DETERMINING THE EFFECTS OF FACILITATED COLLABORATION ON CONSTRUCTION TEAM PERFORMANCE AND PROJECT OUTCOMES

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by
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ABSTRACT

The construction industry has shown considerable interest in collaborative approaches such as integrated project delivery (Kent & Becerik-Gerber, 2010) as well as team-building, relational delivery methods, and their potential benefits. There are also guidelines and implementation plans that focus on particular delivery methods and contracts. However, the exact tools and procedures used to develop effective teams and produce superior outcomes can vary drastically from one project to another due to unique constraints. Additionally, once a project team successfully delivers a collaboratively-driven project, it is impossible to know whether the same results could have been attained without those efforts. Lastly, many studies have extensively compared traditional and collaborative teams, but few have limited their comparisons to a single owner or institution. Thus, to understand how such efforts impact project and team performance within a specific sample group, this research sought to aggregate the collaborative efforts and results from multiple projects with a single owner. The extent of the collaboration and teamwork in these projects, along with their successes and failures, were measured against a traditionally-delivered project with the same owner and general circumstances.
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1.1 State of the Industry

Instances of team and project underperformance are well-documented within the Architecture, Engineering, and Construction (AEC) industry. According to Teicholz’ analysis of data from the Bureau of Labor Statistics, construction productivity has remained stagnant since the mid-20th century as all other non-farm industries increased productivity over the same period (2013). While the automotive, aerospace, and manufacturing industries are often cited for their rapid response to new tools and techniques, construction is more often criticized for its slow adoption. Such industry-wide problems are especially poignant, considering that construction is a major component of our Gross Domestic Product (Teicholz, 2013), and the significant amount of resources consumed per project.

In construction, there are innumerable variables and circumstances that can produce inefficiencies. When projects underperform, project team fragmentation is often a primary factor (Howard et al, 1989). Fragmentation is a product of the industry’s gradual shift towards specialization: there are now countless trades that focus on the manufacture, installation, and/or maintenance of increasingly-specific building systems. This delineation often creates project teams with competing interests, roles, and relationships (Teicholz, 2004). While specialization improved productivity before the 1960’s and can potentially spark innovation, it can also produce disjointed groups instead of cohesive teams. Such “silos” of information can impede communication, interparty problem solving, and project success (Howard et al., 1989)

1.2 From Fragmentation to Collaboration

Certain amounts of wasted time, labor, and materials are inherent to all construction projects (Bossink & Brouwers, 1996). Bossink’s compilation of previous studies showed that project management deficiencies such as incomplete contract documents, frequent design changes, and procurement errors can be significantly wasteful (Gavilan & Bernold, 1994; Craven et al., 1994). Miller’s Commercial Real
Estate Revolution (2009), a primer about collaboration-driven results, attributed many of these inefficiencies to miscommunication and a lack of coordination at the project management level.

Many project delivery methods are currently used in the AEC industry, each with distinct organizational structures. In design-bid-build (DBB), project participants are brought on incrementally: the owner hires a designer, the design is developed to near completion, and then a general contractor (GC) or construction manager (CM) is hired (Asmar et al., 2013). The incremental team assembly then typically extends into subcontractor selection. The exclusionary nature of this selection process, along with the clear separation of design and construction responsibilities, can fragment DBB project teams. This is especially imperative because DBB is still the most prevalent delivery method in the industry. Consequently, the industry has experienced a broad push for design and construction processes that are more collaborative, improve project performance, and result in higher-quality buildings (Miller et al., 2009).

The design-build (DB) delivery method stems from the traditional and somewhat ancient concept of the master-builder, in which a single entity performed all design and construction duties (Songer & Molenaar, 1996). This arrangement allows the builder to provide meaningful input, such as target costing and constructability reviews, at a stage in which design changes are less expensive and time consuming. Contractor involvement can vary from one DB project to another, and thus can lead to varying degrees of success. Still, studies have shown that DB projects generally outperform DBB in cost growth, schedule growth, and other metrics (Konchar & Sanvido, 1998; Hale et al., 2009; Asmar et al. 2013).

Partnering, another project delivery approach, is a broad term referencing the alignment of project teams based on certain criteria. El-adaway (2010) defined it as a team approach to conflict resolution, motivated by the vast number of issues that can occur on any given project. Partnerships are created to avoid the adversarial environments created by traditional team selection processes and contractual relationships (Bresnen & Marshall, 2010). The term “partnering” is often used synonymously with “alliancing,” joint ventures, and similar terms implying relational management approaches.
Integrated Project Delivery (IPD) is yet another emerging project delivery system. It is primarily characterized by a strong focus on collaboration, early participation of key stakeholders, shared risks and rewards, and a multiparty contract that binds the owner, designer, and primary contractors (Asmar et al., 2013). The growing interest in IPD has been fueled by its potential to dramatically improve project outcomes, and by the numerous studies demonstrating its advantages over traditional delivery methods (Kent & Becerik-Gerber, 2010).

Although IPD has been in development since the 2000’s (Matthews and Howell, 2005), the construction industry recognized the need for more integrated approaches decades ago. The master-builder version of design-build was widely used until the early 20th century, when increasingly complex projects spawned design-bid-build (Konchar & Sanvido, 1998). Partnering began in the 1980’s as a means to improve interparty relationships and project outcomes (Abudayyeh 1994), and was led by the success of the US Army Corps of Engineers (Weston, 1993).

1.3 Facilitation

Collaborative methods, practices, and organizational structures tend to be project-specific. Each delivery method has to be tailored to the circumstances of the particular project at hand, despite industry efforts to standardize the associated rules, guidelines, and contracts. The inherent uniqueness of each project and management team can negate such standardization. Consequently, a single person or group is often dedicated to facilitate and supervise the collaborative efforts. Similar titles can vary from “facilitator” to “coach” and other designators, but their responsibilities are fairly similar.

Caltrans, the California Department of Transportation, used independent facilitators to perform multiple tasks: organize workshops to explain the partnering process, moderate the ensuing discussions between project participants, and lead team-building exercises (Abudayyeh, 1994). These sessions were meant to eliminate the barriers between stakeholders by discussing team-related topics often ignored in typical project settings. Ultimately, the facilitators helped the teams establish mutual goals and develop a formal, signed partnering agreement. Although not explicitly stated, the author’s mentioning of “independent partnering specialists called facilitators” implied that such persons should be external
participants, not responsible for daily management duties (Abudayyeh, 1994). Facilitation, in this sense, was defined as a part-time effort focusing on the understanding, development, and approval of a partnering agreement.

Facilitated projects often include multi-level teamwork. Inter-organizational teams, for instance, are broad project management groups with representatives from the owner, designer, and contractors; intra-organizational teams are created within each of those parties. Albanese (1994) argued that inter-organizational teams tend to “focus directly on a project’s effectiveness,” whereas intra-organizational teams work internally and assume that their effectiveness will translate to overall project effectiveness. While it is reasonable for each party to focus on their own roles and responsibilities, the facilitator is supposed to encourage real inter-organizational teamwork. In a study of 41 projects, Albanese (1994) concluded that such broad teamwork is difficult to achieve, and requires more than the owner’s insistence on team cooperation. Such teams “have to be formed, developed, and maintained by an effective team-building process.”

1.4 Defining and Determining Success

Facilitation is intended to improve project team interactions and produce better outcomes. However, there are neither industry-wide guidelines nor standard implementation plans for facilitated projects. Similarly, there are guidelines for specific delivery methods (such as DB and IPD) but there are none for collaboration as a whole. As a result, the facilitative and collaborative efforts of a particular project can be difficult to measure.

While quantifying collaboration can be challenging, a distinction must be made between project-level and team-level performance. Project success is often measured by schedule and cost growth, delivery speed, worker injuries, and sustainable goals. Kraft and Chinowsky (2003) studied the relationships between organizational and project-level success. They admitted that this relationship was inherently difficult to analyze because success is defined differently in each case. Contractors typically emphasize short-term success, in which each project’s performance is scrutinized individually. However, those organizations recognize the need for continued long-term growth beyond a single project (Kraft and
Furthermore, success categories such as schedule, cost, and quality cannot be empirically evaluated because each stakeholder has its own criteria. This issue is further compounded by the number of conflicting success criteria within the literature.

There are also qualitative aspects of project and team-level success that can be captured such as owner satisfaction, administrative burden, finished quality, team environment, and occupant satisfaction. A recent study linking team and organizational-level interactions suggested that intangible aspects of team environments can affect project outcomes (Franz & Leicht, 2013). There has been little work to directly link team-based, quantitative performance traits like communication response times and submittal approval rates to project outcomes. While there are overlaps between project-based and relational performance, there is an inherent assumption in the procurement processes of traditional team approaches that suggests a lack of value in deliberately building teams to deliver successful projects. This research sought to better define the link between relational effectiveness and project-level success.

1.5 Problem Statement

The construction industry has shown considerable interest in collaborative approaches such as integrated project delivery (Kent & Becerik-Gerber, 2010) as well as team-building, relational delivery methods, and their potential benefits. There are also guidelines and implementation plans that focus on particular delivery methods and contracts. However, the exact tools and procedures used to develop effective teams and produce superior outcomes can vary drastically from one project to another due to unique constraints. Additionally, once a project team successfully delivers a collaboratively-driven project, it is impossible to know whether the same results could have been attained without those efforts. Lastly, many studies have extensively compared traditional and collaborative teams, but few have limited their comparisons to a single owner or institution. Thus, to understand how such efforts impact project and team performance within a specific sample group, this research sought to aggregate the collaborative efforts and results from multiple projects with a single owner. The extent of the collaboration and teamwork in these projects, along with their successes and failures, were measured against a traditionally-delivered project with the same owner and general circumstances.
1.6 Research Questions

1. Do collaborative teams deliver more successful projects?
2. How does formal collaboration affect team behaviors that can potentially lead to successful projects?
3. What is the overall value of formal collaboration initiatives?

1.7 Research Objectives

This study analyzed the effects of broad collaborative efforts on project team communication, coordination, collaboration, and project outcomes within two facilitated projects. The primary objectives were:

- Review existing literature and research methods regarding relational performance in the AEC industry.
- Identify metrics that indicate team and project-level performance, and adopt appropriate performance metrics.
- Identify appropriate in-progress and completed construction projects, and collect data indicating team and project performance.
- Identify relationships between the formal collaborative efforts employed, and the relative success and behaviors of each project team.
- Present research contributions and recommendations for continued research.

1.8 Description of the Research

This research used exploratory case study comparisons to measure the effects of facilitated collaboration on team behaviors and project outcomes. The facility management department of a large institutional owner led an effort to incorporate collaborative principles and tools into its projects to improve relational and project-level performance. A research initiative between the owner and a major research university led to the development of a contract document with the following goals: to promote
desirable collaborative principles, to establish a framework for successful collaboration, and to ease the transition for project participants. These efforts produced collaboration charters for several of the owner’s construction projects.

The charters designated project “coaches” to help facilitate collaborative efforts and lead team discussions. Projects with collaboration-specific contract documents (such as the collaboration charter) and designated facilitators will furthermore be referred to as the “facilitated” projects. This research used existing metrics to qualitatively and quantitatively assess facilitated cases in terms of team effectiveness and project outcomes. A recently completed, non-facilitated project was also analyzed to benchmark expectations for the owner’s typical projects. This project, hereafter referred to as the “historical” case, was compared to two facilitated projects. Common attributes across all projects were the owner organization, geographic location, and project size (over $10M in total project costs). By comparing these two case study groups, the researcher aimed to identify the relative benefits and limitations of facilitated collaboration compared to traditional team approaches.
Chapter 2

LITERATURE REVIEW

2.1 Introduction: Literature Review

Integrated, collaborative project management methods have the potential to improve project outcomes and organizational performance. Project teams founded on open communication, trust, respect, mutually established goals, and receptiveness towards new ideas can avoid interpersonal conflict. Collaborative project teams are ideal, but the relationship between the abovementioned characteristics and project performance is not linear. Furthermore, the process of implementing collaborative measures within Architecture, Engineering and Construction (AEC) industry agreements can vary significantly. The following works define the attributes of effective teamwork and collaboration, discuss various ways of developing those attributes in AEC teams, and demonstrate their potential effects on both team and project success. In each study, the intent is to identify management and communication practices that improve upon traditional delivery methods and allowed for greater overall, both project and team, success.

2.2 Industry Trends

This research builds on the previous work of Franz and Leicht (2012), which studied the Pennsylvania State University’s development of contractual agreements, called collaboration charters. These documents were meant to promote Integrated Project Delivery (IPD) principles on non-IPD projects, such as early contractor involvement, collocation, and collaborative decision-making (Franz & Leicht, 2012). The potential for improved organizational and project performance, along with incentives and rewards outlined in the charter, could presumably govern team behaviors and lead to mutual success.

Multiparty contracts are the primary driver of successful IPD projects (Asmar et al., 2013). Such contracts bind the project owner, design team, and principal contractors to the same terms, thus reducing the potential for adversarial relationships and fragmentation. The facilitated projects in Franz and Leicht’s
study did not include true multiparty contracts, financial incentives, or liability waivers, all of which are key aspects of IPD. However, the collaboration-specific contract documents implemented did address the importance of communication and integrated strategies, and encouraged the teams to develop their own collaborative measures within the confines of their projects. Early results showed that, although the charter’s development process was ambitious and outlined realistic collaboration measures, the final terms were heavily based on the selection of key participants, the timing of their involvement, funding requirements, and similar project-specific constraints (Franz & Leicht, 2012).

Thus, the aim of this research was to identify the facilitated teams’ behaviors and methods that led to organizational and project success, focusing less on quantifying variables that differentiated them. Project management characteristics such as teamwork, collaboration, and integration can be difficult to define, and equally difficult to implement through contractual language alone. This research focused instead on the facilitated teams’ individual aspirations as defined in their collaboration agreements, and on their performance relative to the expectations of a typical non-facilitated project. Facilitated project expectations included effective project management, aggressive schedule and cost performance, and cooperative work environments.

2.2.1 New Approaches to Construction Management Research

There is an abundance of literature pertaining to construction management issues. Recent studies suggest that new approaches are needed to avoid repetitive research, while also ensuring that relevant topics are thoroughly examined. AlSehaimi et al. (2013) detailed the shortcomings of previous studies concerning the most common causes of construction delays. Most of these studies agreed that internal, controllable causes of delays were related to management techniques and personnel.

AlSehaimi et al. (2013) analyzed 16 international studies pertaining to construction delays. The 10 most frequently-cited causes were listed, and each study was rated based on the number of times that each cause was mentioned. Finally, the previous studies being analyzed were mapped according to their management recommendations in a matrix-like table. The results showed that a majority of the studies failed in at least one respect: their recommendations did not align with their findings, their
recommendations were not specific enough to be implemented, or they did not give any recommendations at all (AlSehaimi et al., 2013).

The authors proposed “action research” as an alternative approach to construction management studies. Action research involves a cooperative effort between the researcher and industry practitioners managing the actual construction (AlSehaimi et al., 2013). This method allows the researcher to actively pursue real-world solutions as opposed to observing and critiquing. Researchers present their findings to the project teams, who then have an opportunity to learn from their performance and make the changes necessary to improve. Thus, an iterative research approach can provide more real-world context to the study while allowing the test subjects to respond more immediately to the observed issues.

### 2.3 Communication

Construction is inherently a social endeavor that requires constant interaction between multiple professions. Although the technical and physical requirements can be demanding, the relational requirements can be equally challenging. Open, honest communication is often cited as a requirement for efficiency and success.

#### 2.3.1 Communication and Teamwork

Gorse and Emmitt (2007) were among the first to draw statistical conclusions about team interactions during live project meetings. They defined two types of group interactions: task-based, in which information, ideas, and opinions allow the team to complete milestones and discuss problems, and social, in which the emotional nature of the communication can develop or deteriorate relationships. The distinction is essentially between technical and relational interactions.

Results from a previous study reinforced the importance of face-to-face communication (referred to as interpersonal communication) and meetings (both formal and informal) in dealing with construction management issues (Gorse, 2002). Both communication mediums are essential to project success because social interactions develop the relationships that produce effective teamwork, and task-based interactions ensure that basic management responsibilities are completed (Gorse & Emmitt, 2007). The authors
posited that a lack of balanced communication, consisting of both relational and technical interactions, could deteriorate teamwork and deter project progress.

Gorse and Emmitt (2007) used Bales’ interaction process analysis (IPA), a method of classifying and examining different group interactions. 10 project teams were observed, representing two DB and eight traditionally-delivered projects. Recording and analyzing each individual word spoken during the meetings would have been impractical, so the authors focused more on verbal interactions, body language, facial expressions, and similar communicative indicators. This data was coded according to the IPA method, and then compared with the findings of previous studies that analyzed communicative habits of different groups, including spouses, children, and research participants.

