality.

Analyzing the partnering practices over the project timeline, it is evident that project performance outcomes for schedule and team outcomes at the organizational level were correlated with the ups and downs of the partnering practices implemented. Results from the implementation of partnering practices are evident with a time lapse. For example, better results for performance outcomes for quality and safety showed up a month after partnering practices were implemented. The researcher

also noted that there was low performance of quality and safety. This can be attributed to less partnering drivers at the contractual and procurement level.

Team characteristics at individual as well as at team level were also identified and studied. It was observed that team characteristics at team level were more prominent and effective as compared to the ones at the individual level. Cooperation, mutual trust, commitment to win, teamwork and winning attitude were the team characteristics observed at the team level. Whereas, researcher could only identify promise keeping and positive attitude as the team characteristics at the individual level that contributed in successful partnering.

It is well evident from the case study that better team characteristics lead to better team performance. The researcher also found that project performance outcome for schedule and cost are related to the high team characteristics, however, with a time lapse of at least a month.

The researcher also studied the changes in the team interactions and compared those changes with project performance outcomes and partnering practices implemented in the project. It was observed that implementation of large number of partnering drivers resulted in high degree of centrality and network density during the succeeding month, which in turn resulted in high project performance during another succeeding month. Also, due to the implementation of partnering practice of open communication, contractor's team (Tier 2) showed high degree centrality and betweeness. Therefore the average geodesic distance of the contractor's team (Tier 2) was least. High implementation of partnering drivers also resulted in low overall geodesic distances in the team network.

6.2 Discussions

After analyzing the facts discussed in the section 6.1 and the feedback from the participants during the closeout session, the research discusses the lessons learned and compares the applied issues with the theoretical applications suggested by the literature.

For a successful project partnering experience, it is important that all the participants including top management should be the part of the partnering kick-off partnering session (Beach et al., 2005). The participants of the case study project also agreed with the fact that partnering kick-off session at the beginning of the project is essential as it allows all team members to collaboratively recreate the project so that major milestones and deadlines are achieved within time.

Construction is a challenging industry which is full of conflicts and litigations. This characteristics of the construction industry can be attributed to high competition and profit associated with the industry (Drexler Jr. & Larson, 2000). Literature states that to achieve better project delivery in spite of the adversarial nature of the industry, partnering can be implemented contractually or philosophically as well (Lahdenpera, 2012; Yeung et al., 2012; Saunders & Mosey, 2005). However, results of the research suggests that to maintain project quality and safety, inclusion of as much as partnering drivers in the contract is essential. Also, the use of collaboration at the time of procurement of other team members will definitely help in maintaining quality selection.

A study conducted by Chan et al., (2003) states that the establishment of conflict and issue resolution strategies assists in increasing team and project performance outcomes during all phases of construction. Literature also states that resource sharing and clear definition of lines and responsibilities helps in communicating mutual goals and objectives (Chan et al., 2003). Similarly, results of the research showed that proper coordination and cooperation through open communication and resolving issues at the lowest level was the motto of the teams on the case

study project. Participants on the project agreed to the fact that FAST (Focused Strategic Teams) teams, cohabitation strategies and overall partnering plans were the only reasons for the success of the project. Any call into the main office from the personals deputed on the field were taken as highest priority and a FAST team was assigned for resolving the issue. Chan et al., (2003) also states the importance of constant feedback about the team performance should be given to the participants. Case study project implemented the concept of feedback through score cards. Also, close-out session was conducted to receive feedbacks from the participants for future collaborations. Teams also discussed the lessons learned during the project close-out so that the same can be implemented in future projects while working together.

6.3 Limitations and Recommendation for Future Research

This sections discusses about the limitations for doing this research. Following that, this section also covers that recommendations for the future research.

6.3.1 Limitations

While performing qualitative analysis, project goals and the key issues were not self-scored for the initial months of the project. It would have been an added advantage in judging the project performance through the perspective of the participants. Due to cohabitation, some conversation was verbal and off the record in the project documents. Therefore research does not incorporate the practices and incidents that were not recorded in the project documents.

In the documents analyzed for SNA, 90% of the issues did not have the names of the individual participants involved in the interactions. Instead, the documents analyzed listed the teams / organizations that are called for a task or an action item, in most instances. Therefore, the distinction between Tier 1 and 2 members from the same organization in the study coding was

accomplished via following the list of attendees in a given document (i.e., executive meeting minutes included mostly Tier 1 members and stakeholders, while weekly meeting minutes included Tier 1-3 members).

6.3.2 Recommendations for Future Research

The research was restricted to only one case study. For future research it is advised to conduct research on another partnered project and then compare those results with the results of this research. This will help in generating a stronger evidence to show how project partnering affects the project and team performance outcomes. It is suggested to find another partnered construction project specifically in the aviation industry to compare the effects of partnering on such large scale public project. Also, there can be a future research comparing the implementation of project partnering on a large scale public project with a small scale private project.

There should be a research on comparing the project and team performance outcomes of a partnered construction project and a non-partnered construction project. This will result in a stronger evidence to answer the research question, i.e. if and how project partnering improves the project and team performance in the AEC industry.

Future research on documenting the barriers to partnering using a failed partnered construction project as a case study should be accomplished. The results of the study will help in verifying the literature on the barriers to partnering (Sparkling, 2014; Mollaoglu et al., 2015).

The research was a retrospective case study, as this research was limited to the project documents only. It is recommended that aspiring researchers should perform longitudinal study of an on-going project to better understand the team interactions including informal exchanges of information. This will result in the development of even more precise sociograms and team interaction models.

6.4 Concluding Remarks

This research provides an evidence based guide developed based on a partnered construction project. This research provides an empirical and rigorous study for project partnering in the AEC industry, especially focusing on and documenting its immediate implications, that is: the mediating effects on project performance via improvements in team performance.

The research suggests the use of project partnering for large public projects as compared to small project. The case study project selected for the in-depth case study is from the aviation construction industry. Aviation construction industry in particular has really complex construction projects with multiple stakeholders and multiple sources of funding. Project partnering in the aviation industry helps in bringing all the stakeholders to one single table and lets participants to successfully communicate their mutual goals and objectives with each other. Analysis of the project documents of the selected case study project showed how project partnering really affected the project performance. The researcher found that the implementation of project partnering in large public projects helps in maintaining good public perception about the project.

The research includes qualitative analysis of the project documents using the partnering framework (Mollaoglu and Sparkling, 2015; Sparkling, 2014) that was developed through meta-analytical synthesis of partnering literature. This provides a future guidance to the use of partnering framework in qualitatively analyzing the construction project documents. The research also provides a verification to the partnering framework (Mollaoglu and Sparkling, 2015; Sparkling, 2014) and confirms the integrity of the framework for its use in such longitudinal case study researches in future.

The research includes SNA to study the change in the team interactions by developing sociograms. Following that, results from qualitative analysis and SNA were compared. Researcher found that

the potential and effective system of issue resolution and open communication helped case study project teams in completing project one month prior to the originally scheduled date and well within budget. It was observed that the partnering practice of joint problem solving showed the highest occurrence. It was also observed that in order to achieve better team characteristics over long term of time, it is important to implement partnering drivers at the time of procurement. The researcher also observed that implementation of partnering drivers helps in achieving better team characteristics in the succeeding month. The researcher observed that project performance outcomes for project quality, operational disruption, and public perception improved with better team characteristics. While the project performance outcomes for schedule, cost, safety, and security depends on the implementation of partnering drivers. The results of the research showed the links between the implementation of partnering practices, change in team interaction, and project performance outcomes. In the end, the researcher combined all the finding and developed lessons learned and recommendations for the industry.

APPENDICES

APPENDIX A

IRB DOCUMENTS

MICHIGAN STATE
UNIVERSITY

Initial IRB Application Determination *Exempt*

December 16, 2014

To: Sinem Korkmaz
111-A Human Ecology Building
East Lansing

Re: **IRB# x14-1256e** Category: EXEMPT 4
Approval Date: December 16, 2014

Title: Evidence based research for partnering success factors - Phase III: Partnering Case Study via Social Network and Content Analysis OSP/CGA 140786

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **your project has been deemed as exempt** in accordance with federal regulations.

This approval is only for part one of this study which constitutes using existing data.

The IRB has found that your research project meets the criteria for exempt status and the criteria for the protection of human subjects in exempt research. **Under our exempt policy the Principal Investigator assumes the responsibilities for the protection of human subjects** in this project as outlined in the assurance letter and exempt educational material. The IRB office has received your signed assurance for exempt research. A copy of this signed agreement is appended for your information and records.

Renewals: Exempt protocols do not need to be renewed. If the project is completed, please submit an *Application for Permanent Closure*.

Revisions: Exempt protocols do not require revisions. However, if changes are made to a protocol that may no longer meet the exempt criteria, a new initial application will be required.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants regarding the risk and benefits of the project must be reported to the IRB.

Follow-up: If your exempt project is not completed and closed after three years, the IRB office will contact you regarding the status of the project and to verify that no changes have occurred that may affect exempt status.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with the IRB office.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or via email at IRB@msu.edu. Thank you for your cooperation.

Sincerely,

H. McGee

Harry McGee, MPH
SIRB Chair

c: Shivam Sohani

Office of Regulatory Affairs
Human Research Protection Programs

Biomedical & Health Institutional Review Board (BIRB)

Community Research Institutional Review Board (CRIRB)

Social Science Behavioral/Education Institutional Review Board (SIRB)

Olds Hall
408 West Circle Drive, #207
East Lansing, MI 48824
(517) 355-2180
Fax: (517) 432-4503
Email: irb@msu.edu
www.humanresearch.msu.edu

MICHIGAN STATE
UNIVERSITY

Initial IRB Application Determination *Exempt*

April 7, 2016

To: Sinem Korkmaz
111-A Human Ecology Building
East Lansing

Re: **IRB# x14-1256e** Category: EXEMPT 2, 7
Approval Date: December 16, 2014

Title: Evidence based research for partnering success factors - Phase III: Partnering Case Study via Social Network and Content Analysis OSP/CGA 140786

The Institutional Review Board has completed their review of your project. I am pleased to advise you that **your project has been deemed as exempt**.