The results were conclusive, but contradicted the findings of previous studies. Overall, most of the construction teams’ interactions were task-based, and centered on providing, not requesting, information (Gorse & Emmitt, 2007). Relational communication was mostly positive, though examples of exceedingly positive or negative emotions were rare. Gorse & Emmitt concluded that “the construction participants are either reluctant to use, or are avoiding, socio-emotional communication in the meeting” (Gorse & Emmitt, 2007). Still, the lack of relational discussions aligned with previous findings, in which teams developed their own communicative practices over time and were then more open to socio-emotional interactions.

The authors furthermore attributed the project teams’ reliance on task-based interactions to the temporary and mercurial nature of construction teams (Gorse & Emmitt, 2007). Management personnel are commonly involved in multiple projects at once, thus limiting their focus on any given project. High turnover rates are also typical as each stakeholder manages its own personnel needs. These discontinuities can hinder team-building efforts and lead to “groupthink,” in which participants hide their disagreements for the sake of conformity. Lastly, the authors claimed that the temporary nature of construction project teams prevents them from fully maturing, “which has implications for teamwork and relational forms of contracting” (Gorse & Emmitt, 2007).
2.3.2 Computer-Assisted Communication

Efficient communication practices during team meetings are crucial to project success. However, not all team interactions occur during formal meetings. Advancements in wireless technology provide new, emerging communication platforms. Lee and Bernold (2008) identified three basic problems of the current technology-assisted communication methods in the AEC (Architecture/Engineering/Construction) industry. First, construction projects involve a tremendous amount of information, which can be susceptible to mismanagement. Secondly, while these technologies allow for the rapid compilation and distribution of information, they also increase the probability of “overloading” a single party with too much information. Finally, few applications are able to solve these issues and function independently.

One potential solution involves autonomous agents: sensors that can collect information, react to their environments, and act based on preset parameters. Lee and Bernold (2008) studied the use of an agent-based system during the construction of a new chilled water plant at a North Carolina State University campus. An extensive system of Wi-Fi enabled cameras, routers, sensors, and computers were first established. After adjusting locations and arrangements to mitigate connectivity issues, these agent-based tools proved to be invaluable. A weather-monitoring system, for instance, was integrated with the cameras and sensors. Crane operators were then alerted when weather patterns were detrimental, and could more easily determine whether each pick was securely attached to the crane. This alert agent automatically created weather and safety reports and distributed them to key team members.

A separate agent-based communication system was established for real-time problem solving. Using Wi-Fi enabled phones, cameras, and computers, the researchers created a ubiquitous e-meeting space (UeMS) that helped facilitate interpersonal communication (Lee & Bernold, 2008). These Web-based tools were used to improve participants’ understanding of the project to the extent that requests for information (RFI’s) would be unnecessary. A structural steel inspector was thus able to use a hardhat-mounted camera and phone to find field issues and discuss them with off-site management in real time.

Industry applications of communication-enhancing technologies are undoubtedly in the future for the AEC community. However, Lee and Bernold’s (2008) work focused heavily on task-based
communication, such as weather alert systems and real-time steel inspection. The authors did not address the impact of these systems on relational communication, and did not state whether the use of such systems improved or even involved “teamwork.” Still, such trends depict the industry’s willingness to stray from traditional means and methods for the sake of team effectiveness and project success.

2.4 Team Integration

Integration is another important aspect of project team collaboration. Since project teams are typically formed according to the delivery method of each project, it is often implied that teams are as integrated and collaborative as their delivery methods allow them to be. Konchar and Sanvido (1998) defined project delivery methods as the prescribed relationships between project participants and the timing of their involvement. Thus, a comparison of delivery methods is essentially a comparison between teams that are integrated to different extents.

According to this definition, Design-bid-build (DBB) is characterized by a disintegrated team due to the utter separation of design and construction responsibilities (Asmar et al., 2013). Procurement typically starts with the designer followed by the CM or GC, and finally the subcontractors and vendors. A Construction Manager at-Risk (CMR) delivery approach is similar to DBB in terms of integration, except that the CM or GC is involved earlier to influence the design (Konchar & Sanvido, 1998). Design-build (DB) teams have sole responsibility for design and construction duties (Asmar et al., 2013) which enables integration, but individual scopes can still be delineated within that group. Design-builders can be hired at virtually any stage of design completion. Integrated Project Delivery (IPD) teams rely on key team members contractually forming a multiparty entity. The combined team works as a unit rather than a hierarchy, is involved as early as possible, and is responsible for both design and construction tasks (Asmar et al., 2013).

2.4.1 Quantifying Integration

The correlation between project integration and project performance is generally accepted within the AEC industry. Pocock et. al (1997) sought to quantify integration in order to test this long-held belief. Their previous work developed a metric called the Degree of Interaction (DOI), which approximates
design and construction integration (Pocock et al., 1996). Team members’ participation is measured at each project phase from planning and conceptual design through operation and maintenance. Participation is quantified and produces the overall DOI of a particular project.

Pocock et al.’s (1997) study involved 38 completed military projects with traditional delivery methods, partnering, DB, or a combination of these. The four performance metrics were cost and schedule growth; the total number of contract changes per million dollars, as an indicator of problem frequency; and the percentage of changes caused by design deficiencies, as an indicator of design quality (Pocock et al., 1997).

In order to measure DOI, the importance of interactions during each individual phase had to be weighted. Generally, communication is most impactful during the initial project phases when design changes are less expensive and easier to implement. Consequently, a separate questionnaire was distributed to independently weight each phase. DOI was then calculated as the ratio of total interaction hours to construction duration. As the construction phase was the most consistently and accurately-recorded duration, it was used instead of total project duration (Pocock et al., 1997).

The results reinforced the relationship between project integration and performance outcomes. Partnered, DB, and projects with hybrid delivery methods had higher DOI scores than traditional projects. Of the three alternatives, the combined projects scored highest followed by partnered and DB projects. However, the alternative projects had a much wider range of DOI scores, suggesting that partnering, DB, and combined delivery methods “do not guarantee increased interaction…[but] provide the opportunity for more interaction” (Pocock et al., 1997). Likewise, alternatively-delivered projects scored better according to the four performance indicators: cost, schedule, change frequency, and design deficiency.

2.5 General Collaborative Approaches

Collaboration is inherently a broad term. Consequently, this study defined collaboration as the willingness of individuals to work together as a team to achieve common goals. Teamwork is an important aspect of collaboration, and is similarly difficult to define. During the team selection process, emphasis is often placed on technical capabilities to ensure the functional and aesthetic performance of
the finished product. However, effective teams require problem-solving and interpersonal skills in addition to technical knowledge (Boss & McConkie, 2011). According to one particular study, six indicators define true teams: limited size, compatible skillsets, a shared purpose, mutually-established goals, a clearly-defined organizational structure, and mutual accountability (Boss & McConkie, 2011).

2.5.1 Teamwork

While Boss and McConkie’s (2011) team observations were not industry-specific, Chan et al. (2001) studied team effectiveness in construction and the relationship between teamwork, organizational performance, and overall project performance. They distinguished their work from previous literature by studying relational performance, specifically project participants’ job satisfaction, as an indication of effective teamwork. Previous studies had mostly focused on the direct impacts of successful teamwork on final project outcomes.

Data collection involved 53 questionnaire responses from 19 design-build projects completed in Hong Kong over a five-year period. DB projects were targeted due to their inherent reliance on coordination, cooperation, and aggressive scheduling, all of which can be addressed by efficient teamwork (Chan et al., 2001). Project performance, inter-organizational teamwork, and job satisfaction were each measured according to separate variables. These variables were then analyzed to determine which ones had significant correlations. The results showed that the strongest correlations were between job satisfaction and overall project performance, job satisfaction and personal opinions of DB, and inter-organizational teamwork and opinions of DB.

While demonstrating a strong connection among teamwork, organizational success, and project success, Chan et al. (2001) acknowledged that many variables and circumstances must be considered. For example, the study distinguished partnering as a formalized long-term approach, and defined teamwork as informal and project-specific. Both approaches are founded on similar principles of trust, mutual goals, and effective communication; both can improve relationships, efficiency, and project outcomes (Chan et al., 2001). Presumably, the degree to which a team initiates, develops, and executes “partnering” or a team-based approach will influence their effectiveness. Simply acknowledging that a particular effort will
be made (emphasizing teamwork, using a partnering agreement, or being more collaborative) might not be enough to improve outcomes.

2.5.2 Partnering

Chan et al. (2001) acknowledged that partnering was a distinct management approach, beyond the scope of their design-build study. One particular institutional owner, the California Department of Transportation (Caltrans), used partnering in the early 1990’s as a way to improve management practices and reduce litigation risk by improving owner-contractor relationships (Abudayyeh, 1994). The study concluded that successful partnering relied on the same fundamental principles as collaborative team-based approaches: trust, respect, open communication, and “win-win attitudes” (Abudayyeh, 1994).

The partnering process typically begins after contracts are awarded, at which point the owner meets with individual contractors and expresses interest in a formal partnership agreement (Abudayyeh, 1994). Next, the owner hires professional consultants to lead the project participants in an extensive discussion of the partnering concept. These “facilitators” teach the participants about the basic tenets of partnering and the potential benefits, while also providing a forum for sharing opinions and past experiences. This discussion produces a list of mutually-established project goals, the means and methods of attaining those goals, and a written agreement that is signed by all parties. Such “goals and actions” lists can contain a wide range of topics such as safety, timeliness, management procedures for change orders, and conflict resolution.

Abudayyeh (1994) observed one of Caltrans’ earliest partnering attempts, developed a general implementation plan, and created a framework of benefits and expectations. Caltrans’ partnering benefits were demonstrated observationally, not statistically. Results included zero claims, early problem identification and resolution, a reduction in change order frequency and costs, and an overall successful experience for the owner and contractors (Abudayyeh, 1994). While the results indicated substantial benefits, the author did not discuss the follow-up process after the discussion period and development of the formal partnering agreement. Abudayyeh (1994) mentioned that the facilitated workshops could be repeated throughout the length of the project to reinforce principles within the project team. Still, the
study lacked specificity in describing team behaviors throughout the project. It also failed to mention whether the contractor-to-contractor relations improved as well, since in this instance the partnering efforts focused on owner-contractor relationships. Overall, the study was unable to specifically correlate the observed improvements with the use of a partnering agreement.

2.5.3 Relational Contracting

Relational contracting (RC) is often an integral part of collaborative team-based approaches such as joint ventures, alliancing, and partnering (Ling et al., 2006). Typical construction contracts are fairly rigid in establishing roles, responsibilities, and risks, even though projects can encounter numerous uncertainties. Rigid contracts can lack the flexibility needed to actively resolve such uncertainties.

Relational contracts can improve outcomes by offering performance incentives, improving interparty relationships, and allowing the project team to collectively make decisions rather than relying on the contractual language (Ling et al., 2006). As is common with most collaborative approaches, an RC is founded on mutual trust, values, goals, and open communication (Ling et al., 2006). RC is further related to such approaches because it involves interpersonal constructs that are not commonly used in the AEC industry. For this reason, RC can involve initial adjustment periods, training, or facilitated implementation (Ling et al., 2006).

A study of 96 Singaporean owners, contractors, and architects/engineers (A/E’s) sought to identify factors that enable or weaken relational contracts, and enable or weaken their incentives (Ling et al., 2006). The authors cited project uncertainties as motivators for flexible, practical contracts that drive positive outcomes. The researchers developed a questionnaire based on previous studies concerning contract theory, risk allocation, and collaboration (Ling et al., 2006). It contained 52 RC enablers and deterrents, broadly categorized between top management support, RC-related team objectives, a relationship-building culture, and risk management. The majority of the respondents had no previous experience with RC, implying a lack of broad acceptance in Singapore. The respondents believed that all 52 factors were relevant to RC, although they disagreed on the importance of each one.
Of the enabling factors, the respondent groups similarly rated the influence of open communication, experience with RC approaches, and effective coordination (Ling et al., 2006). Contractors emphasized mutual trust, while owners and A/E’s prioritized upper management support. Of the factors that deter relational contracting’s effectiveness, the groups similarly ranked low-bid procurement, fragmented coordination, and improper risk allocation. Contractors stressed the lack of trust and reliability between project participants, while owners and A/E’s stressed the lack of room for innovation. The contractual incentives deemed most appropriate were mutually-established dispute resolution methods, clearly-defined risk sharing, and equitable risk sharing.

Ling’s (2006) study concluded that, although industry professionals disagree on its strengths and weaknesses, relational contracting is a viable tool for organizational and project-level success. Its benefits stem from the ability to resolve unexpected issues through flexible, team-oriented contract terms that empower rather than disjoint. The respondents acknowledged the role of interpersonal relationships, collaborative cultures, and other “soft” aspects often overlooked in construction contracts.

2.5.4 Deemphasizing Delivery Methods

Kluenker (1996) claimed that the construction industry is overemphasizing delivery methods and relational models. Instead, the author argued that effective, experienced construction management firms can improve interparty relationships and lead to success. CM’s can also reduce the complexity of using new and untested delivery methods, especially considering the industry’s skepticism about the effectiveness of IPD, partnering, and other emerging systems. Design-build was suggested as a proven and effective manner to align design intent with construction knowledge, while also shortening the design phase and promoting cost-effective solutions.

Kluenker (1996) stressed the importance of fundamental management principles such as prompt payment, quality control, owner involvement, and schedule maintenance, independent of the contractual relationships and delivery methods in place. While inferring that effective teams produce successful projects, Kluenker did not elaborate on how to create such teams or produce such outcomes. Kluenker’s
argument against the emerging delivery methods contrasts most AEC literature, but the advocacy of DB suggests that integration is still an important element of success.

2.6 Specific Collaborative Approaches

Partnering, bridging, and similar terms refer to broad methods of goal alignment and team integration. In addition to these broader approaches, studies have sought to definitively rank project delivery methods in terms of performance. Since emerging delivery methods often lack broad support, project delivery studies can provide statistical comparisons that help owners make informed decisions about their delivery strategies. Such studies also indicate the AEC industry’s tendency to address new challenges with new delivery methods.

2.6.1 Delivery Methods

Studies by Pocock (1996), Bennet et al. (1996), Riley et al. (2005), and Korkmaz et al. (2010) compared delivery methods according to different metrics with diverse results. DBB projects were outperformed in nearly every comparison, suggesting that the collaboration-focused alternatives (CM at-Risk, DB, and IPD) are generally more successful (Asmar et al., 2013). Cho and Ballard (2011) did not find performance differences amongst IPD and non-IPD projects, but concluded that individual aspects of IPD could improve outcomes. Since many delivery method comparisons have used different comparison methods and metrics, results have typically had limited applicability.

Pocock’s study (1997) indicated strong relationships between project integration and overall project performance. Asmar et al. (2013) broadened this research scope by statistically comparing IPD performance with that of traditionally-delivered projects (DBB, DB, and CM-R). Integrated Project Delivery joins the owner, designer, and builder at the earliest stages of the project (Asmar et al., 2013), creating an opportunity for integration-driven success. As previously established, the most common delivery methods are typically ranked in the following manner in terms of integration, from most integrated to least integrated teams: IPD, DB, CM-R, and DBB.

Asmar et al. (2013) gathered data from 12 IPD and 23 non-IPD projects, with the majority of the information coming from a CM or GC. Based on previous findings, the authors compared the projects
across nine metrics with a total of 304 variables. The broad performance metrics included the usual cost, schedule, and quality metrics, but also included labor performance, communication, and other less-typical metrics. Results varied according to the applied significance level (p-value): IPD was statistically better than the other delivery methods in 3 of 9 areas at the 0.01 level, 6 of 9 areas at the 0.05 level, and 8 of the 9 performance areas at the 0.10 level (Asmar et al., 2013). At the strictest significance level (0.01), IPD projects were superior in terms of quality, communication, and change performance. Interestingly, cost growth was the second-least significant comparison metric between IPD and non-IPD projects.

2.6.2 Procurement Methods

Procurement as with delivery methods, are means and not results. As observed in previous studies, procurement constraints can limit the use of collaborative team approaches, especially those requiring contractual agreements. Public funding can pose such limitations by prohibiting certain delivery methods, risk and reward clauses, liability waivers, and similar contract terms. Section 905 of the Pennsylvania Title 62 Procurement Code states that design firms are to be contracted based on qualifications and demonstrated competence. The same code requires that construction contracts be awarded to the lowest responsible bidders. Design-build is briefly mentioned as an alternative method, but the Procurement Code’s emphasis on low bidding is clear.

Hampton (1994) reviewed the most common design procurement methods in the public sector. He defined success as a satisfied owner, an effective design team, and a finished product that “promotes and protects the health and welfare of the public” (Hampton, 1994).

In cost-based procurement, the owner can choose to use a prequalified list of firms to ensure competency, or publicly announce requests for proposals (RFP’s). Interested firms respond with cost estimates based on the provided scopes. According to a professional practice manual by the American Society of Civil Engineers, low-bid procurement does not provide room for the owner and designer to develop the project requirements before the contracts are awarded (ASCE, 1988). Also, change orders are more common because the owner does not have the opportunity to accurately define all required design
services. Finally, the emphasis on initial costs reduces opportunities for innovative designs, which could potentially reduce overall lifecycle costs (ASCE, 1988).