This application involves the use of identifiable data and interviewing subjects.

This project has qualified for the demonstration initiative exempt category 7 Research involving existing sets of identifiable data and pose no more than minimal risk to subjects and must not contain any of the following:

- Federal funding or federal training grants
- Sponsor or other contractual restrictions
- Previous restrictions on data use
- FDA regulated components
- Receipt of an NIH certificate of confidentiality to protect identifiable research data.
- Research subject interactions or interventions (refer them to the "Did you know" document sent with the letter).

Under our exempt policy the Principal Investigator assumes the responsibilities for the protection of human subjects in this project as outlined in the assurance letter and exempt educational material. The IRB office has received your signed assurance for exempt research. A copy of this signed agreement is appended for your information and records.

Renewals: Exempt protocols do not need to be renewed. If the project is completed, please submit an *Application for Permanent Closure*.

Revisions: Exempt protocols do not require revisions. However, if changes are made to a protocol that may no longer meet the exempt criteria, a new initial application will be required.

Problems: If issues should arise during the conduct of the research, such as unanticipated problems, adverse events, or any problem that may increase the risk to the human subjects and change the category of review, notify the IRB office promptly. Any complaints from participants regarding the risk and benefits of the project must be reported to the IRB.

Follow-up: If your exempt project is not completed and closed after three years, the IRB office will contact you regarding the status of the project and to verify that no changes have occurred that may affect exempt status.

Please use the IRB number listed above on any forms submitted which relate to this project, or on any correspondence with the IRB office.

Good luck in your research. If we can be of further assistance, please contact us at 517-355-2180 or Sincerely at IRB@msu.edu. Thank you for your cooperation.

H. McGee

Harry McGee, MPH
SIRB Chair

c: Shivam Sohani

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Consent Form – A: Case Study Team Leaders

The research on "Partnering Case Study via Social Network and Content Analysis", is been conducted by Dr. Sinem Mollaoglu (Professor) and Shivam Sohani (Graduate Assistant) in Construction Management program at Michigan State University. This project is funded by "International Partnering Institute (IPI)".

The main objective of this research is to *develop evidence-based documents on key success factors, and build the foundations of a longitudinal study of partnering via an in-depth case study.* The data collected will be used to understand the effects of the partnering process on team communication and collaboration and project performance.

Your participation in this research will be via providing and giving permission for the analysis of archival case study data. Specifically:

a) Project delivery documents including project performance (e.g. cost, schedule, claims);

b) Project meeting minutes; and

c) Chain of e-mail communications and information exchanges among project participants;

All information collected will be kept confidential in the principal investigator's office and would only be accessible to the research team involved in this project. The information collected will only be used to achieve the research objectives as well as for written or oral reports and published papers. All project participants' name and other critical information (such as cost, schedule or any other information as per the discretion of the interviewee) received about the project will be kept confidential in all public references to this research and your and your project team members' confidentiality will be maintained to the maximum extent allowable by law. There are no known risks associated with participation in the study.

As a possible benefit of your participation, you could gain a better understanding about your project's overall performance in context to the process of partnering. This research can help in advancing the partnering process and get it implemented in as many construction projects possible. Also as a participant we will be glad to share with you a copy of our final report.

You participation is voluntary i.e., you may choose not to participate at all, or refuse to participate in certain procedure or discontinue your participation at any time without consequences. One copy of this document will be kept together without research records at Michigan State University for 3 years after the project completion. If at any time you would like to discuss questions regarding this research, you may do so by contacting Dr. Sinem Mollaoglu (Korkmaz) (517-353-3252) or Shivam Sohani (517-580-9362). Also, if you have any questions or concerns about your roles and rights as a research participant, or would you like to register a complaint about this study, you may contact anonymously if you wish to the director of MSU's Human Research Protection Program at 517-355-2180 or email at irb@msu.edu or regular mail at 202, Olds Hall, East Lansing, MI- 48824

Research team contacts:

Primary Investigator: Dr. Sinem Mollaoglu (Korkmaz) , Associate Professor, Construction Management department, 201-D Human Ecology Building, Michigan State University, Office: 517-353-3252. Email: korkmaz@msu.edu

Secondary Investigator: Shivam Sohani, Graduate Student, Construction Management department, Room no. 105, Human Ecology Building, Michigan State University, Phone: 517-580-9362.

I voluntarily agree to participate in this study.

| --- | --- | --- |
| Please print your full name | Signature | Date |

I voluntarily agree to participate in this study.

| --- | --- | --- |
| Please print your full name | Signature | Date |

Consent Form - B

The research on "Partnering Case Study via Social Network and Content Analysis", will be conducted by Dr. Sinem Mollaoglu (Professor) and Shivam Sohani (Graduate Assistant) in Construction Management program at Michigan State University. This project is funded by "International Partnering Institute (IPI)".

The main objective of this research is to *develop evidence-based documents on key success factors, and build the foundations of a longitudinal study of partnering via an in-depth case study.* The data collected will be used to understand the effects of the partnering process on team communication and collaboration and project performance.

Your participation in this research is in the form of structured interviews that will be voice recorded and transcribed verbatim later. All information collected through interviews will be kept confidential in the principal investigator's office and would only be accessible to the research team involved in this project. The information collected will only be used to achieve the research objectives as well as for written or oral reports and published papers. Your name and other critical information (such as cost, schedule or any other information as per the discretion of the interviewee) received about the project will be kept confidential in all public references to this research and your confidentiality will be maintained to the maximum extent allowable by law (unless the interviewee agrees to the inclusion of his/her name and/or professional affiliation and/or critical project information in the study). There are no known risks associated with participation in the study.

As a possible benefit of your participation, you could gain a better understanding about your project's overall performance in context to the process of partnering. This research can help in advancing the partnering process and get it implemented in as many construction projects possible. Also as a participant we will be glad to share with you a copy of your (only) interview and the final report.

You participation is voluntary i.e., you may choose not to participate at all, or refuse to participate in certain procedure or answer certain questions or discontinue your participation at any time without consequences. One copy of this document will be kept together without research records at Michigan State University for 3 years after the project completion. If at any

time you would like to discuss questions regarding this research, you may do so by contacting Dr. Sinem Mollaoglu (517-353-3252) or Shivam Sohani (517-580-9362). Also, if you have any questions or concerns about your roles and rights as a research participant, or would you like to register a complaint about this study, you may contact anonymously if you wish to the director of MSU's Human Research Protection Program at 517-355-2180 or email at irb@msu.edu or regular mail at 202, Olds Hall, East Lansing, MI- 48824

Research team contacts:

Primary Investigator: Dr. Sinem Mollaoglu, Assistant Professor, Construction Management department, 201-D Human Ecology Building, Michigan State University, Office: 517-353-3252.

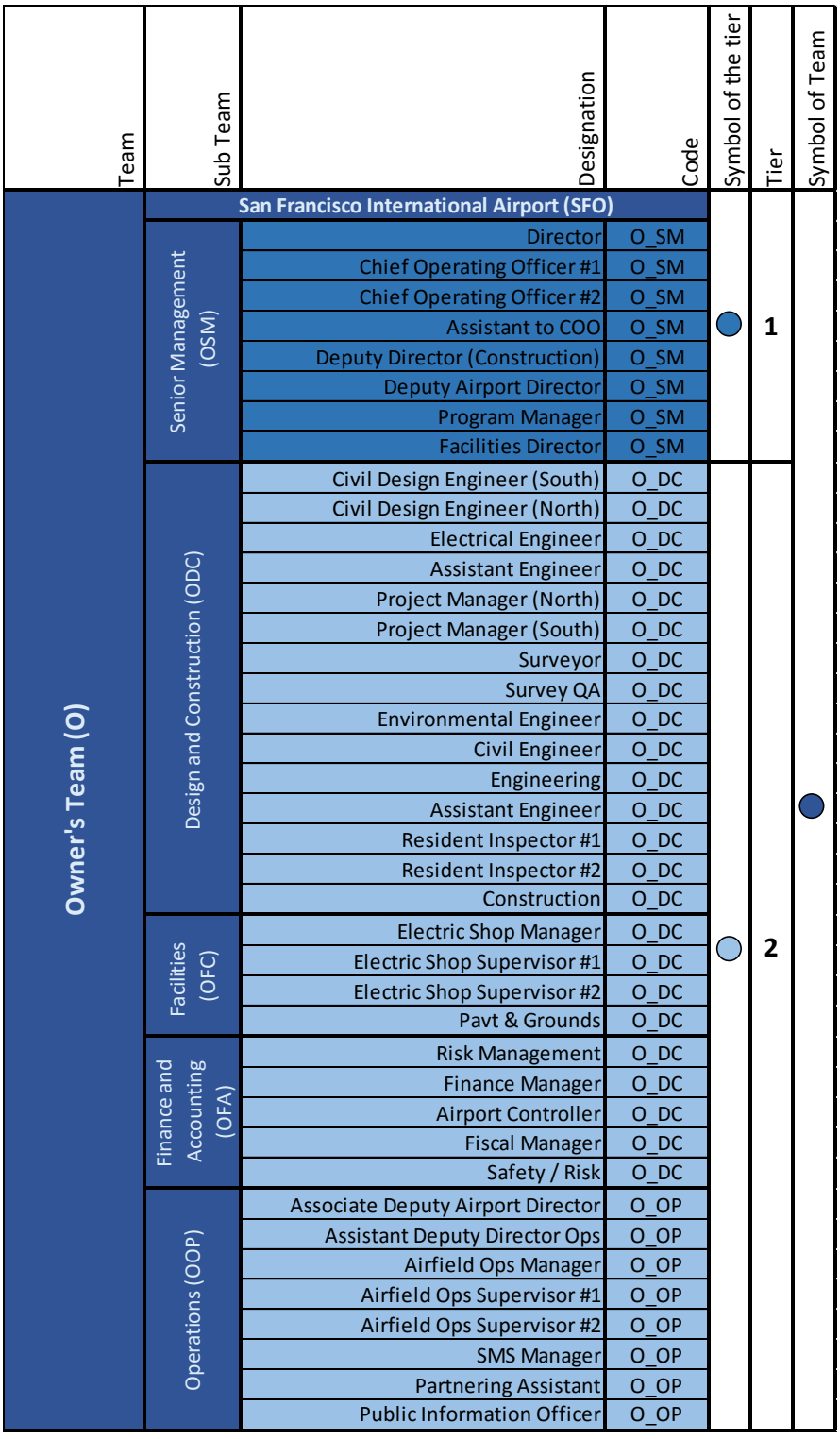
Secondary Investigator: Shivam Sohani, Graduate Student, Construction Management department, Room no. 105, Human Ecology Building, Michigan State University, Phone: 517-580-9362.