The two-envelope procurement process involves a two-step analysis of the bidders’ technical proposal and price (ASCE, 1988). “Two envelopes” suggest that the technical aspects are reviewed first, and the costs are secondary considerations. When this procurement process is used, bidders face the risk of developing detailed proposals, not winning the contract, and not being compensated for their work (Hampton, 1994).

Hampton contended that qualification-based procurement is the best approach (1994). This process includes the familiar steps of scope definition and project advertisement, at which point requests for qualifications (RFQ’s) become the deciding factor. Fee negotiation is the final step, and it can establish owner-designer relationships based on mutual benefit or inequality (Hampton, 1994). Disadvantages of qualification-based selection are the influence of owner bias and the preference for larger, more established firms.

Although the study did not address contractor procurement, Hampton (1994) implied the importance of selecting project team members based on other considerations besides initial cost. It also linked the use of cost-based selection methods to litigation risk and unsatisfied teams, two relational outcomes frequently discussed in aforementioned studies. Other previously-discussed topics included effective conflict resolution techniques, win-win attitudes, and partnering principles (Hampton, 1994), all of which can be enabled or disabled by the selection process.

2.6.3 Facilitated Collaboration

The paths towards collaborative project teams and project success are diverse. Many studies have referenced the importance of certain facilitating tools, measures, and roles that help ease the transition into the emerging collaborative methods. Facilitators lead the transition into collaborative team-based approaches, especially for project participants that are inexperienced with such practices. While facilitation can play an important role in implementing new approaches, many studies disagree on the extent of its role.
Boss and McConkie (2011) defined team-building as a relational activity led by an outsider, typically a professional consultant, whose goal is to objectively moderate discussions and workshops. Team development, conversely, is led internally by a formal leader who provides similar guidance but is directly involved with project management (Boss & McConkie, 2008). While the authors described the team development leaders as the only true facilitators, both roles attempt to lead team maturation and adoption of new methods. Thus, both roles could be described as facilitators. Boss and McConkie also described the relationship between continuous team-building efforts and long-term success, indicating that successful facilitation requires persistence.

Abudayyeh (1994) likewise described facilitators as third-party consultants who lead partnering workshops. These specialists establish the rules and expectations of the workshops, provide a platform for participants to introduce themselves and express their opinions, and ultimately shape the ensuing discussions into a signed partnering agreement (Abudayyeh, 1994). Though the author briefly described the facilitator as an external role, the qualities of leadership, guidance, and effective communication resemble the definition of Boss and McConkie (2008). Once again, the facilitator in question was guiding a team towards a new and relatively unknown approach: partnering.

Ling et al. (2006) referenced facilitation more broadly, as an enabler. They examined industry views on relational contracting and ranked the importance of contractual incentives based on practitioners’ responses. The incentives either facilitated or constrained the relational contracting efforts, depending on how fair or influential the respondents deemed them. Facilitators, in this sense, were contractual elements that benefited project participants and justified specific collaborative efforts. In this study, the motivational factor behind facilitation resembled that of Abudayyeh (1994) and Boss and McConkie (2011), but was implemented contractually rather than personally.

The study of WiFi-enabled autonomous agents at NC State University (Lee & Bernold, 2008) contained the broadest facilitation definition. Using real-time audio and visual feeds, workers and offsite management personnel were able to efficiently communicate (Lee & Bernold, 2008). The use of real-time
sensory data allowed these tools to exceed the limits of 2D drawings, electronic correspondence, and other “traditional” communication methods.

2.7 Defining and Measuring Success

This research proposed that formal collaboration within the AEC industry relies on team-centered approaches, requires effective communication, is promoted by integrated delivery methods, and can be implemented by a facilitator. Successful collaborative efforts, and thus successful project teams and projects, are difficult to define. Previous studies have shown that cost and schedule performance are the most common indicators of project performance, while team performance is usually based on each participant’s own criteria. A cohesive set of success indicators could normalize the evaluation of project and team-level performance.

2.7.1 Organizational and Project-Level Success

The relationship between organizational management and project success is evident, and yet is ignored in some construction success studies. Before this relationship is considered, “success” has to be contextualized. Kraft and Chinowsky (2003) asserted that project success is defined by more than the outcomes of any particular project. They also stated that each stakeholder has different parameters for budget, schedule, and quality performance, the three most basic components of success analysis. Although other success factors can be used, the same dilemma exists: different stakeholders prioritize them differently. The considerable range of project sizes, scopes, and locations in the AEC industry can further limit the applicability of any success checklists (Kraft & Chinowsky, 2003).

Project and organizational success first have to be distinguished in terms of their cultural underpinnings (Kraft & Chinowsky, 2003). Organizational culture, also referred to as corporate culture, refers to the management principles of individual companies. Project culture is thus the product of a company restructuring and adapting its principles to the needs of a single project. This distinction implies that stakeholder characteristics such as priorities, values, and communication habits can change contextually. Similarly, strategic management is the long-term executive management of a single organization, while operational management entails daily management tasks (Kraft & Chinowsky, 2003).
Extrapolating from this explanation, a hypothetical project participant will likely behave within a given project team according to its organizational culture. If that organizational culture is founded on collaboration and team-oriented behavior, than the participant will likely be a collaborative project team member. Conversely, a participant whose corporate culture lacks those values will most likely be a non-collaborative project team member. In the same manner, the stakeholder organization’s strategic management practices could reflect on its daily project management practices.

In the abovementioned study, the authors acknowledged a measurable relationship between project participants’ organizational management practices and the success of their individual projects (Kraft & Chinowsky, 2003). Basically, project teams fail or succeed according to the collective managerial principles of each participating company. However, the authors have not yet defined or tested this relationship since their 2003 publication. They did not provide a single definition of organizational success either, but mentioned that it has traditionally been measured by the total number of profitable projects managed within a given year.

2.7.2 Success Indicators

While organizational success in the AEC industry is a nebulous research topic, project success has been extensively studied and defined. Chan et al. (2004) reviewed seven prominent management journals to identify the most relevant predictors of project success. These publications included the U.S.-based Journal of Construction Engineering and Management (JCEM) and Journal of Management in Engineering (JME), and were selected based on quality ratings.

Critical success factors (CSF’s) were identified, narrowed, and then categorized into five key areas. Project-related factors included project size, type, scope, and complexity; procurement factors included selection criteria for design and construction services, as well as bidding practices; external factors ranged from the overall economic environment to the current state of technology (Chan et al., 2004). The two largest categories of success determinants were project management and human-related, with a combined total of 31 factors. Project management encompasses communication systems and planning efforts, among others. Project participant (human-related) factors were the most numerous, and
were further separated organizationally: those related to the owner, designer, construction manager, and contractors.

This particular work produced a single list of construction success factors based on previous literatures (Chan et al., 2004). However, it did not statistically weigh each of the 5 categories to determine which ones were most impactful on project success. Consequently, without further research, the combined 44 factors had to be considered equally important. The authors did list the factors numerically within each category, but did not explain whether this was done to rank the importance of each factor within each category.

2.7.3 Success Measures

In a previous study, the same author reviewed the seven abovementioned publications and used search engines to identify project success studies published between 1990 and 2000 (Chan, 2001). While cost, schedule, and quality were the most frequently mentioned performance measures, alternatives emerged such as participant satisfaction, frequency of litigation claims. Other emerging measures included safety, specification adherence, operation and maintenance costs, construction aggravation, and user expectations. Chan (2001) noticed that each study had its own categorical delineations, though some of the basic performance measures seemed to overlap. He summarized these overlaps in a framework of eight general success considerations: cost, time, safety, participants’ satisfaction, user expectations and satisfaction, environmental performance, commercial value, and quality (Chan, 2001).

Using these considerations as the basis, Chan (2001) defined 14 key performance indicators (KPI’s) which could be used to directly measure project success. They were divided into eight objective measures including unit cost, construction speed, and accident rate, and six subjective measures such as quality, functionality, and satisfaction. Each of the objective measures had its own measurement equation, but the six subjective measures were all rated according to a seven point scale. Chan (2001) acknowledged the industry’s abundance of success criteria, but argued that this system provided consistency and measurability.
2.8 Potential Collaboration Issues

The AEC industry is clearly shifting towards collaborative, team-focused management practices. This literature review summarized some of the most common methods of employing such practices. As with any paradigm shift, the collaborative movement can be risky and uncertain. In the broadest sense, the more established delivery methods and team approaches have been used on a greater number of projects, and are thus perceived as less risky.

2.8.1 Dissenters

Albanese (1994) conducted interviews with project participants from 41 projects to analyze the relationships between inter-organizational teams, team-building activities, and improved project outcomes. He concluded that team-building provided product benefits, such as less rework and litigation, and process benefits, such as improved communication and a more enjoyable work environment. The results also showed that some team members were dissenters who would not actively engage in the team-building activities for multiple reasons. The most common response to this problem was to simply remove such persons from the project team (Albanese, 1994). However, the issue of encountering resistance towards collaborative measures poses a major hurdle. The construction industry is known for its conservative approach towards new ideas and practices, so some resistance is expected. Furthermore, the complete removal of dissenters is not always feasible, especially when projects are well underway.

2.8.2 Ambiguous Definitions, Implementations, and Expectations

While the use of collaborative methods can encounter inter-organizational obstacles, it can also be hindered by much broader issues. Collaboration is exceedingly difficult to define, and can be as simple as the cooperation of multiple parties. By this definition, even ineffective teams could be considered collaborative. Bresnen and Marshall (2000) focused on three primary issues with “partnering,” which was used as a collective term for all collaborative approaches.

First, the contracts, incentives, delivery methods, team-building exercises, and organizational structures used in collaborative projects are often project-specific. In some instances, partnering represents the means and methods of developing better teams. In other cases, partnering is the outcome
with the final result of a project team with a formal partnership. Similarly, Bresnen and Marshall (2000) doubted whether collaboration could be engineered on a short-term basis because trust is related to “the length of the relationship between [the participants].” Many studies have suggested collaborative benefits, but little clear evidence exists relating collaboration to specific project outcomes.

Secondly, the fundamental principles behind collaboration could conflict with participants’ business goals. Construction’s adversarial nature, as Bresnan and Marshall (2000) described, can stem from the basic need for each party to maintain profitability. While traditional methods might be considered archaic and confrontational, they are often built on valid economic reasons. Owners, for example, could use partnerships to exploit their contractors by continuously raising their expectations and standards while rewarding them with little more than the potential for future work. Such uneven benefits could ultimately weaken partnering’s long-term feasibility. Bresnan and Marshall (2000) stated that extended relationships could be detrimental to the owner, too, because they are prevented from “taking advantage of price competition and more favorable deals from alternative suppliers.”

Lastly, collaborative principles typically include an alignment of goals and values, which could be exceedingly difficult to achieve in practice. While Kraft and Chinowsky (2003) noted that organizational cultures can translate into project-level behaviors, Bresnen and Marshall (2000) contended that organizational culture is rarely cohesive. Even when executive leaders clearly define their company’s values and principles, those cultural beliefs can vary amongst individual employees. Thus, if it is difficult to establish behavioral unity within a single organization, establishing multi-organizational unity within a construction project team would, therefore, be exceedingly difficult (Bresnen & Marshall, 2000).

2.9 Literature Review Summary

Previous studies have shown the wide range of benefits, limits, implementation practices, and prerequisites for collaboration-focused delivery methods. Some institutional owners have expressed interest in these approaches, and there is a need for research that analyzes their transition from traditional to collaborative methods. These methods are founded on team principles such as trust, respect, and mutual goals. The implementation of collaborative methods can be shaped by general constructs, such as
partnering and multiparty alliances, or by specific delivery methods and contractual provisions. In either case, effective communication is paramount and a facilitated effort can help ease the transition. Collaborative teams aim to be as integrated as possible to avoid fragmentation, which can negate teamwork. Success is highly objective in the construction industry, but is primarily determined by the actions, qualities, and procedures of project management teams. Collaboration is not an all-encompassing remedy, and cannot guarantee results.
Chapter 3

RESEARCH METHODOLOGY

3.1 Methodology Introduction: Research Goal and Objectives

The goal of this research is to understand the effects of formalized collaborative efforts on relational performance and project outcomes on several construction projects with a single institutional owner. The intent of this research is to contextualize the value of such efforts, summarized as the owner’s “collaboration initiative,” to the delivery of their capital facilities. The extents and implementation of the collaborative efforts varies for each project, but for the studied projects generally includes a collocation space on-site for the core project team, a collaboration-specific contract document, a project facilitator, referred to as a “coach”, periodic team effectiveness performance reviews, and a general emphasis on teamwork and communication. An exploratory case study approach was used to compare three projects: an ongoing pilot project on which the abovementioned tools were first implemented, a second ongoing project with comparable efforts, and a recently completed project without a formal collaboration initiative. The research questions are restated below:

1. Do collaborative teams deliver more successful projects?
2. How does formal collaboration affect team behaviors that can potentially lead to successful projects?
3. What is the overall value of the owner’s collaboration initiative?

To satisfy the research questions, the following research objectives and tasks were performed:

1. Review existing literature and research methods.
a. A wide range of literature regarding relational performance in construction; specific topics included underperformance trends, fragmentation, proposed solutions, fostering teamwork, communication habits, and measuring success was analyzed.

2. Identify metrics that indicate team and project-level performance.
   a. Team-level and project-level performance metrics from previous studies and ongoing research were defined and adopted for analysis.

3. Identify appropriate in-progress and completed construction projects, and collect data.
   a. Identified one recently completed and two ongoing construction projects, all from the same geographic location and owner organization.

4. Identify relationships between the efforts employed, and the relative success and behaviors of each project team.
   a. Collected data and used explanation building to determine the relative success of each project team and each project, and related those performance outcomes to the use (or lack) of formalized collaboration efforts.

5. Present research contributions and recommendations for continued research.
   a. The facilitated and non-facilitated projects were compared across various performance metrics, and demonstrated how those comparisons form a baseline understanding of the owner’s collaboration initiative; and how different efforts can influence different team and project performance outcomes. As the owner expands the number of projects participating in the initiative, future research will be able to further evaluate its value in terms of improving team and project-level success.

3.2 Case Study Introduction

Robert Yin’s seminal guide to case study research (2003) states that case study comparisons are most effectively used with “how” or “why”-based research questions. In this study, such questions were applied to the relationships between formalized collaboration efforts, and team and project performance. Thus, case study comparisons were chosen as the primary research method.
Thematically, this study asserts that the construction industry is shifting towards more collaborative practices, and some institutional owners have responded with their own initiatives. The case study owner’s efforts aimed to facilitate that collaborative transition on several projects, promote improved team performance and presumably improve project outcomes, and identify best practices for use on future projects. The relative value of the initiative could determine whether the owner would decide to mandate it as a whole, or specific elements such as collocation, on future major construction projects.

To determine the effects of the collaboration initiative, it was necessary to establish a benchmark for expected results on typical projects. While the owner maintained extensive information regarding cost and schedule outcomes on completed projects, it did not have a database comparing projects across multiple performance metrics. The researcher thus chose to focus on projects that were actively participating in the initiative and had similar efforts, including a formal collaboration requirement or contract document, a collocation space, and a project coach. At the commencement of this study, the owner’s initiative was in its initial stages and was limited to a single campus, thus only two ongoing projects had formalized collaboration efforts. A third project, completed within the last two years without such efforts, was added to benchmark expectations.

3.2.1 Case Study Categories and Selection Criteria

The first case study group consists of two projects actively participating in the collaboration initiative. As both of these projects had designated coaches responsible for facilitating their team’s efforts, these two projects will be referred to as the facilitated projects. Both were in-progress at the time of the study, were from the same owner and geographic location, and had contractual terms for collaboration. The pilot project, hereafter referred to as the design-build case, was a multi-phased renovation and addition to a large housing complex. The second facilitated project, referred to as the target case, was an educational and research renovation and addition; and the second phase of a broader campus-wide development.
The owner’s facility management department initially developed a collaboration charter on the pilot project as an addendum to the contract documents. This charter was developed along with several key project participants and focused on establishing the team’s mutual goals, outlining the tools and methods of attaining those goals, and providing structure to the collaboration initiative on a project-to-project basis. Ideally, a standardized addendum would be adapted to each project team’s individual needs, thus streamlining the initiative across multiple projects. Although the target case’s project team could not adopt a collaboration charter due to contractual constraints, they added contract language to their project specifications defining collaboration and collocation as project requirements. Thus, the facilitated case studies represent project teams that documented commitments to higher standards of relational performance than on typical construction projects.

The facilitated projects had varying scopes, sizes, project delivery methods, project teams, and other characteristics. The following criteria were used to select these cases:

1. Projects had sufficient work scheduled throughout the 2012 and 2013 academic years, allowing for ample data collection and analysis,
2. Projects were limited to major renovations and additions, with total project costs exceeding $10 million,
3. Projects were limited to the owner’s campus to ensure that the researchers had direct access to the project teams, and,
4. As part of an academic research partnership, project teams were willing to meet with the researchers and provide information needed for the study.