I voluntarily agree to participate in this study.

If you decide to participate to this study with the structured interview, your consent will be collected over the phone and be voice recorded.

APPENDIX B

LIST OF PARTICIPANTS



Team	Sub Team	Designation	Code	Symbol of the tier	Tier	Symbol of Team
Owner's Team (O)	San Francisco International Airport (SFO)					
	Senior Management (OSM)	Director	O_SM			
		Chief Operating Officer #1	O_SM			
		Chief Operating Officer #2	O_SM			
		Assistant to COO	O_SM	●	1	
		Deputy Director (Construction)	O_SM			
		Deputy Airport Director	O_SM			
		Program Manager	O_SM			
		Facilities Director	O_SM			
	Design and Construction (ODC)	Civil Design Engineer (South)	O_DC			
		Civil Design Engineer (North)	O_DC			
		Electrical Engineer	O_DC			
		Assistant Engineer	O_DC			
		Project Manager (North)	O_DC			
		Project Manager (South)	O_DC			
		Surveyor	O_DC			
		Survey QA	O_DC			
		Environmental Engineer	O_DC			
		Civil Engineer	O_DC			
		Engineering	O_DC			
		Assistant Engineer	O_DC			●
		Resident Inspector #1	O_DC			
		Resident Inspector #2	O_DC			
		Construction	O_DC			
	Facilities (OFC)	Electric Shop Manager	O_DC			
		Electric Shop Supervisor #1	O_DC	●	2	
		Electric Shop Supervisor #2	O_DC			
		Pavt & Grounds	O_DC			
	Finance and Accounting (OFA)	Risk Management	O_DC			
		Finance Manager	O_DC			
		Airport Controller	O_DC			
		Fiscal Manager	O_DC			
		Safety / Risk	O_DC			
	Operations (OOP)	Associate Deputy Airport Director	O_OP			
		Assistant Deputy Director Ops	O_OP			
		Airfield Ops Manager	O_OP			
		Airfield Ops Supervisor #1	O_OP			
		Airfield Ops Supervisor #2	O_OP			
		SMS Manager	O_OP			
		Partnering Assistant	O_OP			
		Public Information Officer	O_OP			

Figure 23: Snapshot of list of participants

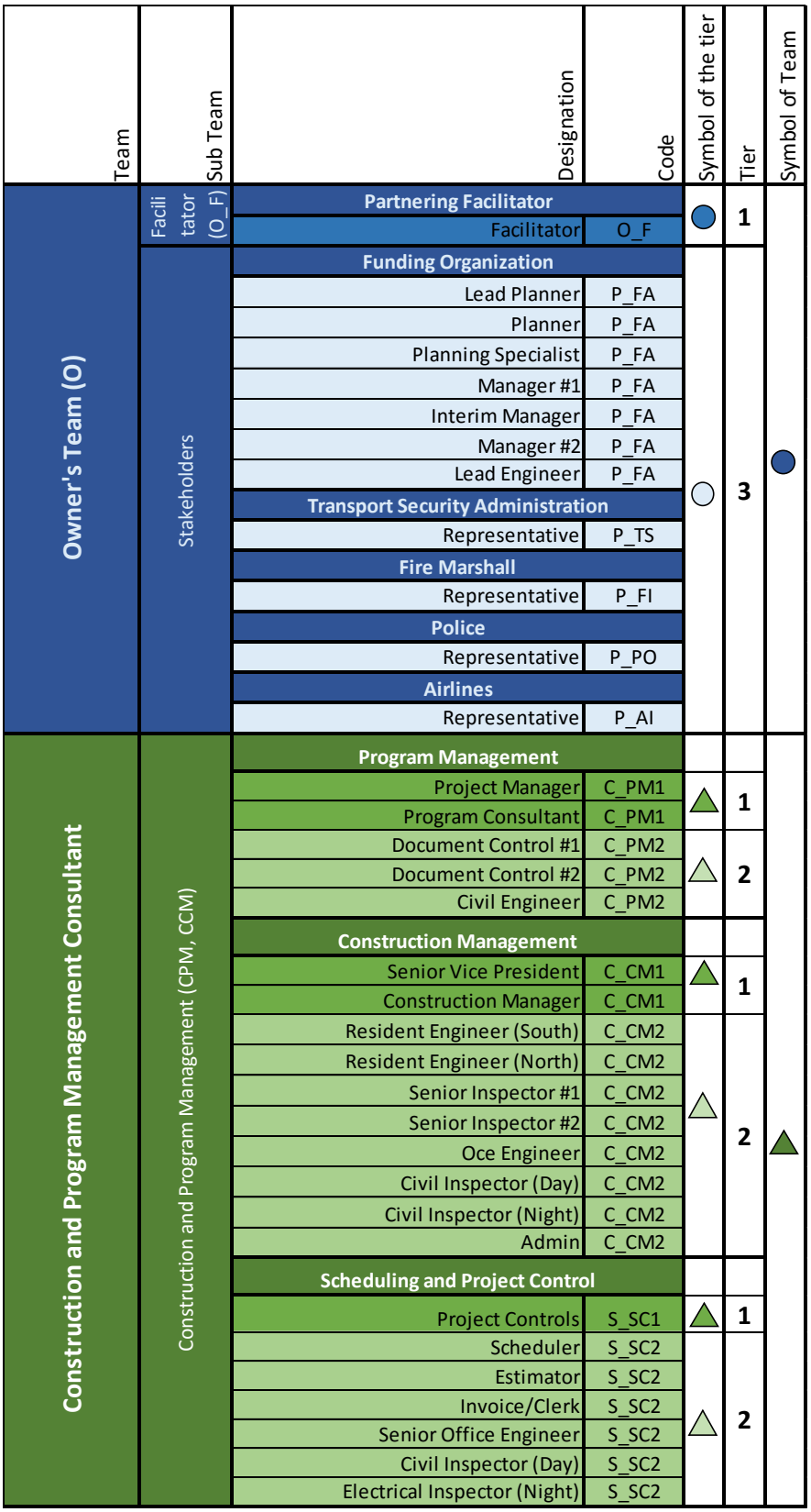
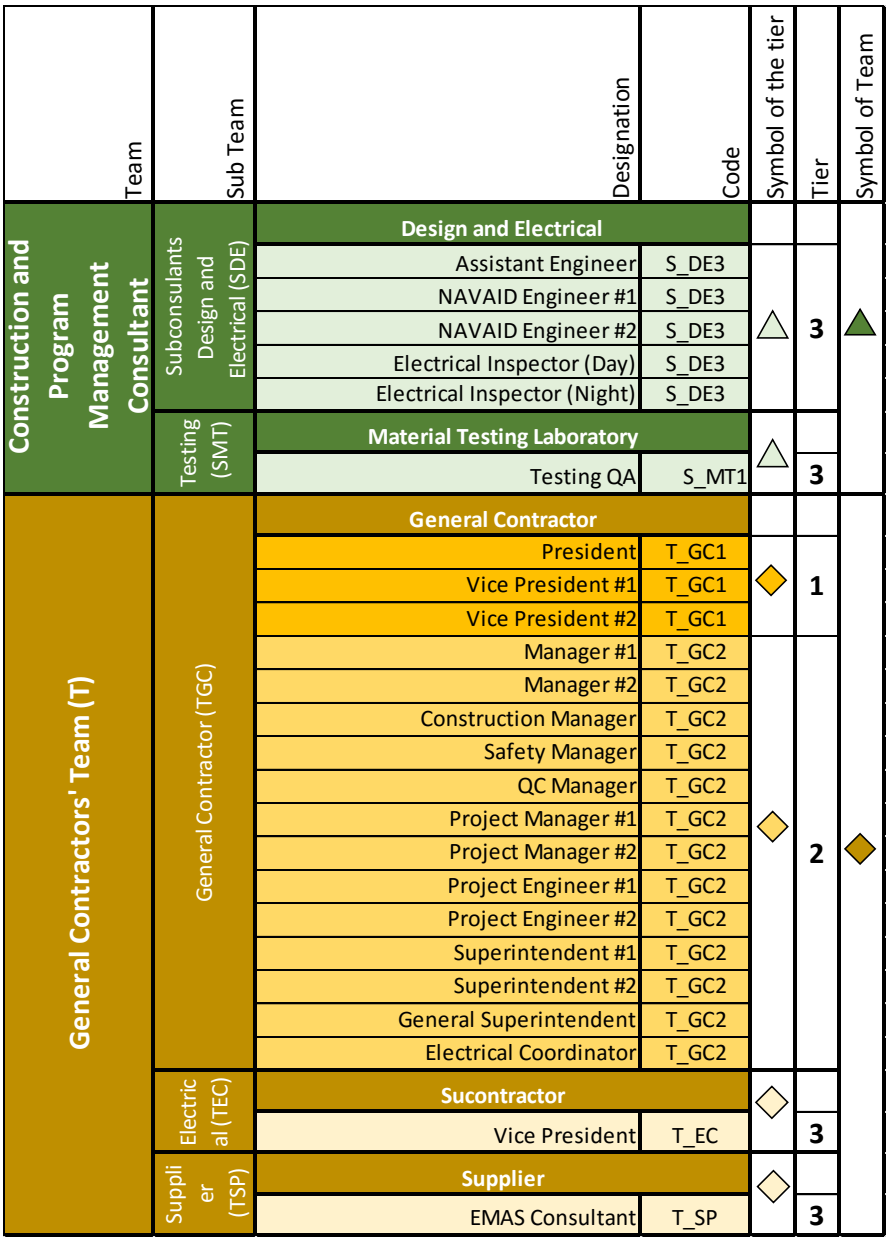