The second case study category contains a recently completed project, hereafter referred to as the historical (or non-facilitated) case. As Phase 1 of a broader campus-wide project, the historical case preceded the target case; both shared the same building type (educational building with laboratory, office, and classroom spaces) and had similar scopes, although Phase 1 was all-new construction and Phase 2 involved some renovations. The core project team participants were also nearly similar, and the historical case adhered to the size and location requirements listed above. The short list of ongoing facilitated
projects limited the number of comparable historical projects available in terms of scope, organizational structure, building type, contract type, and other key variables. Due to its similarities with the target project, the historical project was a logical choice for benchmarking expectations. Table 3-1 summarizes the project selection timelines for both facilitated and historical projects:

Table 3-1: Project selection criteria and timelines

<table>
<thead>
<tr>
<th>Facilitated Projects</th>
<th>Historical Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Owner considered projects with A/E and CM selection between 2011 and 2012 as potential candidates for the collaboration initiative.</td>
<td>1. In 2012, the research team defined historical projects as ones completed during the past five years.</td>
</tr>
<tr>
<td>2. Between 2011 and 2012, a collaboration charter was drafted, developed, and signed for the pilot project.</td>
<td>2. Once facilitated projects were identified, historical projects were limited to the same campus to maintain consistency and ensure access to the project teams.</td>
</tr>
<tr>
<td>3. All facilitated projects involved new construction and/or substantial renovations, and had total project costs above $10 million.</td>
<td>3. To remain consistent with the identified facilitated projects, historical projects were limited to new construction and/or substantial renovations with total project costs above $10 million.</td>
</tr>
</tbody>
</table>

The abovementioned case study selection method allowed the research team to deal with two significant obstacles. First, the owner did not maintain a comprehensive database of completed projects and their outcomes, nor did it have a single set of performance metrics for all projects. Secondly, the amount and variety of construction overseen annually made it impractical to define the owner’s “typical” project.

3.3 Data Types and Sources

As discussed in the literature review, there are numerous variables to consider when analyzing the effects of collaboration, team-building, and other relational activities on team performance and project outcomes. These topics involve both “hard” quantitative project data, such as cost growth and correspondence turnaround times, and “soft” qualitative data, such as inter-organizational communication effectiveness. A combination of qualitative and quantitative data collection was pursued to provide an indication of both team and project-level performance.
3.3.1 Facilitated and Historical Project Data

The various case study data sources are summarized in Figure 3-1. Most of the data for the historical case was obtained through one-time collection methods, since the project concluded before this study began. Facilitated project data came from several in-progress sources for the ongoing case study projects, including periodic surveys, meeting observations, and semi-structured interviews with project team members. Collaboration-specific contract documents provided non-cumulative data collection for facilitated projects.

![Figure 3-1: Project data sources for each case study category.](image)

Figure 3-2 demonstrates how each data collection method was used to satisfy the research questions. Data describing project outcomes were used to satisfy the “project success” research question. Data describing relational outcomes were used to satisfy the “team behaviors” research question. Conclusions drawn from these two research questions were used to indicate the value of the overall collaboration initiative, thereby satisfying the third research question. Figure 3-2 also shows how the study combined qualitative and quantitative data to capture numerical performance indicators, and added contextual information to explain how or why the initiative was a factor.
### 3.3.2 Cost and Schedule Performance

The researcher interviewed lead contacts from the construction management firms towards the end of the data collection period to capture cost and schedule growth data for each project. CM personnel were targeted because, as the lead project coordinators, they were best positioned to provide cost and schedule outcomes. Interviews focused on identifying original project costs and durations as well as current costs and expected completion durations. For the ongoing facilitated projects (the DB and target cases), “actual” figures were based on the CM’s most recent projections. The same CM firm and personnel worked on the historical and target project, thus a single interview provided information for both cases.
AEC studies frequently cite cost and schedule performance as key indicators of project success. The facilitated teams did not target specific project outcomes (e.g. a 10% reduction in overall project costs) as part of their collaboration initiatives. Instead, it was generally accepted that by focusing on relational improvement, teams had the potential to communicate, manage, and deliver their projects more efficiently. Those efficiencies could improve project outcomes through less redundant work and similar improvements. Since the collaboration initiatives did not prescribe specific objectives for cost and schedule goals, beyond meeting contract requirements, the relationships between collaborative efforts and project outcomes were not clearly defined. This study therefore did not collect cost and schedule performance data to precisely measure success, but to situate the facilitated projects’ outcomes relative to the historical project.

3.3.3 Team Environment Surveys

Team environment surveys were distributed periodically, typically on a monthly basis when schedules allowed. The survey questions targeted eight key relational metrics, as identified in previous studies: communication, whether issues were acknowledged, response timeliness, cooperation, accountability, teamwork, trust, and respect. While these metrics did not represent all aspects of project team dynamics and performance, they were frequently mentioned in the literature as indicators of team effectiveness and success. The eight metrics were converted into questions with a 6-point Likert scale (0 representing poor performance and 5 representing ideal performance), allowing the respondents to rate the adequacy or deficiency of each characteristic within their team.

Members of the primary project stakeholder organizations, including the owner, design team, construction management firm, and key contractors, could numerically describe the current state of their project team at various stages of the project through these surveys. A separate question allowed respondents to identify themselves vaguely or explicitly, and an optional question allowed them to add comments. The research team periodically presented survey results to facilitated teams to encourage discussions about current issues and relational progress. Five team environment surveys were distributed on the DB project, and four on the target project. On the historical project, a similar survey was
completed as part of a consultant-led partnering session, but subsequent surveys were never distributed. A template of the team environment survey can be found in Appendix A.

These surveys served a dual purpose. First, they provided a quantifiable way to define the relational progress of the teams at a given stage of their projects. While these figures were not expected to provide a perfect description of team effectiveness, they provided consistent measurements that could be compared across multiple project teams and multiple time periods. Secondly, the process of reviewing the in-progress results with the project teams led to discussions that might not have occurred otherwise, thus strengthening the formal collaboration efforts.

### 3.3.4 360 Team Evaluation Surveys

360 team evaluations contained the same questions and Likert scale as the team environment surveys; however, a separate copy of the survey was created for each stakeholder group to allow the team members to rate the owner, design team, CM firm, and specialty contractors, or others, individually. For example, owner representatives and the end-user groups could rate the timeliness of the CM and vice versa. Similarly delivered to the team environment surveys, 360 survey results were presented periodically during team meetings as a catalyst for group discussions. These surveys were completed five times on the design-build case (on a quarterly basis) and twice on the target case, two months apart. As the historical case study project was already completed, it did not include any 360 surveys.

Research and AEC industry experience suggest that few project teams openly discuss relational issues during team meetings, and even fewer establish relational metrics that allow for self-assessment. The purpose of the team environment and 360 surveys was to allow the team members to anonymously voice their opinions about underlying problems, and then openly discuss them in a conflict-resolving and relationship-building manner. A template of the 360 survey can be found in Appendix A.

### 3.3.5 Project Documents: RFI’s, Submittals, and Collaboration Agreements

Three primary sources of information were gathered from the project teams: submittal logs, request for information (RFI) logs, and collaboration contract documents. Since the historical project did not have a formal collaboration agreement, only RFI and submittal logs were available.
RFI’s are written requests for clarifications between different parties, and are commonly used to rectify differences between the contract documents and field conditions (Clough et al., 2005). RFI’s can serve as an indicator of team effectiveness, because collaborative, openly-communicating teams presumably have richer communication leading to either fewer necessary RFI’s, or more easily (quickly) resolved questions. Project teams with proactive communication habits are also more likely to take action based on face-to-face interactions and decision-making, thereby reducing the time for documenting answers. Overall, the numerical data provided by RFI frequency and turnaround times allowed the researcher to define “typical” performance expectations and to determine whether the facilitated cases differed, and to what extent.

Submittal documents, such as shop drawings, ensure that the construction product fabrication or procurement conform to designer specifications, by verifying details such as material types, manufacturers, field dimensions, and performance characteristics (Clough et al., 2005). As a quality control mechanism, submittals can be used to measure project performance, thus indicating project-level success. Submittal approval rates and review durations can reveal how effectively team members aligned expectations, and how well they collectively understood the project's functional requirements, thus indicating relational performance. Consequently, submittal approval/rejection rates and review durations were analyzed to assess the facilitated cases’ relational and project-level success relative to the historical case. Once again, the intent of this research was not to create absolute comparisons, but to define performance expectations on “typical” projects and to assess the relative performance of the facilitated cases.

Neither the research team nor the studied project teams expected the RFI and submittal data to be flawless indicators of team effectiveness and project performance. Instead, the intent was to leverage these commonly-used management tools to create timelines depicting long-term trends. Using these trends to identify improvements and setbacks, the researcher was able to define the relative success of one case in relation to the others. The results indicated whether the facilitated teams’ formal collaborative
efforts led to above-average performance (as defined by the historical case), thus satisfying the posited research questions.

Contractual terms for collaboration further distinguished the facilitated projects from the historical case. These terms were reviewed and categorized to capture the intent of each team’s formal collaborative efforts: their goals, prescribed methods, requirements, and success criteria. By comparing the original terms of the collaboration agreements to what was implemented and achieved in the field, relational success could be evaluated according to each team’s own conditions. This research did not focus on comparing the specific mandates of each team’s collaboration agreements, but on the extent to which each teams attempted to “force” collaboration contractually.

3.3.6 Meeting Observations

The researcher observed numerous team meetings throughout the construction of the facilitated projects as a means of studying each teams’ communication habits. Gorse and Emmett (2007) used similar observations to distinguish between task-based and socio-emotional team interactions. Task-based interactions allow information, ideas, and opinions to be shared for the sake of coordination; socio-emotional interactions are more communal, and less focused on the team’s objective requirements. While task-based communication allows teams to meet their goals and resolve their problems, social interactions foster relationship-building (Gorse & Emmitt, 2007).

Gorse and Emmitt (2007) concluded that truly effective teams balance task-based communication, necessary for decision-making and management duties, with socio-emotional content, which builds trust, respect, and increases team efficiency. Their study determined that the majority of construction team interactions during project meetings are task-based. This research used meeting observations to satisfy the following objectives:

1. To broadly categorize the team interactions by the nature of the topics (positive, negative, or neutral) and by the number of team members involved in each discussion (group versus individual-led discussions).
2. To qualitatively assess the teams’ communication habits, relational interactions, and willingness to engage in the collaborative efforts,

3. To identify the project facilitators’ role and participation in these team meetings, and

4. To identify each team’s collaboration-focused tools and methods, as a way to define their version of the collaboration initiative.

Meeting interactions were not categorized as task-oriented or socio-emotional because, as Gorse and Emmett (2007) concluded, most construction teams favor task-based communication. For the purposes of this study, simply stating that there were a definite number of task-based versus interpersonal interactions would not have indicated much about the effects of the initiative. Instead, the researcher focused on participation (individual-led versus group discussions) as a sign of team engagement, and on the relative nature of the topics (positive, negative, or neutral) as an indication of behavioral changes. Without any historical meeting observations to serve as benchmarks, this analysis technique provided a more relevant manner to compare the facilitated teams. To capture these interactions, the researcher took detailed notes during team meetings and later organized them by participation and the nature of the topics.

### 3.3.7 Semi-structured Interviews

Towards the end of the data collection period, the researcher conducted semi-structured interviews with key members of the facilitated teams. Team members directly involved in the abovementioned meetings were targeted first since they were involved with their project’s day-to-day operations, were aware of the ongoing collaboration initiative, and could thus describe the nature and efficacy of their team’s efforts. Attempts were made to interview at least one person from each of the four stakeholder groups, as well as all of the project coaches.

The interviews consisted of semi-structured conversations, either in person or by telephone. Interview questions were developed based on the three identified research questions, primarily focusing on collaborative efforts, the coaches’ facilitation efforts, the particular challenges of each project, and related information. Separate questions were developed for the project stakeholders and coaches, and
were further developed based on feedback from the research team. Pilot interviews were also conducted on the DB case: one with the project coach, and one with a project stakeholder.

Below, Figure 3-3 shows how the interview questions were categorized and related to the research questions. The intent of the interviews was to document individual perspectives regarding the main components of the collaboration initiative: collocation, the emphasis on teamwork, the effects of facilitation, and the implementation of the initiative. Additional information was obtained regarding team dynamics, behavioral trends, and the use of measurable goals. These interviews provided in-depth qualitative information needed to contextualize the quantitative data results, thereby inferring whether the collaboration initiative drove success, improved team behaviors, and had value.

Interviewees were notified that their responses would be collected and presented anonymously. They were also encouraged to be as open and honest as possible, and to elaborate their responses as much as they deemed necessary. Although a few of the questions were open-ended, the researcher avoided simply asking the respondents each of the three research questions. Such an approach could have provoked heavily biased answers. Instead, the intent was to allow interviewees to explain their answers comprehensively, and to use those answers to satisfy the research questions somewhat indirectly.

After obtaining written consent, the researcher audio-recorded each interview while simultaneously taking notes. These notes were later refined based on the audio recordings to more accurately portray the interviewees’ responses. Finally, responses were categorized by project and the roles of the interviewees.
3.4 Data Analysis Processes

Yin (2003) described multiple techniques for analyzing case study research data. The first step towards choosing the appropriate techniques was to establish the appropriate case study comparisons. All three research questions required conclusions drawn from both case study groups in order to be satisfied. As the two in-progress projects with the greatest opportunities for team-oriented data collection, the facilitated cases (DB and target projects) were the primary focus of the case study comparisons.

The limited expanse of the collaboration initiative did not allow the researcher to choose comparable case studies based on building type, project delivery type, or other key factors. Similarly, the initiative was still in its initial stages, so collaborative efforts and methods were not yet standardized across multiple projects. The following considerations impacted the expected results of the case study comparisons:
1. The pilot case, as a design-build project, was expected to have elevated performance due to the team integration that design-build enables. Similarly, the early involvement of the design-assist contractors on design matters presumably improved the team’s chances of relational and project-level success. Finally, the DB team’s initiative was developed from the initial planning stages of the project, allowing for discussion and refinement before implementation. To some extent, this raised the team’s performance expectations even higher.

2. The target case, as the second phase of the historical case, had several core team members who had previously worked together. Although the two phases had varying percentages of new work versus renovations, the buildings themselves were fairly similar. Thus, the project team had the benefit of building similar facilities for a second time, using virtually the same project team members. Improved outcomes and relational performance were thus expected, regardless of the presence of formal collaboration.

Due to these circumstances, the design-build case represented high expectations for team and project performance within formal collaborative environments. The target case was subsequently compared to the DB case in terms of project outcomes and team performance, to identify whether success indicators were similar in both cases, or if the target case varied considerably. The historical team therefore represented baseline expectations for non-formalized collaborative environments. Thus, the spectrum of expected team and project-level performance due to the collaboration initiative ranged from the historical case (typical expectations) to the DB case (high expectations), with the target case projected to be somewhere in between. Demonstrable differences in relational and project performance amongst facilitated and historical projects would indicate the value of the overall initiative.

3.4.1 Analysis Techniques per Research Question

The researcher attempted to satisfy the research questions using two analytic techniques, as defined by Yin (2003): cross-case synthesis and explanation building. To reiterate the first research question: *Do collaborative teams deliver more successful projects compared to traditional project teams?* Cross-case synthesis involved visual, side-by-side comparisons of the three projects according to a
particular metrics. For example, graphs depicting submittal approval rates and durations were used to determine if the facilitated projects outperformed the historical project, as expected. If the results could not be readily distinguished, the comparisons were narrowed into further levels of detail. Once potential trends were identified, other data sources were used to corroborate those trends. Results were typically shown graphically for quantitative data and were tabulated for qualitative data. The summarized qualitative results provided the narrative needed to explain the graphic patterns.

The second research question was: How does formal collaboration affect team behaviors that can potentially lead to successful projects? Again, cross-case synthesis and explanation building were used to distinguish facilitated and historical projects in terms of relational performance, as this question focused on team members’ behaviors, attitudes, and actions, qualitative information took precedence over quantitative. For instance, 360 survey results were analyzed to determine how teams perceived individual stakeholders’ performance. Those perceptions were then cross-referenced with interview responses and meeting observations to more accurately assess whether individual team members displayed collaborative behaviors. Explanation building was then used to determine why such behaviors were, or were not present, and what role the initiative played in promoting those behaviors.

The final research question was: What is the overall value of the collaboration initiative on these projects? This question primarily relied on the combined implications of the first two research questions. If the facilitated cases projected better outcomes than those on the historical project, it could be inferred that the initiative enabled better project performance. If the facilitated teams were found to have better relational attributes than the historical benchmarks, the initiative could be associated with improved team performance. Thus, the demonstrated benefits of the collaboration initiative (or lack thereof) were used to define its overall value.

3.5 Research Validity

Case study research has four basic quality control measures for validity: construct validity, internal validity, external validity, and reliability (Yin, 2003). The use of multiple data collection sources, including project documents, electronic surveys, and semi-structured interviews, helped establish
construct validity. A chain of evidence was established to show how the data collection methods were relevant to the research questions, as shown in Figures 3-2 and 3-3. Although project participants did not extensively review the collected data for accuracy, there were opportunities to point out errors or discontinuities during data presentations. By cross-referencing the conclusions drawn from multiple data sources, to ensure that one data source’s conclusions contradicted those of another data type, the researcher inferred causal relationships and established internal validity. Finally, a case study database was maintained to increase the reliability of the results, by ensuring that the same research methods and data collection approaches were used consistently.

3.6 Methodology Summary

In summary, this research aimed to examine the initial results of an institutional owner’s collaboration initiative. The three research questions developed relate to the potential relationships between collaborative management techniques and improved team and project-level outcomes. By examining these relationships, the researcher sought to understand how future teams could apply team-centered principles to improve their chances of success. Ongoing projects participating in the initiative were identified as facilitated cases, and a completed project without a formal collaborative focus was identified as the historical case. Data collection methods and analysis techniques were designed to allow the researcher to draw conclusions across multiple projects with varying characteristics.
Chapter 4

DATA COLLECTION

4.1 Introduction

The methodology chapter described how the research questions centered on the three main tenets of the study: to determine how formal collaborative efforts affect project outcomes and team behaviors, and to define the relative value of collaborative efforts on projects. Data was collected from two ongoing, facilitated projects and one completed, non-facilitated project. To determine the abovementioned relationships, facilitated projects’ outcomes were compared to baseline expectations, derived from a historical project. In-progress data sources such as meeting observations were unavailable from the historical project. In such cases, the facilitated projects were directly compared without historical benchmarks. This chapter will discuss summary-level results from each data source, arranged from project-level indicators to relational indicators. Individual team results will progress from the historical teams (when applicable) to the design-build (DB) team, and finally the target team.

4.1.1 Case Study Background

The institutional owner participating in this study owns over 22,000 acres of land, nearly 1,800 buildings, and over 30 million gross square feet of building space as of 2011. An internal department typically provides design, construction management, and facility management services for those facilities. With over $2 billion spent on new construction and renovations over the past five years, delivering projects within cost and schedule constraints is imperative.

The owner’s collaboration initiative grew from the consensus that better team collaboration can produce better project outcomes. Chapter 2 described some of the industry solutions for enabling such success, including contractual and non-contractual collaborative agreements. This particular owner’s public funding sources often constrain the use of certain delivery methods and contractual means for integrating the project team. Thus the two project teams participating in the initiative, the design-build
team and the target team, represent attempts to facilitate better outcomes given the unique contractual constraints.

4.1.2 Design-build Project Overview

The design-build project involved major renovations to a series of dormitory buildings and a student commons area, along with the construction of a new dormitory building. The scope of work included significant alterations to exterior and interior finishes, updated mechanical, electrical, and plumbing (MEP) systems, a reconfiguration of interior spaces, and demolition and replacement of structural components. The budget was set at $82 million with 44 months planned from design through substantial completion, including 32 months for construction. Significant phasing was necessary to balance required occupancy with the ongoing work. By cost, the project was estimated to be 75% new construction and 25% renovations. The approximate area of all renovated and new spaces was 245,000 square feet.

This project used a design-build delivery in which the CM was contracted to the owner under a guaranteed maximum price (GMP) contract, and the design firm was contracted to the CM on a lump-sum basis. The mechanical, electrical, plumbing, fireproofing, masonry, exterior panels, and exterior framing trades were hired by the CM as design-assist contractors using a best value approach. As with much of the owner’s previous construction projects, team selection was based on prequalification and a two stage proposal process. Members of the core project team drafted and developed a collaboration charter, which was signed one month prior to the start of construction.

4.1.3 Target Project Overview

The target project included the partial demolition of an existing academic facility, renovations to 39,000 square feet of laboratory space, and 92,000 square feet of new classrooms, offices, and research spaces. Renovations to the existing spaces ranged from façade removal and replacement to upgraded MEP systems and reconfiguration of interior spaces. The new building included ground-up construction of foundations, superstructure, interiors, MEP systems, and matching façade. The original budget was
approximately $40 million, with a duration of 42 months including 27 months of construction. By area, the project was approximately 70% new construction and 30% renovation.

Public funding mandated the use of a multiple prime delivery method, which the owner supplemented with a CM-agency. Thus, the owner hired the design and CM firms as consultants, and directly contracted the MEP, general trades, masonry, structural steel, and nine other specialty trades under lump sum contracts. Vendors and subcontractors were subsequently hired by individual prime contractors. Funding constraints mandated that the lowest responsible bidders be awarded the prime contracts. The owner, A/E, and CM developed contractual terms mandating collocation and collaborative practices for the prime contractors, which were included in the project specifications and bid documents.

4.1.4 Historical Project Overview

The historical project entailed the ground-up construction of a new academic building including 94,000 square feet of classrooms, offices, and research spaces. Aesthetically, the building was intended to relate to the surrounding campus buildings. The original budget was approximately $41.5 million, with a planned schedule of 45 months including 32 months of construction.

Delivery methods, contract types, and procurement methods for the historical project mirrored those of the target project: CM-agency with multiple prime contractors, lump sum contracts for all prime contractors, and contracts awarded to the lowest responsible bidders. No formal collaboration agreements were used.

4.1.5 Project Selection

At the commencement of this study, four projects were expected to participate in the owner’s collaboration initiative. Two projects were unable to commit for various reasons, leaving the DB and target projects as the only actively facilitated projects. A completed project was also needed to define standard expectations and outcomes on the owner’s typical, non-facilitated projects. Of the owner’s projects completed within the previous five years, the historical case most closely resembled a “typical” project: it was publicly funded, was in the same geographic location as the facilitated projects, and was delivered using multiple prime contracts. Additionally, three prime contractors involved with the
historical case were prime contractors on the target case, providing opportunities for reasonable comparisons.

In the following sections, data collection and results will be presented starting with the historical case, representing typical expectations, followed by the design-build case, representing high expectations for a project whose delivery method choice was not constrained by public funding, and finally the target case, representing the target for potential improvement over the typical delivery outcomes. Once again, in-progress data was unavailable from the historical project and will therefore not be presented.

4.2 Data Collection and Results

Data collection for all three cases concluded in the spring of 2014. In order to create consistent project timelines, the scheduled end dates for construction were designated as the end dates for the collected data. The start dates for construction were not used as the start dates for the data, since it was common for RFIs, submittals, and other correspondence to begin before construction. Instead, start dates were adjusted to the first date that RFIs or submittals were processed, as it was confirmed that most primary team members were actively involved on their respective projects by that date. Differences between the construction start dates and designated start dates ranged from 1-3 months.

4.2.1 Results: Cost and Schedule Performance

As mentioned in the methodology chapter, interviews were conducted with CM personnel to capture original project costs and schedule durations, actual costs and durations, and the underlying reasons for the projects’ cost and schedule growth. This data was collected to establish reasonable expectations for project performance, based on the historical project’s outcomes. Cost and schedule performance are summarized below in Table 4-1.

<table>
<thead>
<tr>
<th>Cost &amp; Schedule Metrics</th>
<th>Design-Build Project</th>
<th>Target Project</th>
<th>Historical Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original project costs ($)</td>
<td>$82.07M</td>
<td>$39.57M</td>
<td>$41.50M</td>
</tr>
<tr>
<td>Actual/projected costs ($)</td>
<td>$88.70M</td>
<td>$44.00M</td>
<td>$48.00M</td>
</tr>
<tr>
<td>Cost growth (%)</td>
<td>8.1 %</td>
<td>11.2 %</td>
<td>15.7%</td>
</tr>
<tr>
<td>Original construction schedule duration</td>
<td>32 months</td>
<td>30 months</td>
<td>32 months</td>
</tr>
<tr>
<td></td>
<td>Projected construction schedule duration</td>
<td>32 months</td>
<td>30 months and 7 workdays</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------------------------</td>
<td>-----------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Schedule growth (%, calculated in workdays)</td>
<td>0 %</td>
<td>1.2%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Unit cost ($/SF)</td>
<td>$359/SF</td>
<td>$333/SF</td>
<td>$511/SF</td>
</tr>
<tr>
<td>Intensity ($/SF/Month)</td>
<td>$11.22/SF/month</td>
<td>$12.35/SF/month</td>
<td>$15.02/SF/month</td>
</tr>
<tr>
<td>Construction speed (SF/Month)</td>
<td>7719 SF/Month</td>
<td>4889 SF/Month</td>
<td>2765 SF/Month</td>
</tr>
</tbody>
</table>

### 4.2.2 Results: Team Environment Surveys

A single “Benchmark Survey,” separate from this research study, was conducted on the historical project prior to the start of construction. A consultant firm specializing in AEC industry partnering and coaching distributed the survey. Consequently, the metrics used were slightly different than those of this study, but were comparable. Survey participants were instructed to rate metrics such as accountability and communication based on their prior experiences within the industry, not based on the current state of their project team. The results were then used to benchmark expectations on the historical project. A five point Likert scale was used; metrics and results are summarized below in table 4-2. Individual ratings per metric were not provided to the researcher, thus only average ratings are shown. Cooperation, accountability, and “overall feeling at project completion” were the best-scoring metrics with scores of 3.40 out of a possible 5; “acknowledging problems” was the worst-performing metric at 3.00.

Table 4-2: Historical project’s benchmark survey results, per metric.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Average Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperation</td>
<td>3.40</td>
</tr>
<tr>
<td>Accountability</td>
<td>3.40</td>
</tr>
<tr>
<td>Overall Feeling at Project Completion</td>
<td>3.40</td>
</tr>
<tr>
<td>Communication</td>
<td>3.30</td>
</tr>
<tr>
<td>Problem-Solving Process</td>
<td>3.30</td>
</tr>
<tr>
<td>Response to Problems</td>
<td>3.20</td>
</tr>
<tr>
<td>Resolving Differences</td>
<td>3.20</td>
</tr>
<tr>
<td>Acknowledging Problems</td>
<td>3.00</td>
</tr>
</tbody>
</table>
The design-build team completed five team environment surveys over a 25-month period. Participation varied from 12 to 8 participants per survey with an average of 9.6. In Table 4-3, each month represents a completed survey. The center of the table shows the average rating for each metric per survey period. The bottom row contains overall monthly averages across all metrics. Individual metrics are shown in descending order from highest to lowest by average across all survey periods, as shown in the right-most column. For instance, teamwork had the highest average rating (4.35) and is thus at the top of the list, whereas timeliness had the lowest average rating (3.79) and is at the bottom. Based on the 0-5 Likert scale, ratings ranged from 3.50 to 4.60.

Table 4-3: Design-build’s team environment results, per metric.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Mar-12</th>
<th>Sep-12</th>
<th>Mar-13</th>
<th>Jan-14</th>
<th>Feb-14</th>
<th>Average per Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork</td>
<td>4.45</td>
<td>4.33</td>
<td>4.13</td>
<td>4.50</td>
<td>4.33</td>
<td>4.35</td>
</tr>
<tr>
<td>Respect</td>
<td>4.55</td>
<td>4.08</td>
<td>4.00</td>
<td>4.63</td>
<td>4.33</td>
<td>4.32</td>
</tr>
<tr>
<td>Accountability</td>
<td>4.55</td>
<td>4.17</td>
<td>4.25</td>
<td>4.00</td>
<td>4.44</td>
<td>4.28</td>
</tr>
<tr>
<td>Communication</td>
<td>4.36</td>
<td>4.08</td>
<td>4.25</td>
<td>4.38</td>
<td>4.22</td>
<td>4.26</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>4.55</td>
<td>4.17</td>
<td>4.25</td>
<td>4.13</td>
<td>4.00</td>
<td>4.22</td>
</tr>
<tr>
<td>Trust</td>
<td>4.55</td>
<td>4.00</td>
<td>4.13</td>
<td>4.13</td>
<td>4.22</td>
<td>4.20</td>
</tr>
<tr>
<td>Cooperation</td>
<td>4.27</td>
<td>4.08</td>
<td>4.00</td>
<td>4.13</td>
<td>4.22</td>
<td>4.14</td>
</tr>
<tr>
<td>Timeliness</td>
<td>4.09</td>
<td>3.83</td>
<td>3.75</td>
<td>3.50</td>
<td>3.78</td>
<td>3.79</td>
</tr>
<tr>
<td>Monthly Averages</td>
<td>4.42</td>
<td>4.09</td>
<td>4.09</td>
<td>4.17</td>
<td>4.19</td>
<td></td>
</tr>
</tbody>
</table>

The monthly rating frequencies for the DB case are summarized in Table 4-4 by score and percentage. For example, in the September 2012 survey there were 18 instances of 3/5 ratings, which accounted for 18.8% of all ratings for that survey. The first survey period had the highest monthly average of 4.42; the second and third periods had the lowest at 4.09.

Table 4-4: Design-build’s team environment results: number and percentage of individual ratings.

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Mar-12</th>
<th>Sep-12</th>
<th>Mar-13</th>
<th>Jan-14</th>
<th>Feb-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Mar-12</th>
<th>Sep-12</th>
<th>Mar-13</th>
<th>Jan-14</th>
<th>Feb-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>
The target project team completed four team environment surveys over seven months. Participation varied from 17 to nine individual respondents, with an average of 13 respondents per survey. Table 4-5 shows that cooperation and respect had the highest average rating per metric (4.33) and timeliness had the lowest (3.91). Monthly averages across all metrics increased from the first to last survey. Individual ratings varied from a low of 3.59 to a high of 4.89.

Table 4-5: Target project’s team environment results, per metric.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Oct-13</th>
<th>Nov-13</th>
<th>Feb-14</th>
<th>Apr-14</th>
<th>Average per Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperation</td>
<td>3.82</td>
<td>4.07</td>
<td>4.75</td>
<td>4.67</td>
<td>4.33</td>
</tr>
<tr>
<td>Respect</td>
<td>4.06</td>
<td>4.07</td>
<td>4.42</td>
<td>4.78</td>
<td>4.33</td>
</tr>
<tr>
<td>Accountability</td>
<td>3.76</td>
<td>3.93</td>
<td>4.50</td>
<td>4.78</td>
<td>4.24</td>
</tr>
<tr>
<td>Communication</td>
<td>3.82</td>
<td>3.86</td>
<td>4.58</td>
<td>4.67</td>
<td>4.23</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>3.76</td>
<td>3.86</td>
<td>4.42</td>
<td>4.89</td>
<td>4.23</td>
</tr>
<tr>
<td>Teamwork</td>
<td>3.76</td>
<td>3.86</td>
<td>4.42</td>
<td>4.78</td>
<td>4.20</td>
</tr>
<tr>
<td>Trust</td>
<td>3.82</td>
<td>3.71</td>
<td>4.42</td>
<td>4.67</td>
<td>4.16</td>
</tr>
<tr>
<td>Timeliness</td>
<td>3.59</td>
<td>3.43</td>
<td>4.08</td>
<td>4.56</td>
<td>3.91</td>
</tr>
<tr>
<td>Monthly Averages</td>
<td>3.80</td>
<td>3.85</td>
<td>4.45</td>
<td>4.72</td>
<td></td>
</tr>
</tbody>
</table>

Below, Table 4-6 shows the frequency of individual ratings from the target case’s team environment surveys. The last survey period (April 2014) had the highest monthly average at 4.72, and the first survey period (October 2013) had the lowest at 3.80.
Table 4-6: Target project’s team environment results: number and percentage of individual ratings.

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Oct-13</th>
<th>Nov-13</th>
<th>Feb-14</th>
<th>Apr-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>11</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>27</td>
<td>35</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>68</td>
<td>47</td>
<td>43</td>
<td>16</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>26</td>
<td>48</td>
<td>54</td>
</tr>
<tr>
<td>Totals:</td>
<td>136</td>
<td>112</td>
<td>96</td>
<td>72</td>
</tr>
<tr>
<td>Monthly Averages</td>
<td>3.80</td>
<td>3.85</td>
<td>4.45</td>
<td>4.72</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Oct-13</th>
<th>Nov-13</th>
<th>Feb-14</th>
<th>Apr-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1</td>
<td>1.5%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2</td>
<td>8.1%</td>
<td>3.6%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>3</td>
<td>19.9%</td>
<td>31.3%</td>
<td>5.2%</td>
<td>2.8%</td>
</tr>
<tr>
<td>4</td>
<td>50.0%</td>
<td>42.0%</td>
<td>44.8%</td>
<td>22.2%</td>
</tr>
<tr>
<td>5</td>
<td>20.6%</td>
<td>23.2%</td>
<td>50.0%</td>
<td>75.0%</td>
</tr>
<tr>
<td>Totals:</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

4.2.3 Results: 360 Team Evaluation Surveys

360 team evaluation surveys applied the same metrics and 0-5 scale to each of the four stakeholder groups: the owner, construction manager, architect/engineering firm, and the contractors. The historical project did not include any 360 surveys. The design-build team completed five 360 surveys over 21 months, and the results are summarized in Table 4-7 below. Accounting for the four individual stakeholder surveys, average participation was 7.1 respondents. Metrics are shown in descending order from highest to lowest average ratings across all survey periods. Teamwork had the highest average rating (4.41) and timeliness had the lowest (4.00). Average scores within each survey ranged from 3.84-4.63.