Figure 24: Snapshot of list of participants



Team	Sub Team	Designation	Code	Symbol of the tier	Tier	Symbol of Team
Construction and Program Management Consultant	Subconsulants Design and Electrical (SDE)	**Design and Electrical**				
		Assistant Engineer	S_DE3	△	3	▲
		NAVAID Engineer #1	S_DE3			
		NAVAID Engineer #2	S_DE3			
		Electrical Inspector (Day)	S_DE3			
		Electrical Inspector (Night)	S_DE3			
	Testing (SMT)	**Material Testing Laboratory**		△		
		Testing QA	S_MT1		3	
General Contractors' Team (T)	General Contractor (TGC)	**General Contractor**				
		President	T_GC1	◆	1	
		Vice President #1	T_GC1			
		Vice President #2	T_GC1			
		Manager #1	T_GC2		2	◆
		Manager #2	T_GC2			
		Construction Manager	T_GC2			
		Safety Manager	T_GC2			
		QC Manager	T_GC2			
		Project Manager #1	T_GC2			
		Project Manager #2	T_GC2			
		Project Engineer #1	T_GC2			
		Project Engineer #2	T_GC2			
		Superintendent #1	T_GC2			
		Superintendent #2	T_GC2			
		General Superintendent	T_GC2			
		Electrical Coordinator	T_GC2			
	Electrical (TEC)	**Sucontractor**		◇		
		Vice President	T_EC		3	
	Supplier (TSP)	**Supplier**		◇		
		EMAS Consultant	T_SP		3	

Figure 25: Snapshot of list of participants

APPENDIX C

SOCIOGRAM OF EACH MONTH

JAN	Degree	Betweeness	Closeness
O_SM	3	0.500	41
O_DC	1	0.000	43
O_FC	1	0.000	43
O_FA	1	0.000	43
O_OP	1	0.000	43
P_FA	1	0.000	43
P_TS	1	0.000	43
P_FI	1	0.000	43
P_PO	1	0.000	43
P_AI	1	0.000	43
C_PM1	1	0.000	43
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	1	0.000	43
S_SC1	1	0.000	43
S_SC2	1	0.000	43
S_DE3	1	0.000	43
S_MT1	1	0.000	43
T_GC1	2	0.000	42
T_GC2	2	0.000	42
T_EC	1	0.000	43
T_SP	1	0.000	43
O_F	22	228.500	22

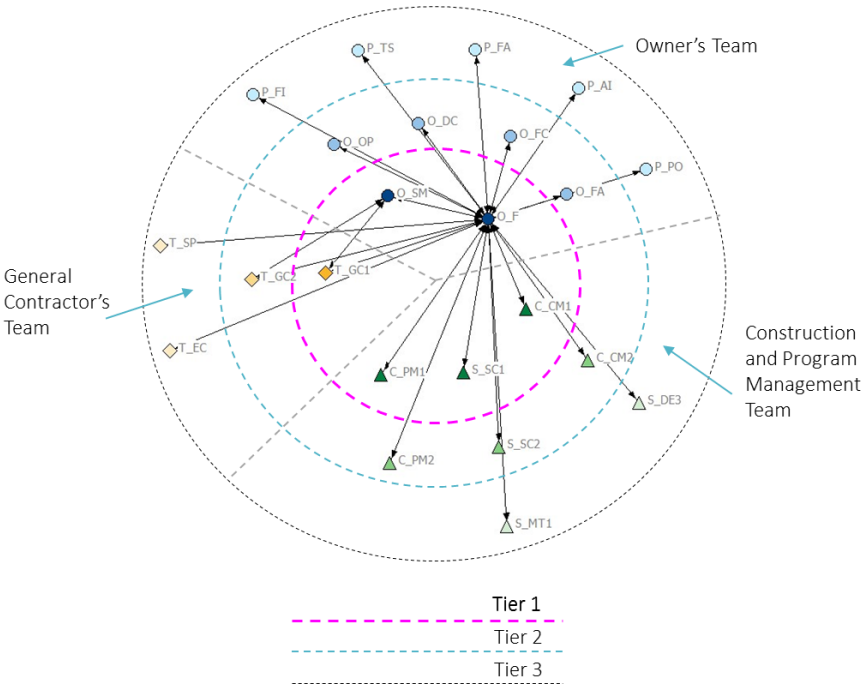


Figure 26: Sociogram showing team interactions for the month of January

FEB	Degree	Betweeness	Closeness
O_SM	5	2.833	39
O_DC	3	0.333	41
O_FC	1	0.000	43
O_FA	1	0.000	43
O_OP	2	0.000	42
P_FA	2	0.000	42
P_TS	1	0.000	45
P_FI	1	0.000	45
P_PO	1	0.000	45
P_AI	1	0.000	45
C_PM1	1	0.000	45
C_PM2	1	0.000	45
C_CM1	1	0.000	45
C_CM2	3	0.000	43
S_SC1	2	0.000	42
S_SC2	1	0.000	45
S_DE3	1	0.000	45
S_MT1	1	0.000	45
T_GC1	2	0.000	42
T_GC2	5	2.833	39
T_EC	1	0.000	43
T_SP	3	0.333	41
O_F	22	216.667	22

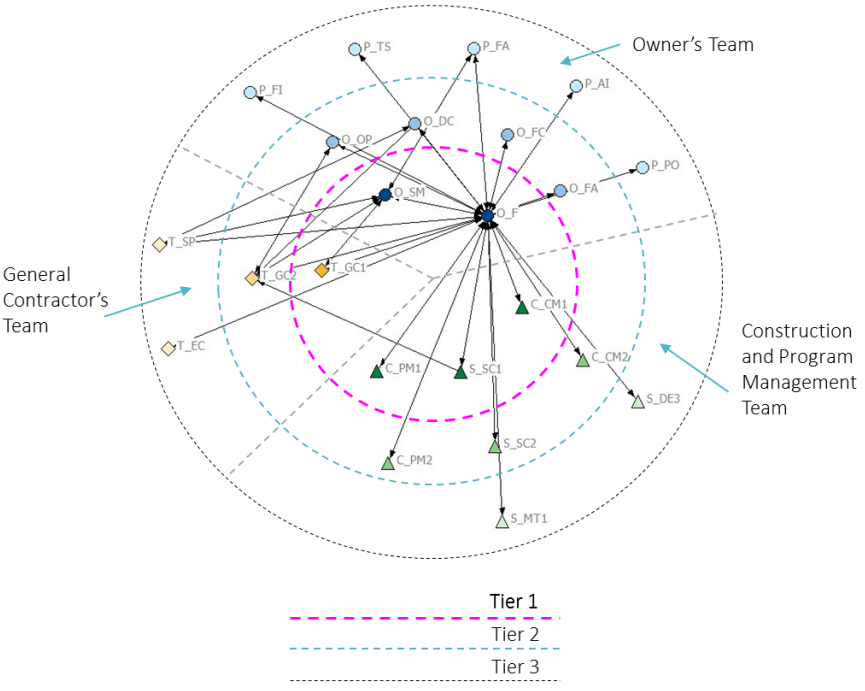


Figure 27: Sociogram showing team interactions for the month of February

MAR	Degree	Betweeness	Closeness
O_SM	3	0.333	41
O_DC	4	0.250	40
O_FC	1	0.000	43
O_FA	1	0.000	43
O_OP	3	0.250	41
P_FA	4	0.667	40
P_TS	1	0.000	43
P_FI	1	0.000	43
P_PO	1	0.000	43
P_AI	1	0.000	43
C_PM1	1	0.000	43
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	1	0.000	43
S_SC1	5	2.000	39
S_SC2	1	0.000	43
S_DE3	1	0.000	43
S_MT1	1	0.000	43
T_GC1	3	0.333	41
T_GC2	5	1.583	39
T_EC	1	0.000	43
T_SP	1	0.000	43
O_F	22	215.583	22

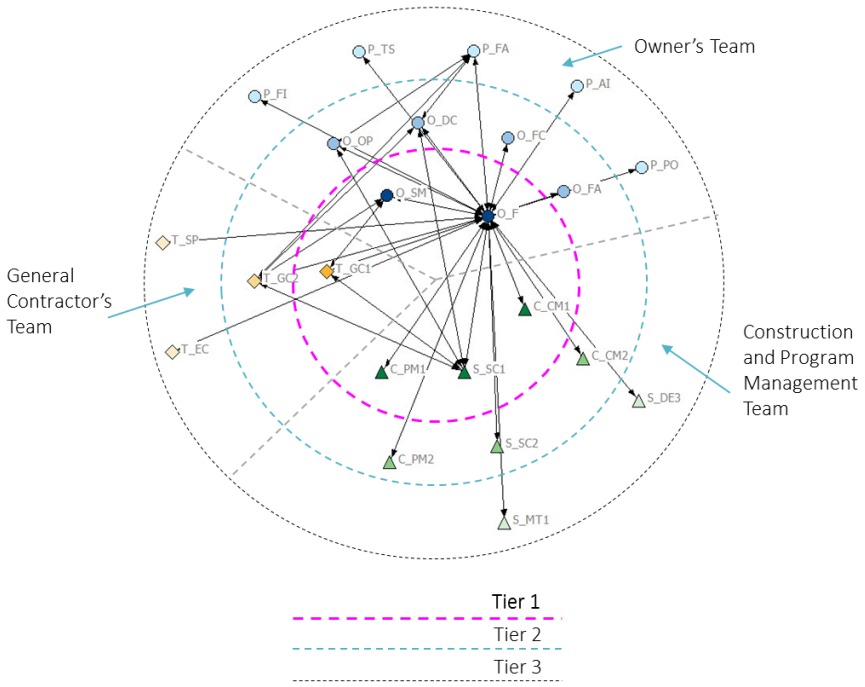


Figure 28: Sociogram showing team interactions for the month of March

APR	Degree	Betweeness	Closeness
O_SM	8	1.744	36
O_DC	14	14.311	30
O_FC	3	0.000	41
O_FA	2	0.000	42
O_OP	6	0.311	38
P_FA	6	1.733	38
P_TS	1	0.000	43
P_FI	2	0.000	42
P_PO	1	0.000	43
P_AI	1	0.000	43
C_PM1	5	0.111	39
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	7	2.667	37
S_SC1	3	0.167	41
S_SC2	7	0.567	37
S_DE3	6	0.311	38
S_MT1	7	1.594	37
T_GC1	9	3.517	35
T_GC2	12	10.550	32
T_EC	9	4.961	35
T_SP	7	1.811	37
O_F	22	138.644	22

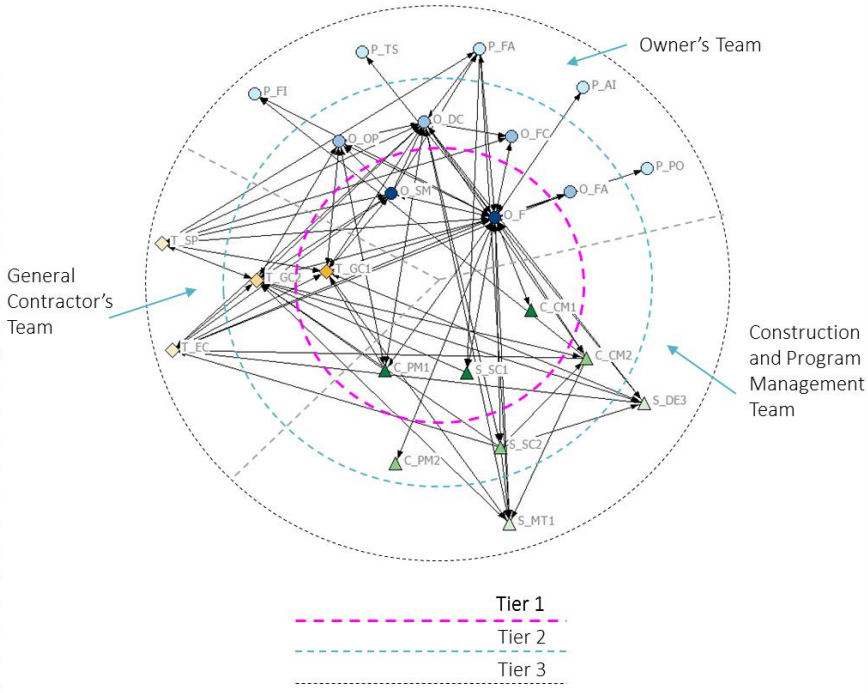


Figure 29: Sociogram showing team interactions for the month of April

MAY	Degree	Betweeness	Closeness
O_SM	6	2.000	38
O_DC	7	1.833	37
O_FC	3	0.000	41
O_FA	1	0.000	43
O_OP	7	1.833	37
P_FA	3	0.000	41
P_TS	1	0.000	43
P_FI	1	0.000	43
P_PO	1	0.000	43
P_AI	3	0.000	41
C_PM1	2	0.000	42
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	5	0.667	39
S_SC1	1	0.000	43
S_SC2	1	0.000	43
S_DE3	2	0.000	42
S_MT1	1	0.000	43
T_GC1	2	0.000	42
T_GC2	12	19.833	32
T_EC	2	0.000	42
T_SP	5	0.000	39
O_F	22	181.833	22

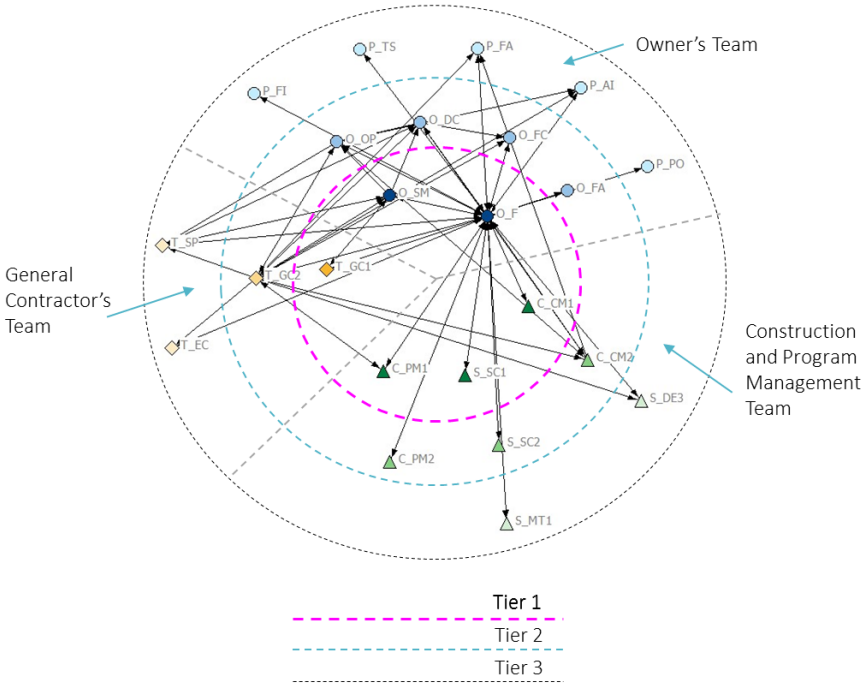


Figure 30: Sociogram showing team interactions for the month of May

JUN	Degree	Betweeness	Closeness
O_SM	3	0.500	41
O_DC	6	1.917	38
O_FC	2	0.000	42
O_FA	1	0.000	43
O_OP	3	0.000	41
P_FA	3	0.000	41
P_TS	1	0.000	43
P_FI	2	0.000	42
P_PO	1	0.000	43
P_AI	1	0.000	43
C_PM1	4	0.250	40
C_PM2	2	0.000	42
C_CM1	5	1.750	39
C_CM2	5	1.750	39
S_SC1	1	0.000	43
S_SC2	2	0.000	42
S_DE3	2	0.000	42
S_MT1	2	0.000	42
T_GC1	2	0.000	42
T_GC2	13	28.667	31
T_EC	2	0.000	42
T_SP	1	0.000	43
O_F	22	175.167	22

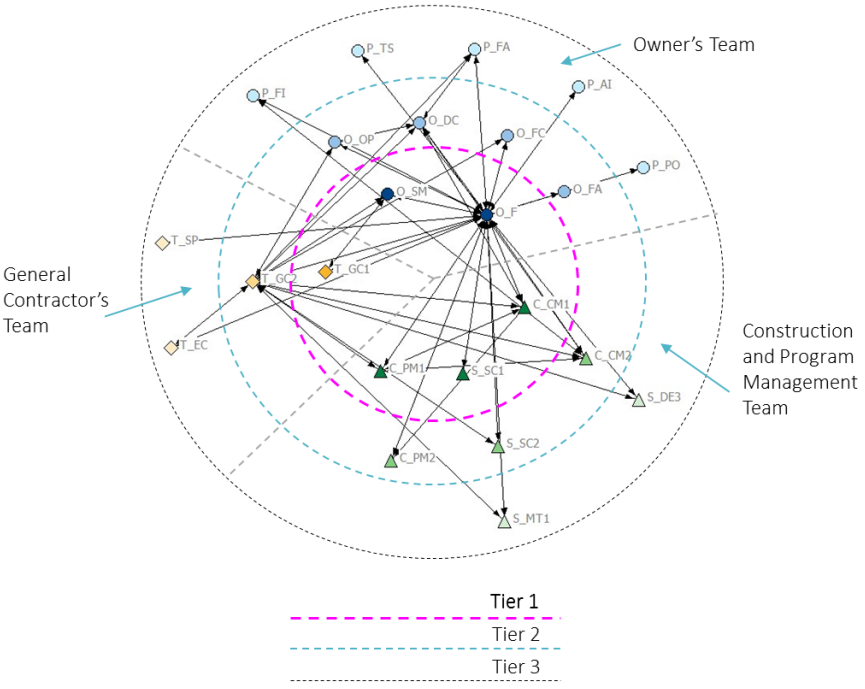


Figure 31: Sociogram showing team interactions for the month of June

JUL	Degree	Betweeness	Closeness
O_SM	3	0.500	41
O_DC	8	7.000	36
O_FC	3	0.000	41
O_FA	1	0.000	43
O_OP	8	7.000	36
P_FA	6	1.143	38
P_TS	1	0.000	43
P_FI	1	0.000	43
P_PO	2	0.000	42
P_AI	1	0.000	43
C_PM1	1	0.000	43
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	5	0.143	39
S_SC1	1	0.000	43
S_SC2	3	0.143	41
S_DE3	3	0.143	41
S_MT1	2	0.000	42
T_GC1	2	0.000	42
T_GC2	7	3.643	37
T_EC	3	0.143	41
T_SP	1	0.000	43
O_F	22	190.143	22