Table 4-7: Design-build’s 360 survey results, per metric.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Jul-12</th>
<th>Nov-12</th>
<th>May-13</th>
<th>Nov-13</th>
<th>Mar-14</th>
<th>Average per Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teamwork</td>
<td>4.56</td>
<td>4.21</td>
<td>4.60</td>
<td>4.47</td>
<td>4.21</td>
<td>4.41</td>
</tr>
<tr>
<td>Communication</td>
<td>4.47</td>
<td>4.36</td>
<td>4.46</td>
<td>4.37</td>
<td>4.36</td>
<td>4.40</td>
</tr>
<tr>
<td>Accountability</td>
<td>4.56</td>
<td>4.18</td>
<td>4.40</td>
<td>4.63</td>
<td>4.18</td>
<td>4.39</td>
</tr>
<tr>
<td>Cooperation</td>
<td>4.44</td>
<td>4.18</td>
<td>4.46</td>
<td>4.58</td>
<td>4.18</td>
<td>4.37</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>4.50</td>
<td>4.29</td>
<td>4.29</td>
<td>4.42</td>
<td>4.29</td>
<td>4.36</td>
</tr>
<tr>
<td>Respect</td>
<td>4.38</td>
<td>4.11</td>
<td>4.57</td>
<td>4.58</td>
<td>4.11</td>
<td>4.35</td>
</tr>
<tr>
<td>Trust</td>
<td>4.50</td>
<td>4.07</td>
<td>4.49</td>
<td>4.53</td>
<td>4.07</td>
<td>4.33</td>
</tr>
<tr>
<td>Timeliness</td>
<td>4.06</td>
<td>3.96</td>
<td>4.17</td>
<td>3.84</td>
<td>3.96</td>
<td>4.00</td>
</tr>
<tr>
<td>Monthly Averages</td>
<td>4.43</td>
<td>4.17</td>
<td>4.43</td>
<td>4.43</td>
<td>4.17</td>
<td></td>
</tr>
</tbody>
</table>
Rating frequencies for the design-build’s 360 survey results are shown in table 4-8. The first, third, and fourth surveys had the highest monthly averages with 4.43, while the second and fifth period was lowest at 4.17.

Table 4-8: Design-build 360 survey results: number and percentage of individual ratings.

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Jul-12</th>
<th>Nov-12</th>
<th>May-13</th>
<th>Nov-13</th>
<th>Mar-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>17</td>
<td>24</td>
<td>16</td>
<td>6</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>105</td>
<td>117</td>
<td>128</td>
<td>75</td>
<td>117</td>
</tr>
<tr>
<td>5</td>
<td>132</td>
<td>76</td>
<td>136</td>
<td>71</td>
<td>76</td>
</tr>
<tr>
<td>Totals:</td>
<td>256</td>
<td>224</td>
<td>280</td>
<td>152</td>
<td>224</td>
</tr>
<tr>
<td>Monthly Averages</td>
<td>4.43</td>
<td>4.17</td>
<td>4.43</td>
<td>4.43</td>
<td>4.17</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ratings</th>
<th>Jul-12</th>
<th>Nov-12</th>
<th>May-13</th>
<th>Nov-13</th>
<th>Mar-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>1</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>2</td>
<td>0.8%</td>
<td>3.1%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>3.1%</td>
</tr>
<tr>
<td>3</td>
<td>6.6%</td>
<td>10.7%</td>
<td>5.7%</td>
<td>3.9%</td>
<td>10.7%</td>
</tr>
<tr>
<td>4</td>
<td>41.0%</td>
<td>52.2%</td>
<td>45.7%</td>
<td>49.3%</td>
<td>52.2%</td>
</tr>
<tr>
<td>5</td>
<td>51.6%</td>
<td>33.9%</td>
<td>48.6%</td>
<td>46.7%</td>
<td>33.9%</td>
</tr>
<tr>
<td>Totals:</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

The DB case’s 360 stakeholder ratings are shown in table 4-9. Timeliness was consistently the lowest-rated metric, and communication was the highest-rated metric for two of the four stakeholder groups.

Table 4-9: Design-build’s 360 survey results, per stakeholder.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Design-build: Contractors</th>
<th>Design-build: Construction Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jul-12</td>
<td>Nov-12</td>
</tr>
<tr>
<td>Communication</td>
<td>4.50</td>
<td>4.33</td>
</tr>
<tr>
<td>Accountability</td>
<td>4.50</td>
<td>4.33</td>
</tr>
<tr>
<td>Cooperation</td>
<td>4.30</td>
<td>4.22</td>
</tr>
<tr>
<td>Trust</td>
<td>4.30</td>
<td>4.11</td>
</tr>
<tr>
<td>Respect</td>
<td>4.30</td>
<td>4.22</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>4.60</td>
<td>4.11</td>
</tr>
<tr>
<td>Teamwork</td>
<td>4.60</td>
<td>4.22</td>
</tr>
<tr>
<td>Timeliness</td>
<td>4.50</td>
<td>4.11</td>
</tr>
</tbody>
</table>
The target team completed two 360 surveys over seven months. Participation varied from 28 to 34 respondents, with a per-stakeholder average of 7.8. As shown in Table 4-10, communication had the highest average rating (4.49) and timeliness had the lowest (4.04). Scores ranged from 3.96 to 4.71.

Table 4-10: Target project 360 survey results, per metric.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Jan-14</th>
<th>Mar-14</th>
<th>Average per Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td>4.36</td>
<td>4.62</td>
<td>4.49</td>
</tr>
<tr>
<td>Teamwork</td>
<td>4.21</td>
<td>4.68</td>
<td>4.45</td>
</tr>
<tr>
<td>Cooperation</td>
<td>4.18</td>
<td>4.65</td>
<td>4.41</td>
</tr>
<tr>
<td>Respect</td>
<td>4.11</td>
<td>4.71</td>
<td>4.41</td>
</tr>
<tr>
<td>Accountability</td>
<td>4.18</td>
<td>4.56</td>
<td>4.37</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>4.29</td>
<td>4.38</td>
<td>4.33</td>
</tr>
<tr>
<td>Trust</td>
<td>4.07</td>
<td>4.53</td>
<td>4.30</td>
</tr>
<tr>
<td>Timeliness</td>
<td>3.96</td>
<td>4.12</td>
<td>4.04</td>
</tr>
<tr>
<td>Monthly Averages</td>
<td>4.17</td>
<td>4.53</td>
<td></td>
</tr>
</tbody>
</table>

Rating frequencies for the target project’s 360 survey results are shown in table 4-11. The average rating was 4.17 in the first survey period and 4.53 in the second.
Table 4-11: Target project’s 360 survey results: number and percentage of individual ratings.

<table>
<thead>
<tr>
<th>Target Project: Number of Individual Ratings</th>
<th>Target Project: Percentage of Individual Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratings</td>
<td>Jan-14</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>117</td>
</tr>
<tr>
<td>5</td>
<td>76</td>
</tr>
<tr>
<td>Totals:</td>
<td>224</td>
</tr>
<tr>
<td>Monthly Averages:</td>
<td>4.17</td>
</tr>
</tbody>
</table>

In Table 4-12, the data shows the target case’s 360 survey results per stakeholder. Timeliness once again had the lowest average rating across all surveys. The metric with the highest average rating varied for each stakeholder.

Table 4-12: Target project 360 survey results, per stakeholder.

<table>
<thead>
<tr>
<th>Target project: <strong>Contractors</strong></th>
<th>Target project: <strong>CM</strong></th>
<th>Target project: <strong>Owner</strong></th>
<th>Target project: <strong>A/E</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Metrics</td>
<td>Metrics</td>
<td>Metrics</td>
<td>Metrics</td>
</tr>
<tr>
<td>Cooperation</td>
<td>Communication</td>
<td>Teamwork</td>
<td>Respect</td>
</tr>
<tr>
<td>4.57</td>
<td>5.00</td>
<td>-4.86</td>
<td>4.50</td>
</tr>
<tr>
<td>Teamwork</td>
<td>Acknowledgment</td>
<td>Respect</td>
<td>Trust</td>
</tr>
<tr>
<td>4.43</td>
<td>5.00</td>
<td>-4.86</td>
<td>4.38</td>
</tr>
<tr>
<td>Respect</td>
<td>Teamwork</td>
<td>Trust</td>
<td>Cooperation</td>
</tr>
<tr>
<td>4.29</td>
<td>5.00</td>
<td>-4.86</td>
<td>3.88</td>
</tr>
<tr>
<td>Trust</td>
<td>Respect</td>
<td>Cooperation</td>
<td>Accountability</td>
</tr>
<tr>
<td>4.29</td>
<td>5.00</td>
<td>4.71</td>
<td>3.88</td>
</tr>
<tr>
<td>Communication</td>
<td>Trust</td>
<td>Accountability</td>
<td>Teamwork</td>
</tr>
<tr>
<td>4.14</td>
<td>4.75</td>
<td>4.71</td>
<td>4.00</td>
</tr>
<tr>
<td>Acknowledgment</td>
<td>Cooperation</td>
<td>Communication</td>
<td>Communication</td>
</tr>
<tr>
<td>4.29</td>
<td>4.50</td>
<td>4.71</td>
<td>3.75</td>
</tr>
<tr>
<td>Accountability</td>
<td>Acknowledgment</td>
<td>Acknowledgment</td>
<td>Acknowledgment</td>
</tr>
<tr>
<td>4.29</td>
<td>4.50</td>
<td>4.57</td>
<td>3.63</td>
</tr>
<tr>
<td>Timeliness</td>
<td>Timeliness</td>
<td>Timeliness</td>
<td>Timeliness</td>
</tr>
<tr>
<td>4.14</td>
<td>4.25</td>
<td>4.57</td>
<td>3.25</td>
</tr>
</tbody>
</table>

4.2.4 Results: Team Environment and 360 Survey Comments

Both team environment and 360 surveys contained an optional comments section, allowing the respondents to elaborate on their survey ratings. Since these sections were optional, participation varied greatly and several survey periods contained no comments. In the DB case, 1-2 survey comments were
provided in each of the first five team surveys, both environment and 360, and none were provided afterwards. Earlier comments showed optimism about the overall initiative and praised specific stakeholders. Latter comments noted that certain stakeholders were not as engaged as they should have been.

Four of the target team’s six surveys contained comments, ranging from 1-4 per survey. Earlier comments described how the initiative was working better than the participants had anticipated. Comments made during the middle survey periods were mostly positive, and several mentioned that the owner’s continuous efforts enabled other stakeholders to perform better. In the same survey, one commenter noted that certain stakeholders were stalling the decision-making process. Others praised the weekly coordination meetings and use of collocation.

4.2.5 Results: Requests for Information (RFIs)

Requests for Information (RFIs) allow team members to clarify design issues or information before work is continued. For the facilitated projects, RFI data collection occurred concurrently with the 360 and team environment survey distribution periods. This allowed the teams’ collaborative reviews to include the latest survey, RFI, and submittal communication data, thus providing a quantitative perspective of their progress. Facilitated projects’ RFI logs were obtained through online document management software, with access provided by the CM firms for each of the projects. For the historical project, the CM provided an RFI list after project completion.

The RFI data consists of two components: total number of RFIs, and review durations based on when each RFI was created and answered. Neither team established goals for limiting the total number of RFIs on their project. The design-build team set the goal that for review durations, 90% of RFIs should be answered within three business days. Although the target team did not formally agree to the same terms, the 90% goal provided a benchmark for team comparisons.

Table 4-13 shows how quickly RFIs accumulated on each project. The heat map is scaled from zero to the maximum number of RFIs on any project (560). Red cells are closer to 0, yellow cells are
closer to the median point (280), and green cells are closer to the maximum 560; black cells represent project months for which RFI data was unavailable or was not yet collected.

Table 4-13: Cumulative RFIs, per project.

<table>
<thead>
<tr>
<th></th>
<th>Month 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>Month 15</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design-Build</strong></td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>53</td>
<td>95</td>
<td>140</td>
<td>164</td>
<td>171</td>
<td>187</td>
<td>212</td>
<td>240</td>
<td>254</td>
<td>277</td>
<td>296</td>
<td>303</td>
</tr>
<tr>
<td><strong>Target Project</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>9</td>
<td>19</td>
<td>27</td>
<td>38</td>
<td>66</td>
<td>79</td>
<td>95</td>
<td>123</td>
<td>142</td>
<td>171</td>
<td>196</td>
</tr>
<tr>
<td><strong>Historical Project</strong></td>
<td>4</td>
<td>28</td>
<td>63</td>
<td>97</td>
<td>131</td>
<td>173</td>
<td>209</td>
<td>233</td>
<td>251</td>
<td>277</td>
<td>306</td>
<td>326</td>
<td>342</td>
<td>367</td>
<td>418</td>
</tr>
</tbody>
</table>

**Table 4-14: RFI data comparison.**

<table>
<thead>
<tr>
<th>RFI Metrics</th>
<th>Design-build Project</th>
<th>Target Project</th>
<th>Historical Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timeliness of RFI response (≤ 3 Days)</td>
<td>55.8%</td>
<td>16.8%</td>
<td>27.6%</td>
</tr>
<tr>
<td>Timeliness of RFI response (4 Days)</td>
<td>22.1%</td>
<td>11.2%</td>
<td>9.6%</td>
</tr>
<tr>
<td>Timeliness of RFI response (5 Days)</td>
<td>9.9%</td>
<td>7.7%</td>
<td>10.3%</td>
</tr>
<tr>
<td>Timeliness of RFI response (6 Days)</td>
<td>4.2%</td>
<td>11.2%</td>
<td>7.2%</td>
</tr>
<tr>
<td>Timeliness of RFI response (&gt; 6 Days)</td>
<td>7.9%</td>
<td>53.1%</td>
<td>45.3%</td>
</tr>
<tr>
<td>Total # of RFIs</td>
<td>413</td>
<td>196</td>
<td>560</td>
</tr>
<tr>
<td>RFI accumulation rate (RFIs/completed workdays)</td>
<td>0.79</td>
<td>0.65</td>
<td>0.75</td>
</tr>
</tbody>
</table>

RFIs were categorized according to review durations: three workdays or less, four days, five days, six days, and greater than six days. Table 4-14 summarizes the teams’ RFI performance according to each interval. The figures shown are based on the total number of closed RFIs on the facilitated projects through March 31st, 2014, when data collection concluded. For the historical case, the figures shown represent all RFIs for the entire project. Thus, workdays for the DB and target case were calculated from the designated start date (as explained in section 4.2) to the end of March 2014. For the historical project, workdays were calculated from the designated start date to the end of construction.
Neither team achieved 90% of RFIs reviewed within three business days. The design-build case achieved 55.8% of all RFIs resolved within three days; the historical project achieved 27.6% at 3 days, and the target project achieved 16.8% closure at 3 business days. As the only completed project, the historical project expectedly had the greatest number of RFIs, though it is important to note that the rate of RFI generation is quite similar for all three projects, ranging from 0.65 RFIs/workday to 0.79 RFIs per workday.

For the last RFI metric in Table 4-14, accumulation rates were calculated by dividing the total number of RFIs by the total number of completed workdays as of March 31st, 2014. This metric attempted to normalize the projects’ total number of RFIs, to some degree, by considering the number of completed workdays in each case. A lower accumulation rate indicated that fewer RFIs were created per workday, translating to fewer clarifications. Higher rates indicated more RFIs generated per workday, presumably because clarifications within each project team were more commonly needed. According to this metric, the target project had the lowest RFI accumulation rate per workday with 0.65 at the time data collection was stopped; the historical project was second with 0.75, and the design-build was third with 0.79 RFIs per workday.

4.2.6 Results: Submittals

Submittals are project documents verifying that the characteristics of the installed assemblies match the project specifications (Clough et al., 2005). On the facilitated projects, submittal data was routinely collected at the same time that surveys were distributed; the same online programs used to gather RFI logs provided submittal logs as well, with access once again granted by the CM firms.

The submittal data consists of three components: the total number of submittals, approval rates, and review durations. Durations were calculated as the number of workdays required for each submittal to be received and reviewed by the design team, and then returned to the CM. As with RFIs, only the DB team established a goal for submittal reviews: 90% approved and returned within 10 business days. To more accurately reflect the true review durations, only closed submittals marked as approved, approved as noted, rejected, or “revise and resubmit” were considered for data collection purposes. Such submittals
were most likely to be reviewed in a consistent manner. All other submittals, including those marked “no action taken” or “for record purposes only,” were not included in the data collection.