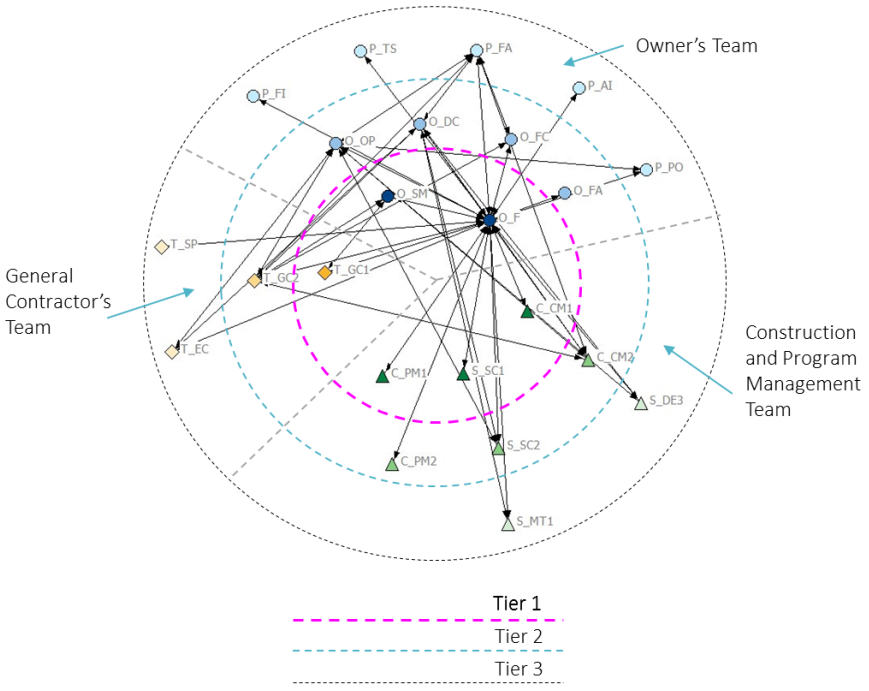


Figure 32: Sociogram showing team interactions for the month of July

AUG	Degree	Betweeness	Closeness
O_SM	4	1.250	40
O_DC	9	5.167	35
O_FC	6	0.000	38
O_FA	1	0.000	43
O_OP	9	4.167	35
P_FA	2	0.000	42
P_TS	1	0.000	43
P_FI	2	0.000	42
P_PO	1	0.000	43
P_AI	2	0.000	42
C_PM1	1	0.000	43
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	6	0.000	38
S_SC1	4	0.250	40
S_SC2	6	0.000	38
S_DE3	7	1.250	37
S_MT1	1	0.000	43
T_GC1	4	0.917	40
T_GC2	7	3.833	37
T_EC	5	1.083	39
T_SP	4	0.583	40
O_F	22	181.500	22

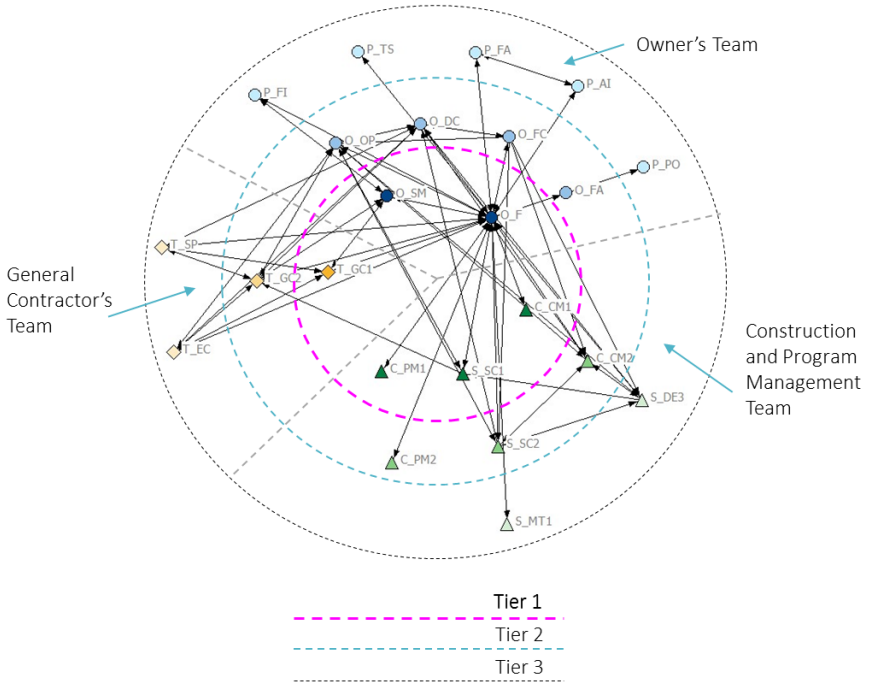


Figure 33: Sociogram showing team interactions for the month of August

SEP	Degree	Betweeness	Closeness
O_SM	3	0.500	41
O_DC	3	0.333	41
O_FC	1	0.000	43
O_FA	1	0.000	43
O_OP	3	0.333	41
P_FA	3	0.333	41
P_TS	1	0.000	43
P_FI	2	0.000	42
P_PO	1	0.000	43
P_AI	1	0.000	43
C_PM1	1	0.000	43
C_PM2	1	0.000	43
C_CM1	1	0.000	43
C_CM2	1	0.000	43
S_SC1	1	0.000	43
S_SC2	1	0.000	43
S_DE3	1	0.000	43
S_MT1	1	0.000	43
T_GC1	2	0.000	42
T_GC2	2	0.000	42
T_EC	1	0.000	43
T_SP	4	1.333	40
O_F	22	1.333	22

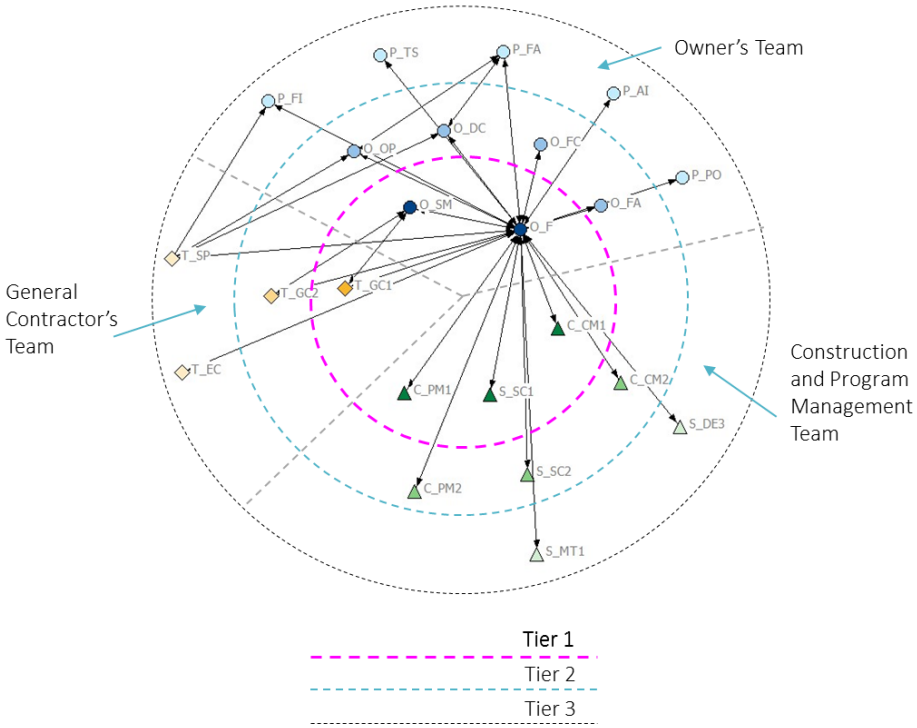


Figure 34: Sociogram showing team interactions for the month of September

APPENDIX D

PROCESS MAPS

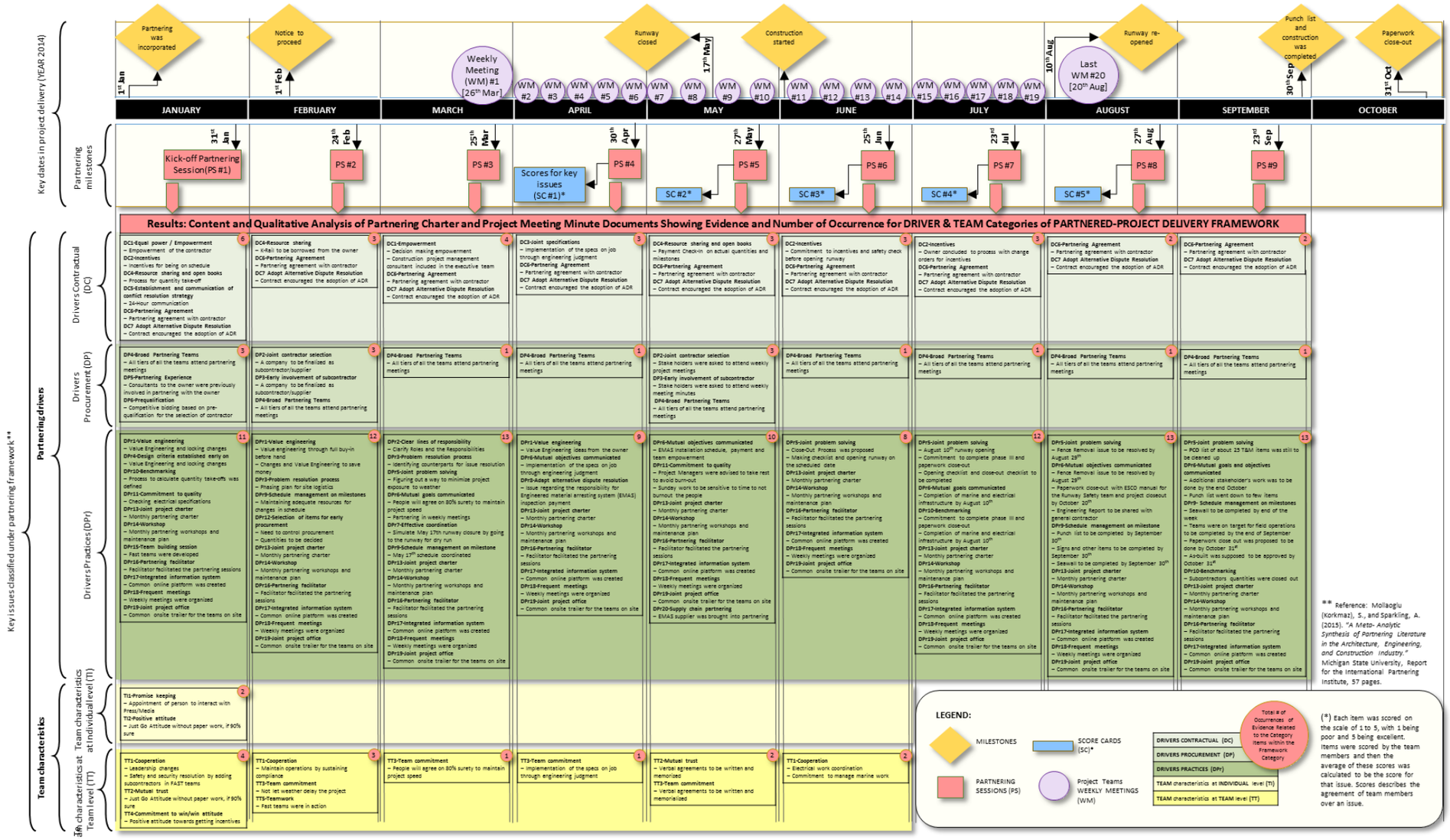


Figure 35: Process Map #1 - Analysis results of project documents showing evidence for drivers & team categories of partnered-project delivery framework