Table 4-15 shows each project’s cumulative submittals, both total and approved, per project month. Month 1 represented the first month of each project (as previously defined); month 5 was the fifth month, and so on. Project timelines once again extended from the first reviewed RFIs and submittals to the construction end dates. The heat map was scaled from zero (red cells) to the largest number of submittals on any individual project (1160; green cells), with the median (580) represented by yellow cells.

Table 4-15: Cumulative submittals, per project.
Submittal durations ranged from 10 working days or less to 15 days or more, representing a range of two to three calendar weeks. Table 4-16 summarizes the relevant submittal data. The start and end dates for data collection were structured in the same manner as for RFIs, as explained in sections 4.2 and 4.2.3. Neither project had 90% of its submittals approved and returned within 10 business days, which was the DB team’s goal. The DB team had the highest percentage (57.4%) at the 10 day mark, followed by the target team (36.4%) and historical team (9.8%).

Table 4-16: Submittal data comparison.

<table>
<thead>
<tr>
<th>Submittal Metrics</th>
<th>Design-Build</th>
<th>Target Project</th>
<th>Historical Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submittal review timeliness (≤ 10 Days)</td>
<td>57.4%</td>
<td>36.4%</td>
<td>9.8%</td>
</tr>
<tr>
<td>Submittal review timeliness (11 Days)</td>
<td>12.9%</td>
<td>4.8%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Submittal review timeliness (12 Days)</td>
<td>7%</td>
<td>8.7%</td>
<td>2%</td>
</tr>
<tr>
<td>Submittal review timeliness (13 Days)</td>
<td>2.7%</td>
<td>4.5%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Submittal review timeliness (14 Days)</td>
<td>2.6%</td>
<td>5.6%</td>
<td>2%</td>
</tr>
<tr>
<td>Submittal review timeliness (15 Days)</td>
<td>2%</td>
<td>0.9%</td>
<td>3%</td>
</tr>
<tr>
<td>Submittal review timeliness (&gt; 15 Days)</td>
<td>4.6%</td>
<td>11%</td>
<td>40.3%</td>
</tr>
<tr>
<td>Submittal rejection rate (# of rejected submittals/total # of submittals)</td>
<td>10.9%</td>
<td>28.1%</td>
<td>39.8%</td>
</tr>
<tr>
<td>Total # of submittals (to date)</td>
<td>1013</td>
<td>1024</td>
<td>1160</td>
</tr>
<tr>
<td>Submittal accumulation rate (total submittals/completed workdays)</td>
<td>1.94</td>
<td>3.39</td>
<td>1.55</td>
</tr>
<tr>
<td>Total # of approved submittals</td>
<td>903</td>
<td>736</td>
<td>699</td>
</tr>
<tr>
<td>Approved submittal accumulation rate (approved submittals/completed workdays)</td>
<td>1.73</td>
<td>2.44</td>
<td>0.93</td>
</tr>
</tbody>
</table>

The last four rows in Table 4-16 contain the total number of submittals and approved submittals per project. Also shown are the total submittal and approved submittal accumulation rates, which indicate the intensity of the project by showing how many individual submittals were closed per completed workday. These rates suggest the relative number of submittals each team reviewed and approved throughout their projects on a given day. Regarding total accumulation rates, the historical team was the lowest (1.55 total submittals per completed workday) followed by the DB team (1.94) and the target team (3.39). Considering that submittals are typically more common at the earliest stages of the project, the rate for the target project may be skewed due to the early stage of the project when data collection was stopped.
Since typical projects require approved submittals before commencing with work, shorter review durations could reflect the continuity of the work and the cohesion of the team. They may also reflect submittals which are clearer in identifying products that align with the specifications. Differences between the total and approved accumulation rates also show how frequently submittals were rejected, meaning products which would not meet the specification requirements. The historical team had the lowest approved accumulation rate (0.93) followed by the DB team (1.73) and the target team (2.44). It should also be noted that the historical team had the highest percentage returned after 15 days (> 40%), whereas the target team had only 11% after 15 days, and the DB team had only 4.6% extend beyond 15 days.

4.2.7 Results: Collaboration-Specific Contract Document Analysis

This study used content analysis to examine the facilitated projects’ collaboration contract documents. The documents provided the foundation for the facilitated teams’ collaboration agreements and their expectations. Although the historical case did not involve a collaboration-specific contract document, the team participated in a consultant-led partnering session during preconstruction. The consulting firm organized the team’s discussions and the results of the partnering session in a summary document similar to meeting minutes. For comparison purposes, this document was used to conduct the historical project’s collaboration document analysis.

Table 4-17: Sample of the collaboration contract document analysis for target project.

<table>
<thead>
<tr>
<th>TEAM PROJECT</th>
<th>SECTION IN PROJECT SPECIFICATIONS – 777 Words</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Team Members Involved</strong></td>
<td><strong>Team Members</strong></td>
</tr>
<tr>
<td>1. Owner</td>
<td>1. Owner</td>
</tr>
<tr>
<td>2. CM</td>
<td>2. CM</td>
</tr>
<tr>
<td>3. A/E</td>
<td>3. A/E</td>
</tr>
<tr>
<td></td>
<td>4. Prime contractors</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Collaboration documents were reviewed and categorized according to their terms: goals and objectives, collaboration-related requirements, key concepts, performance metrics and categories, suggested tools, and consequences for non-compliance. Each document was written for a different purpose; therefore some of the researcher’s review categories did not apply to all three documents. A sample of the collaboration document reviews is shown in Table 4-17. Since this qualitative information cannot be summarized succinctly, the analysis results will be discussed in Chapter 5 with other data results and conclusions.

4.2.8 Results: Meeting Observations

The researcher participated in several of the facilitated teams’ project meetings. For the design-build case, the meetings were required by the collaboration addendum as part of the owner’s initiative, focusing on team discussions, performance reviews, conflict resolution, and other relational aspects of the job that are not typically addressed in an open forum. This differed from typical construction team meetings which often focus on daily tasks and coordination topics. Participants typically included project managers and key personnel from the design team, CM firm, design-assist contractors, and the owner as well as the project facilitator (often referred to as the project coach). Specific topics of conversations included reading materials brought by the coach, the team’s latest challenges, the latest data results as presented by the research team, and the project’s overall collaborative environment.

The target team’s collaboration document did not mandate such meetings. Consequently, the researcher instead participated in meetings held on a weekly basis for typical coordination purposes. Most of the participants were superintendents or foremen from each of the prime contractors, as well as project managers and key personnel from the other stakeholders. Meetings often centered on the following topics: site safety, coordination issues, pending RFIs and submittals, schedule concerns, and upcoming milestone events. Once the team began participating in team environment and 360 surveys, their data was presented and discussed on a bi-monthly basis during these job conferences. At the conclusion of each meeting, the team joined at the pull-scheduling board to write daily construction tasks, weekly milestones, and weekly goals. This was done as part of the CM’s efforts to improve team relationships through better
transparency and accountability, improve schedule performance through the use of a modified Lean scheduling process, and promote the collaborative initiative through goal-setting.

During the facilitated team’s project meetings, the researcher took detailed notes describing the topics of conversation, the stakeholders involved in each discussion, the relative engagement and participation of the team as a whole, and similar content-oriented details. These meeting notes were tabulated and categorized according to the following criteria: the relative nature of each topic discussed (positive, negative, or neutral), the number of topics involving a single speaker, and the number of topics in which multiple team members participated. Positive discussions were defined as those in which the teams discussed their achievements, or aspects of the job that were working well (both project and team-related). Negative discussions included aspects of the team or the overall project that were not working as well as expected, or when pending issues needed to be addressed or rectified. Neutral discussions were all those related to coordination, updates, and mostly objective topics. Table 4-18 contains a sample of meeting observations from the design-build case. Detailed results will be discussed in Chapter 5.

Table 4-18: Sample of design-build case’s meeting observations.

<table>
<thead>
<tr>
<th>INTERACTIONS</th>
<th>NOVEMBER 8TH 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Individual-Led Discussions</td>
</tr>
<tr>
<td><strong>POSITIVE TOPICS</strong></td>
<td>Team environment survey participation has been very strong lately</td>
</tr>
<tr>
<td><strong>NEGATIVE TOPICS</strong></td>
<td>Team Environment survey discussion: all of the metrics have decreased from the July/August 2012 survey to the September survey results</td>
</tr>
<tr>
<td><strong>NEUTRAL TOPICS</strong></td>
<td>Short video clip was shown about the &quot;process of innovation&quot; within the workplace</td>
</tr>
</tbody>
</table>
4.2.9 Results: Semi-structured Interviews

19 semi-structured interviews were conducted towards the end of the data collection period, including nine from the DB case, nine from the target case, and a consultant who coached on one of the owner’s previous jobs. The DB team’s project coach was closely involved with this study since its inception. To avoid a conflict of interest, the researcher did not include this interviewee’s responses as part of the collected data. Instead, the interview was used to refine the researcher’s questions as a pilot process, based on the coach’s feedback.

All project team members were eligible for interview participation. Team members directly involved with their project’s daily tasks and interactions, as well as those that actively participated in the team meetings and periodic surveys were targeted first. All four stakeholder groups on both facilitated projects were represented by at least one interviewee.

The researcher developed a standard questionnaire for project stakeholders and another for project coaches. A few of the questions were altered to the specific circumstances of each project, but most were identical for both project teams. Interviewees were led through each question while being audio-recorded, after written permission was obtained, as the researcher took notes. These notes were later clarified and elaborated based on the audio-recorded responses. Lastly, the notes were organized in a table according to the interviewees’ roles, stakeholder group, and project. Individuals’ names were replaced with designations that reflected their roles on the project, without revealing their exact identity. For example, the first interviewee from the CM on the design-build case was renamed as “CM1” and the first interviewee from the design team was renamed “AE1”. A sample of the interview questions and responses is shown below in Table 4-19. Results will be further discussed in Chapter 5.
Table 4-19: Sample of semi-structured interview responses from the design-build case.

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>INTERVIEWEE</th>
<th>1. Who is on the core project team that you typically interact with?</th>
<th>2. Does this project differ from &quot;typical&quot; projects in terms of team interactions? If so, how?</th>
<th>3. Has collocation affected how you work on this project? If so, how?</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESIGN-BUILD</td>
<td>CM1</td>
<td>The design team and contractors; virtually all PM's and superintendents</td>
<td>It is different; communication is more streamlined; not a forced marriage because it's a design-build project; team members can be selected based on prequalification; having good contractors makes a big difference; change order negotiation is more reasonable than usual as well as pay applications; innovation is enabled because there's more communication; having experienced owner representatives onsite is different, even for this particular owner; also, major issues have been resolved with contingency funds first, so there are fewer major change orders</td>
<td>Collocation has affected work; seeing most of the key players every day makes a big difference; it improves relationships and makes it easier to identify and &quot;put a face&quot; to the person you're dealing with, which makes conflicts less likely; sometimes it could be better to have individual/isolated spaces to get work done because there are so many people together in the shared office space; collocation improves and increases overall communication, especially internally (within the core project team)</td>
</tr>
</tbody>
</table>

4.3 Data Collection Summary

This chapter provided background information of the three case studies, including the selection process and the developing nature of the owner’s collaboration initiative. Data sources were described, and sample data results were summarized for each case in order of expectations: the historical case (standard expectations), the design-build case (high expectations), and the target case (above-average potential).
Chapter 5

DATA ANALYSIS AND DISCUSSION

5.1 Introduction: Data Analysis and Discussion

As discussed in Chapter 3, the goal of this study is to understand how formal collaborative efforts relate to team and project performance outcomes. Exploratory case studies were used to define an owner’s expectations on a typical construction project, and determine whether two teams with formalized team-building efforts outperformed those expectations. A combination of project outcomes, team surveys, correspondence data, meeting observations, and individual interviews were used to analyze project performance, team performance, and the value of the collaboration initiative.

This chapter will analyze each data type in the following order: metrics indicating project-level success, metric indicating team-level success, and metrics that can potentially indicate both. Each data type is divided into three sections: defining success, performance analysis, and conclusions. The first section outlines the criteria used to determine project or relational success based on a particular data type. In section 5.2, the first example, the researcher defines the criteria used to indicate whether, according to cost and schedule performance, each project could be considered successful. The second section, performance analysis, examines the given data to identify trends and underlying contributors. The third section, conclusions, applies the insight gained through the performance analysis to the success criteria to determine how the projects’ success compared and, potentially, discuss why. For each data type, results will introduce the historical case, then the design-build case, and finally the target case.

5.2 Cost and Schedule Performance

For each case, the researcher collected the total project costs for both design and construction as originally contracted. As a completed project, final costs for the historical project were available from the CM. For both incomplete facilitated projects, the researcher relied on the CM’s most recent cost projections to determine whether the final costs currently differed from the original contract costs.
Similarly, start dates for construction were obtained from the CM for all three projects; the actual completion date was used for the historical project, and projected completion dates were used for the facilitated cases. Cost and schedule growth are two of the most used project performance metrics in AEC research, and were therefore used to situate the facilitated projects’ success relative to the historical project.

5.2.1 Defining Project Success: Cost and Schedule Performance

Within their collaboration initiatives, neither facilitated team prescribed methods for reducing project costs through team-based activities. Instead, the consensus was that by focusing on relationships, the teams would be enabled to outperform typical projects and produce better outcomes. Open communication and proactive problem solving, for instance, could lead to fewer mistakes affecting cost and schedule performance. The historical project’s cost and schedule growth were thus used as minimum expectations for the facilitated teams. The following questions were used to understand project-level success based on cost and schedule metrics:

1. Based on the most recent projections, how did the facilitated projects’ cost growth compare to the historical project?
2. How do the projects compare in terms of schedule growth?
3. What were the primary reasons behind each project’s performance, and were there any consistencies across all projects?

5.2.2 Analysis: Cost and Schedule Performance

Table 4-16 in the Data Collection chapter summarized each project’s cost and schedule performance. The historical project had 15.7% cost growth, rising from $41.50M to $48.00M. The construction management firm cited two primary reasons for the increased costs: owner-directed changes and a lack of detailed bid documents for HVAC systems. Schedule delays of approximately two months, equating to 6.2% schedule growth, were attributed to prolonged subcontractor buyout, means and methods issues, and field issues with certain specialty trades.
The design-build project was projected to have an 8.1% cost growth, increasing from $82.07M to $88.70M. The CM stated that most of the increased costs came from owner-directed changes, including roughly $5M to renovate a commons area not included in the original scope. According to the same source, the team aggressively priced change orders affecting multiple buildings to minimize the cost impacts. Since the renovations in each building were very similar, the design team, CM, and owner worked together to anticipate changes for the last few phases to limit further cost growth. The project was also anticipated to finish on the original contractual end date, with zero schedule growth. Permit delays, structural issues, and other factors could have inflated the schedule, but the team managed to meet its occupancy deadlines.

Lastly, the target project saw costs increase by 11.2% from $39.57M to $44.00M. Owner-directed changes and unforeseen changes due to existing conditions were the major contributors. At the conclusion of the researcher’s data collection, the project was projected to be seven days behind schedule for a total growth of 1.2%. Issues with site utilities were cited as the main reason, although funding was delayed prior to the start of construction as well as severe winter weather conditions. The CM noted that the team’s proactive pull-scheduling, which involved setting weekly goals and activities to ensure that prime contractors were following the correct sequences, enabled them to manage delays and minimize schedule growth.

5.2.3 Conclusions: Cost and Schedule Performance

1. Both facilitated projects had less projected cost growth than the historical benchmark. Where cost growth was noted it was from unforeseen conditions or owner, value adding, change orders that increased the project scope. However, the substantial amount of remaining work leaves some opportunity for further cost growth.

2. Both facilitated projects had encouraging schedule performance, with multiple setbacks amounting to no more than a seven-day delay. Both projects had recovered from initial delays to the planned construction start dates. As with cost performance, the facilitated projects’
schedule performance could ultimately change. The facilitated projects’ projected schedule growth was less than the historical project’s actual schedule growth.

3. Owner-directed changes were the most frequently-cited cause of cost growth in all three cases, with potential for further owner directed changes on both projects. Schedule performance factors ranged from delayed funding and buyout to field-specific issues.

The success criteria showed that both facilitated projects were on pace to outperform the historical project’s benchmarks. Still, it is important to acknowledge that the projected outcomes were not directly comparable to the historical projects outcomes due to the amount of construction remaining and the potential for improvements or setbacks. Additionally, numerous factors beyond the scope of collaboration-oriented management can contribute to cost and schedule growth. Without an in-depth analysis of the underlying performance factors and how they relate to the collaboration initiative, the conclusions are more indicative than absolute.

5.3 Team Environment Surveys

Team environment surveys were used to portray relational performance and progress over the course of the facilitated projects. A 0-5 Likert scale provided granularity to allow the teams to be more specific with their evaluations. Each question involved a separate relational metric, such as communication or timeliness. Neither facilitated team set specific goals for survey performance since the intent of the surveys was more about identifying issues through self-assessment and less about attaining certain numerical values. The DB team, during one month’s discussion, agreed, however, that 4/5 was a more appropriate target since 5/5 implied perfection.