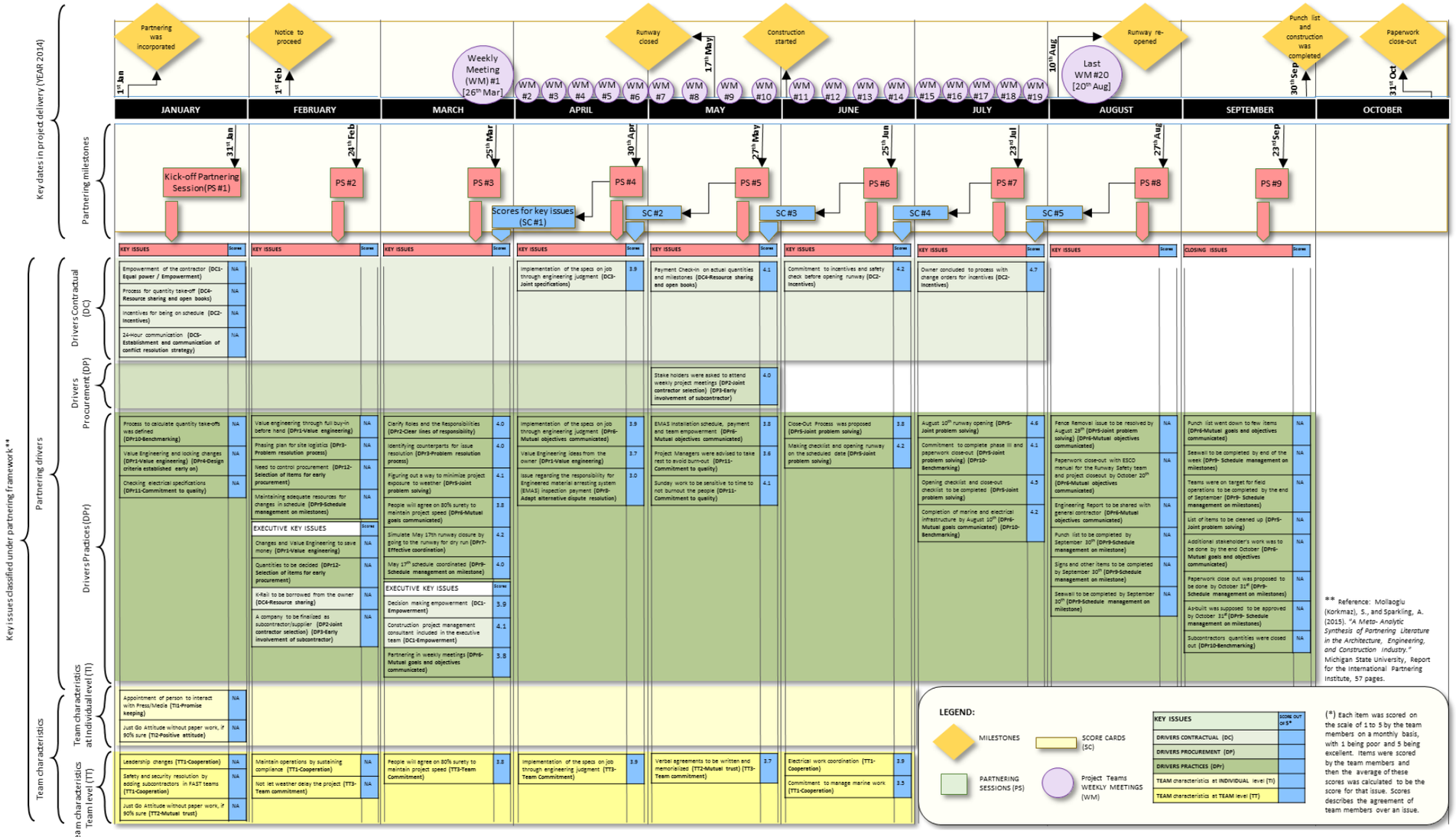
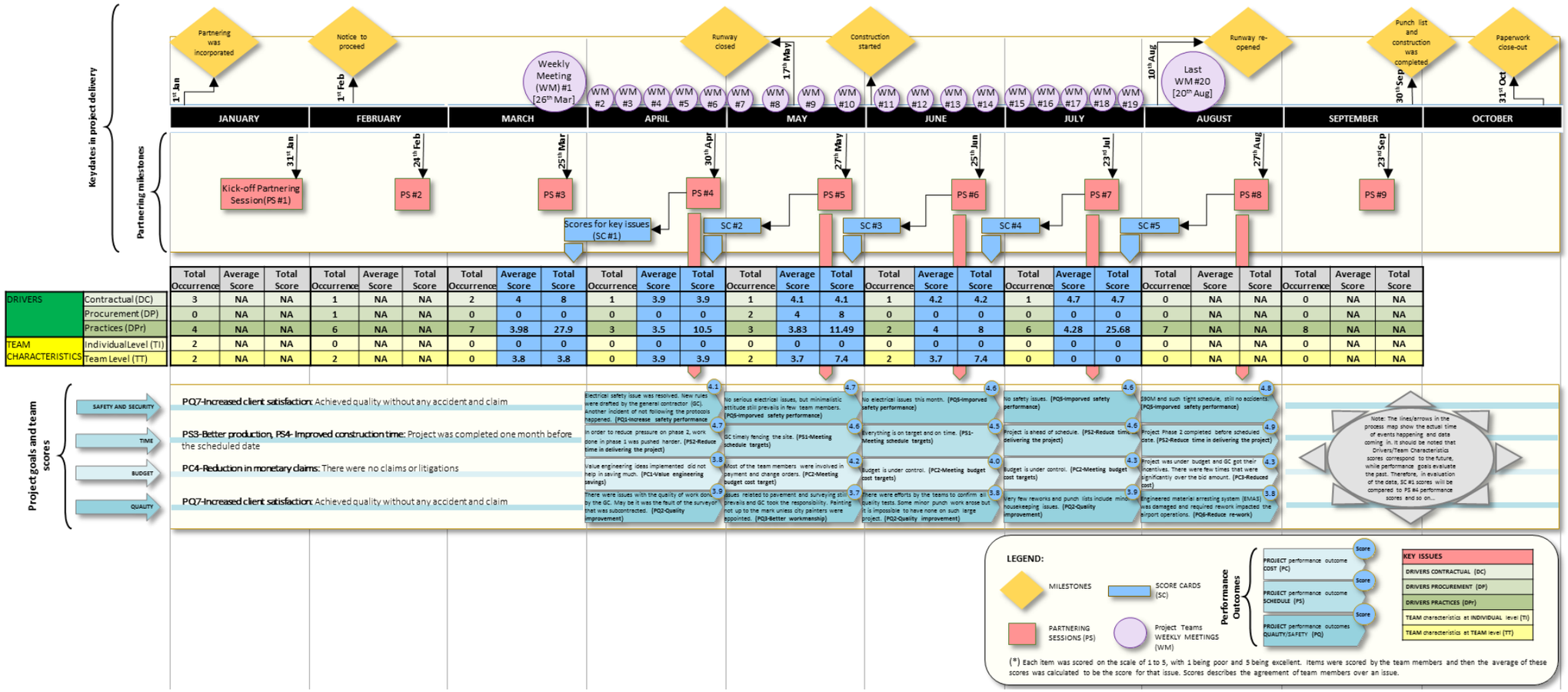


Figure 36: Process Map #2 - Limited version of Process Map #1 where only key issues scored by team members were reported on



		JANUARY			FEBRUARY			MARCH			APRIL			MAY			JUNE			JULY			AUGUST			SEPTEMBER			OCTOBER		
		Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score	Total Occurrence	Average Score	Total Score
DRIVERS	Contractual (DC)	3	NA	NA	1	NA	NA	2	4	8	1	3.9	3.9	1	4.1	4.1	1	4.2	4.2	1	4.7	4.7	0	NA	NA	0	NA	NA			
	Procurement (DP)	0	NA	NA	1	NA	NA	0	0	0	0	0	0	2	4	8	0	0	0	0	0	0	0	NA	NA	0	NA	NA			
	Practices (DPr)	4	NA	NA	6	NA	NA	7	3.98	27.9	3	3.5	10.5	3	3.83	11.49	2	4	8	6	4.28	25.68	7	NA	NA	8	NA	NA			
TEAM CHARACTERISTICS	Individual Level (TI)	2	NA	NA	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	NA	NA	0	NA	NA			
	Team Level (TT)	2	NA	NA	2	NA	NA	0	3.8	3.8	0	3.9	3.9	2	3.7	7.4	2	3.7	7.4	0	0	0	0	NA	NA	0	NA	NA			

Figure 37: Process Map #3 - Illustrating total occurrence of driver and team characteristics categories and total scores form Process Map #2 & project performance outcomes reported based on partnering charters and score cards

APPENDIX E

REVISED PARTNERING FRAMEWORK

Table 7: Elements of CULTURAL Boundary Conditions & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

CULTURAL Boundary Conditions and Constraints	# of Times Identified
Effective communication	16
Open communications	16
Poor understanding of the concept	9
Commitment to continuous improvement	7
Good cultural fit	6
Acting consistent with objectives	4
Creativity and innovation	4
Long-term commitment	4
Respect and appreciation of the system	4
Competent	3
Past negative experience	3
Concerns about opportunistic behavior	3
Flexibility to change	3
Questioning attitudes	3
Conservative industry culture inhibits changes (status quo)	3
Failure to compromise	2
Learning climate	2
Low commitment of partners	2
Cooperative skills	1
Low-bid mentality	1
Attitude towards micromanagement	1
Quick decision making	1
Relationships are effectively managed	1
Attitude towards committing extra resources	1
TOTAL	100

Table 8: Elements of LEGISLATIVE Boundary Conditions & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

LEGISLATIVE Boundary Conditions and Constraints	# of Times Identified
Bureaucratic public client organization	6
Stringent public rules, regulations and laws	4
Need to avoid allegations of corruption	2
Public sector accountability concerns	2
Commercial pressures compromises partnering attitude	1
Flexibility restricted by bidding approach	1
Local labor and community benefits	1
Public sentiments	1
TOTAL	18

Table 9: Elements of ORGANIZATIONAL Boundary Conditions & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

ORGANIZATIONAL Boundary Conditions and Constraints	# of Times Identified
Financial security/stability	9
Availability of resources	8
High cost to adopt partnering	6
Long-term relationships	6
Owner capacity and organization	3
Long-term business strategy	3
Company wide acceptance	3
Client initiatives in relational contracting practices	2
Familiarity with relational contracting approach	2
Strategic benefits unclear	2
Client only has occasional need for project development	2
Staff continuity and availability	1
TOTAL	47

Table 10: Elements of PROJECT Boundary Conditions & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

PROJECT Boundary Conditions and Constraints	# of Times Identified
Top management commitment/support	22
Contract size or appropriate project size	6
Time required to develop	4
Total cost perspective	4
Empowerment in client's representatives	3
Long-term perspective	3
Project type conducive to partnering	3
Project duration	2
Funding plan	1
TOTAL	48

Table 11: Elements of CONTRACTUAL Drivers during Partnered Project Delivery & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

CONTRACTUAL Drivers During Partnered Project Delivery	# of Times Identified
Incentives / Fees / risk-reward/ gainshare-painshare	14
Contract language and form of contract	12
Conflict identification and resolution strategy established	9
Shared Equity	7
Partnering agreement	6
Equal power/empowerment	6
Adopt Alternative Dispute Resolutions (ADR)	4
Incompatible organizational cultures	3
Equality among partnering participants	2
Fair profit assumptions	2
Joint specifications	2
Provisions for continuous improvement	2
Risk allocation	2
Resource sharing and open books	2
Reliable cost data	1
Shared resources	1
Standardized resources	1
TOTAL	76

Table 12: Elements of PROCUREMENT RELATED Drivers during Partnered Project Delivery & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

PROCUREMENT RELATED Drivers During Partnered Project Delivery	# of Times Identified
Early involvement of designer / contractor / subcontractors	13
Partnering experience	8
Previous work experience with other members	6
Technical expertise	6
Formation at design stage	4
Joint contractor selection	3
Prequalification	3
Broad partnering team	2
Limited bid invitations	2
TOTAL	47

Table 13: Elements of PRACTICES to Drive Partnered Project Delivery & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

PRACTICES to Drive Partnered Project Delivery	# of Times Identified
Workshops	22
Mutual goals and objectives communicated	14
Regular monitoring of partnering process (Benchmarking)	12
Clear and Compatible goals	11
Team building session	11
Free flow of information	10
Facilitator / Partnering champion / Neutral third party	9
Integrated information systems and use of technology	7
Clear definition and lines of responsibility	5
Problem-solving process	5
More frequent meetings	4
Joint project charter	3
Reputation	3
Common vision	3
Commitment to quality	3
High ethical standards	2
Align relationships with objectives	2
Effective coordination	2
Design criteria established early on	2
Value engineering	2
Joint problem solving	2
Joint project office	2
Supply chain partnering	2
Target cost set early	2
Lack of common goals	1
Supervision and management characteristics	1
Closer links between demand/supply	1
Cost driven	1
Design / supplier based onsite	1
Detailed plan for operating critical path	1
Early implementation	1
Education and training	1
Effective process for change orders	1
Holding design information in common	1
Joint business planning	1

Table 13 (cont'd)

PRACTICES to Drive Partnered Project Delivery	# of Times Identified
Manpower development	1
Schedule management on milestones	1
Selection of items for early procurement	1
Strategy for checking resources / facilities	1
Work processes established to achieve discipline and goals	1
TOTAL	156

Table 14: Elements of INDIVIDUAL Characteristics during Partnered Project Delivery & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

INDIVIDUAL CHARACTERISTICS	# of Times Identified
Maintaining positive attitudes	6
Working with integrity	2
Unenthusiastic participation	2
Promise-keeping	1
Perceived satisfaction of partners' expectations	1
Reliability	1
TOTAL	13

Table 15: Elements of TEAM Characteristics during Partnered Project Delivery & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

TEAM CHARACTERISTICS	# of Times Identified
Mutual trust within project teams	24
Individual commitment to team	15
Integrated project team	11
Committed to partnering process	7
Commitment to win/win attitude	5
Mutual interests	5
Honesty	4
Inter-personal/cultural clash	2
Timely responsiveness	2
Cooperation	1
Ego/personality indifference	1
Fear of unknown	1
TOTAL	78

Table 16: Elements of COST PERFORMANCE as a Project Outcome Measure & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

COST PERFORMANCE	# of Times Identified
Cost targets met	10
Improved cost savings	7
Reduced additional expenses	6
Claims cost reduced as percent of original cost	5
Increased opportunity for innovation (Cost Savings)	4
Cost growth per change order	3
Liquidated damage cost as percent of total cost	3
Reduce total project cost	3
Reduced cost	3
Reduced paperwork	3
Change order cost	2
Dispute cost percent of original cost	2
Improve cost savings for client	2
Liquidated damage cost as percent of change order	2
Maximize resource utilization	2
Number of change orders	2
Percent cost growth per change order	2
Percent of projects with deducts	2
Percent of projects with liquidated damages	2
Reduce cost of changing partner in project	2
Reduce public client's admin burden	2
Reduced admin cost - defensive case building	1
Value engineering savings	1
TOTAL	71

Table 17: Elements of SCHEDULE PERFORMANCE as a Project Outcome Measure & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

SCHEDULE PERFORMANCE	# of Times Identified
Schedule targets met	12
Reduced time in delivering the project	6
Better productivity	6
Project schedule growth	4
Time variance	3
Improved construction time	2
Integrated solutions to improve efficiency	2
Liquidated damage percent of total contract days	2
Percent of additional days granted	2
Time	1
TOTAL	40

Table 18: Elements of QUALITY/SAFETY PERFORMANCE as a Project Outcome Measure & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

QUALITY / SAFETY PERFORMANCE	# of Times Identified
Improved the quality of project	14
Increased client and/or end-user satisfaction	8
Improved safety performance	8
Reduced environmental issues and/or complaints	5
Reduce wasted work or re-work	5
Improved design	5
Improve non-conformance reports	3
Incident rate	3
Quality improvements	1
Better workmanship	1
Design cycle reductions	1
Improve collaboration in design	1
Reduced engineering rework	1
Reduced variations	1
TOTAL	57

Table 19: Elements of CONFLICT RESOLUTION PERFORMANCE as a Project Outcome Measure & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

CONFLICT RESOLUTION PERFORMANCE	# of Times Identified
Reduced disputes	10
Improved resolution of claims and issues	7
Reduced litigation	7
Improved conflict resolution strategies	3
Reduced risk exposure	3
Reduction in monetary claims	1
Reduced time to resolve claims	1
TOTAL	32

Table 20: Elements of Organizational Performance relating to INDIVIDUALS - TEAMS & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

Organizational Performance / INDIVIDUAL - TEAMS	# of Times Identified
Improved relationship for project participants	16
Long-term trust	10
Improved communications	9
Continuous improvement increased	6
Win-win attitude	5
Less adversarial relationship	4
Better teamwork	3
Joint satisfaction for project participants	3
More flexibility to changes	3
Better decision making	1
Decrease micromanagement	1
Improved administration	1
Increased involvement of user and end customer	1
Increased equality and fairness	1
Increased openness and honesty	1
Increased participation	1
Increased subcontractor contributions to innovation and problem solving	1
Increased support for innovation and improvements	1
Improved commitment	1
Lower level decision making	1
TOTAL	70

Table 21: Elements of Organizational Performance relating to ORGANIZATIONS & Frequency of Their Reporting in Our Database of Partnering Studies (Mollaoglu et al., 2015; Sparkling, 2014)

Organizational Performance / ORGANIZATION	# of Times Identified
Improved profit margins	8
Enhance organization's reputation in industry	7
Improved corporate culture	7
Opportunity to continuously access additional projects	6
Build closer relationships with parties	5
Achieve continuity with prior developments	4
Improve organization's competency	4
Improve long-term competitive advantage	4
Seize new market opportunities	4
Shared risk	4
Respond to collaborative culture	3
Facilitate creative and innovative approaches	2
Increase bidding advantage	2
Increased market share	2
Obtain support of partner's expertise and knowledge	2
Respond to competitors' actions	2
Respond to technology changes	2
Technical performance	2
Assure financing	1
Good public relations	1
Greater certainty to the contractor	1
Improve social responsibilities	1
Improved life-cycle cash flow	1
Individuals' job satisfaction	1
Meet local government/trade/project requirements	1
Serve core customers	1
TOTAL	78

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