As a completed project, the historical case did not provide opportunities for periodic team environment surveys. A single “Benchmark Survey” was completed at the beginning of the project under the direction of a hired consultant. This survey was not intended to describe the current state of the team, as with the researcher’s surveys, but instead created a snapshot of the team members’ past experiences and expectations. Still, valid comparisons can be made: five of the eight benchmark questions mirrored
those of the team environment surveys. Additionally, since the facilitated teams were highly unlikely to assign a 0/5 rating to any particular metric (which would suggest that there was a complete lack of cooperation, respect, etc.), the benchmark survey’s 1-5 Likert scale was functionally the same as the researcher’s 0-5 scale.

5.3.1 Defining Relational Success: Team Environment Survey Performance

Based on the characteristics of the survey data, the researcher developed the following questions to indicate each team’s relational performance:

1. Based on the 0-5 Likert scale, which ratings were the most common across all metrics?
2. How often did ratings fluctuate per metric, and to what extent did they fluctuate?
3. Did ratings generally increase or decrease over the survey periods?

5.3.2 Analysis: Team Environment Survey Performance

The historical case’s benchmark survey results were based on prior experiences in the AEC industry, the same relational results could be expected of the team itself. The lack of a collaboration agreement, formal team initiatives, or coaching (beyond a single partnering session) further demonstrate that there was no effort focused on team development to expect above-average relational performance from the historical team.

Table 5-1 shows how the historical team’s only survey results compared to the facilitated teams’ lowest ratings. The five metrics shown represent the survey questions that were most similar amongst the two different surveys. In each of the five metrics, the facilitated teams’ lowest average ratings were higher than those of the historical team. The DB team’s individual metric ratings were 9.4 % to 33.3 % higher than the historical benchmarks; the target team performed similarly at 7.2 % to 25.3% above the benchmarks.
Table 5-1: Benchmark Survey versus Team Environment Survey Results.

<table>
<thead>
<tr>
<th>Project</th>
<th>Communication</th>
<th>Cooperation</th>
<th>Accountability</th>
<th>Response Timeliness</th>
<th>Acknowledgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Historical Project: Benchmark Survey Results</td>
<td>3.30</td>
<td>3.40</td>
<td>3.40</td>
<td>3.20</td>
<td>3.00</td>
</tr>
<tr>
<td>DB Project: Lowest Rating per Metric</td>
<td>4.08</td>
<td>4.00</td>
<td>4.00</td>
<td>3.50</td>
<td>4.00</td>
</tr>
<tr>
<td>Target Project: Lowest Rating per Metric</td>
<td>3.82</td>
<td>3.82</td>
<td>3.76</td>
<td>3.43</td>
<td>3.76</td>
</tr>
<tr>
<td>Percent Difference: Historical vs. DB Project</td>
<td>23.6%</td>
<td>17.6%</td>
<td>17.6%</td>
<td>9.4%</td>
<td>33.3%</td>
</tr>
<tr>
<td>Percent Difference: Historical vs. Target Project</td>
<td>15.8%</td>
<td>12.4%</td>
<td>10.6%</td>
<td>7.2%</td>
<td>25.3%</td>
</tr>
</tbody>
</table>

The historical team’s benchmark ratings, due to the lack of formal collaboration initiatives, defined the minimum threshold for the facilitated teams’ communication, cooperation, accountability, response timeliness, and problem acknowledgement. Since the facilitated teams’ lowest ratings were higher than the benchmarks, the comparisons suggest that the facilitated teams exceeded their minimum expectations. The historical team’s behaviors presumably changed over the course of their project, so a single benchmark survey cannot show such project-wide differences. Still, the results shown in Table 5-1 suggest that even the facilitated teams’ worst relational assessments were above industry expectations.

To better understand the extent of the two facilitated teams’ relational success it was necessary to directly compare their team environment results. For the purposes of this study, project timelines were defined as the beginning of the RFI and submittal review processes (near the beginning of construction) to the end of construction. According to these timelines, data was collected over approximately three quarters of the DB project duration and one half of the target project duration.
Table 5-2: Team Environment survey results: DB versus Target project.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>1st Survey</th>
<th>2nd Survey</th>
<th>3rd Survey</th>
<th>4th Survey</th>
<th>5th Survey</th>
<th>Average per Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DB: Teamwork</strong></td>
<td>4.45</td>
<td>4.33</td>
<td>4.13</td>
<td>4.50</td>
<td>4.33</td>
<td>4.35</td>
</tr>
<tr>
<td>Target: Teamwork</td>
<td>3.76</td>
<td>3.86</td>
<td>4.42</td>
<td>4.78</td>
<td></td>
<td>4.20</td>
</tr>
<tr>
<td><strong>DB: Respect</strong></td>
<td>4.55</td>
<td>4.08</td>
<td>4.00</td>
<td>4.63</td>
<td>4.33</td>
<td>4.32</td>
</tr>
<tr>
<td>Target: Respect</td>
<td>4.06</td>
<td>4.07</td>
<td>4.42</td>
<td>4.78</td>
<td></td>
<td>4.33</td>
</tr>
<tr>
<td><strong>DB: Communication</strong></td>
<td>4.36</td>
<td>4.08</td>
<td>4.25</td>
<td>4.38</td>
<td>4.22</td>
<td>4.26</td>
</tr>
<tr>
<td>Target: Communication</td>
<td>3.82</td>
<td>3.86</td>
<td>4.58</td>
<td>4.67</td>
<td></td>
<td>4.23</td>
</tr>
<tr>
<td><strong>DB: Accountability</strong></td>
<td>4.55</td>
<td>4.17</td>
<td>4.25</td>
<td>4.00</td>
<td>4.44</td>
<td>4.28</td>
</tr>
<tr>
<td>Target: Accountability</td>
<td>3.76</td>
<td>3.93</td>
<td>4.50</td>
<td>4.78</td>
<td></td>
<td>4.24</td>
</tr>
<tr>
<td><strong>DB: Acknowledgement</strong></td>
<td>4.55</td>
<td>4.17</td>
<td>4.25</td>
<td>4.13</td>
<td>4.00</td>
<td>4.22</td>
</tr>
<tr>
<td>Target: Acknowledgment</td>
<td>3.76</td>
<td>3.86</td>
<td>4.42</td>
<td>4.89</td>
<td></td>
<td>4.23</td>
</tr>
<tr>
<td><strong>DB: Cooperation</strong></td>
<td>4.27</td>
<td>4.08</td>
<td>4.00</td>
<td>4.13</td>
<td>4.22</td>
<td>4.14</td>
</tr>
<tr>
<td>Target: Cooperation</td>
<td>3.82</td>
<td>4.07</td>
<td>4.75</td>
<td>4.67</td>
<td></td>
<td>4.33</td>
</tr>
<tr>
<td><strong>DB: Trust</strong></td>
<td>4.55</td>
<td>4.00</td>
<td>4.13</td>
<td>4.13</td>
<td>4.22</td>
<td>4.20</td>
</tr>
<tr>
<td>Target: Trust</td>
<td>3.82</td>
<td>3.71</td>
<td>4.42</td>
<td>4.67</td>
<td></td>
<td>4.16</td>
</tr>
<tr>
<td><strong>DB: Timeliness</strong></td>
<td>4.09</td>
<td>3.83</td>
<td>3.75</td>
<td>3.50</td>
<td>3.78</td>
<td>3.79</td>
</tr>
<tr>
<td>Target: Timeliness</td>
<td>3.59</td>
<td>3.43</td>
<td>4.08</td>
<td>4.56</td>
<td></td>
<td>3.91</td>
</tr>
</tbody>
</table>

*Items in red depict the highest average rating per metric across all survey periods.

Table 5-2 shows the average ratings per metric for each survey period. The rightmost column shows the average rating for each metric across all survey periods. Items highlighted in red represent the project with the highest average rating across all survey periods for a particular metric. For instance, the targeted team had a higher overall average rating for timeliness: 3.91. Each team had the highest average rating in four of the eight metrics. Overall, their relational performance according to the team environment surveys was similar with the ratings for each metric never varying by more than 0.19 out of 5.

The heat map in Table 5-2 shows one major distinction amongst the facilitated teams across all metrics. Cells were formatted to be red for the lowest possible rating (0), green for the highest possible rating (5), and yellow for the median possible rating (2.5). The gradual shifts from yellow-green to darker green show that, overall, the target team’s ratings increased from the earliest to the last surveys. The
design-build team’s results were less consistent, starting with higher ratings early on, decreasing towards the middle survey periods, and plateauing towards the latter periods.

To further examine these periodic differences, the researcher calculated the standard deviation (0.15) for the average ratings using the STDEV.P function in Microsoft Excel. This function included all average ratings from both teams to determine how widely the values varied from the average. Average ratings that varied by more than 0.15 were considered to be relatively different, while average ratings that varied by less than 0.15 were relatively similar. Using this logic, only two metrics were relatively different: teamwork and cooperation. The following discussions will focus on these two characteristics.

Figure 5-1 compares the facilitated teams’ cooperation ratings from team environment surveys. Results are stacked vertically to show 100% of all ratings for each survey period; 0-5 ratings are shown in ascending order from top to bottom. The majority of the DB team’s cooperation ratings were fours, with fewer fives and threes. The targeted team consistently had a high percentage of fives. Both results for cooperation reflect the broader project-wide trends: the DB team had variable results, while the target team showed consistent improvement.

![Figure 5-1: Comparison of team environment survey results for cooperation.](image)
Figure 5-2 depicts the team environment results for teamwork. Once again, the DB team results varied over time and the target team gradually improved. In both instances, 4/5 and 5/5 ratings were the most common.

Figure 5-2: Comparison of team environment survey results for teamwork.

5.3.3 Conclusions: Team Environment Survey Performance

Overall, the team environment survey results showed that both facilitated teams had high ratings in key relational areas: the most common ratings were 4/5’s and 5/5’s. Using the historical results to define “average” outcomes, both facilitated teams were above-average. Average ratings per individual metric were noticeably similar as the teams never differed by more than 0.19. Timeliness was consistently the worst-performing metric, indicating that either timely responses were not always prioritized or the formal collaborative efforts were not enough to improve each stakeholder’s internal response processes. Among the two most varying attributes, cooperation and teamwork, the differences occurred towards the middle of the survey periods when the DB team declined while the target team steadily improved. According to the success criteria established in 5.3.1, the DB team was moderately successful and the target team was more successful:

1. In both instances, the two highest possible ratings (4/5 and 5/5) were consistently the most common.
2. The DB team’s ratings fluctuated from an early peak to a decrease towards the middle survey periods, and an increase towards the end. The target team’s individual ratings per metric did not fluctuate, but instead showed steady improvement from the first survey to the last.

3. All of the DB team’s metric ratings declined from the first to final survey period. For the target team, all relational metrics performed better in the last survey than in the first, further indicating steady improvement as the project progressed.

5.4 360 Team Evaluation Surveys

360 surveys contained the same questions and 0-5 rating scale as the team environment surveys. Both surveys served the same basic function: portraying relational performance and progress over the course of the facilitated projects. What distinguished the 360 surveys was the separation of each stakeholder group, meaning four copies of the same survey were completed during each survey period. This allowed members of the construction manager’s organization, for example, to assess members of the design team and vice versa. The differentiation allowed the teams to identify problems with specific teammates and resolve underlying issues. 360 surveys were not distributed on the historical project, limiting the case study comparisons to the facilitated teams.

5.4.1 Defining Relational Success: 360 Team Evaluation Survey Performance

Neither facilitated team had mutually-established goals for 360 survey performance. Again, as part of the initiative, the teams focused more on identifying issues through self-assessments and making appropriate adjustments. Thus, the ultimate goal was not to improve the survey results themselves, but to improve the environment and team dynamics that the results portrayed. The researcher applied the same success criteria for team environment results to 360 results, focusing on individual stakeholders:

1. What were the most common ratings for each stakeholder group?
2. Which stakeholder ratings fluctuated the most, and to what extent?
3. Examining each stakeholder group individually did ratings generally increase or decrease as the projects progressed?
5.4.2 Analysis: 360 Team Evaluation Survey Performance

Since the 360 surveys were distinguished by individual stakeholders, this analysis will focus on group performance. Section 4.2.2 summarized the 360 ratings, and Table 5-3 compares each metric.

Table 5-3: 360 survey results: DB versus Target project.

<table>
<thead>
<tr>
<th>Metrics</th>
<th>1st Survey</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
<th>Average per Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB: Teamwork</td>
<td>4.56</td>
<td>4.21</td>
<td>4.60</td>
<td>4.47</td>
<td>4.21</td>
<td>4.41</td>
</tr>
<tr>
<td>Target: Teamwork</td>
<td>4.21</td>
<td>4.68</td>
<td></td>
<td></td>
<td></td>
<td>4.45</td>
</tr>
<tr>
<td>DB: Respect</td>
<td>4.38</td>
<td>4.11</td>
<td>4.57</td>
<td>4.58</td>
<td>4.11</td>
<td>4.35</td>
</tr>
<tr>
<td>Target: Respect</td>
<td>4.11</td>
<td>4.71</td>
<td></td>
<td></td>
<td></td>
<td>4.41</td>
</tr>
<tr>
<td>DB: Communication</td>
<td>4.47</td>
<td>4.36</td>
<td>4.46</td>
<td>4.37</td>
<td>4.36</td>
<td>4.40</td>
</tr>
<tr>
<td>Target: Communication</td>
<td>4.36</td>
<td>4.62</td>
<td></td>
<td></td>
<td></td>
<td>4.49</td>
</tr>
<tr>
<td>DB: Accountability</td>
<td>4.56</td>
<td>4.18</td>
<td>4.40</td>
<td>4.63</td>
<td>4.18</td>
<td>4.39</td>
</tr>
<tr>
<td>Target: Accountability</td>
<td>4.18</td>
<td>4.56</td>
<td></td>
<td></td>
<td></td>
<td>4.37</td>
</tr>
<tr>
<td>DB: Acknowledgement</td>
<td>4.50</td>
<td>4.29</td>
<td>4.29</td>
<td>4.42</td>
<td>4.29</td>
<td>4.36</td>
</tr>
<tr>
<td>Target: Acknowledgment</td>
<td>4.29</td>
<td>4.38</td>
<td></td>
<td></td>
<td></td>
<td>4.33</td>
</tr>
<tr>
<td>DB: Cooperation</td>
<td>4.44</td>
<td>4.18</td>
<td>4.46</td>
<td>4.58</td>
<td>4.18</td>
<td>4.37</td>
</tr>
<tr>
<td>Target: Cooperation</td>
<td>4.18</td>
<td>4.65</td>
<td></td>
<td></td>
<td></td>
<td>4.41</td>
</tr>
<tr>
<td>DB: Trust</td>
<td>4.50</td>
<td>4.07</td>
<td>4.49</td>
<td>4.53</td>
<td>4.07</td>
<td>4.33</td>
</tr>
<tr>
<td>Target: Trust</td>
<td>4.07</td>
<td>4.53</td>
<td></td>
<td></td>
<td></td>
<td>4.30</td>
</tr>
<tr>
<td>DB: Timeliness</td>
<td>4.06</td>
<td>3.96</td>
<td>4.17</td>
<td>3.84</td>
<td>3.96</td>
<td>4.00</td>
</tr>
<tr>
<td>Target: Timeliness</td>
<td>3.96</td>
<td>4.12</td>
<td></td>
<td></td>
<td></td>
<td>4.04</td>
</tr>
</tbody>
</table>

*Items in red depict the highest average rating per metric across all survey periods.

Standard deviation for the average ratings was 0.13. The two most varied metrics, communication (difference of 0.09) and respect (0.06) were further examined.
Figure 5-3 shows the 360 survey results for respect. The targeted team completed two 360 surveys, making it impractical to identify fluctuations and long-term trends. Still, their results followed the same basic trend as their team environment results, showing improvement from the first to last survey period as 5/5’s became more frequent. The DB team was as cyclical as their other survey results, except the team environment results declined towards the middle survey periods and the 360 results improved over the same periods. For both teams, 4/5 and 5/5 ratings were the most common.

Figure 5-4: Comparison of 360 survey results for communication.
Figure 5-4 shows the 360 results for communication. For the first time, the design-build team showed fairly steady results across all survey periods. This suggests that stakeholder communication was least affected by the events and circumstances that caused the other metrics to rise and fall. Trust, on the other hand, was more susceptible to such events and circumstances as shown in Figure 5-3. Once again, the targeted team’s results were limited to only two survey periods. Communication improved from the first to last surveys, and the percentage of 4/5 and 5/5 ratings were comparable to those of the DB team.

360 survey results for respect and communication were further analyzed to identify the stakeholders most connected to the fluctuations. The target team did not have sufficient survey results to isolate such fluctuations, thus only the DB team is shown in Figure 5-5. Scales ranged from 3/5 to 5/5 to emphasize the oscillations. In terms of communication, all four stakeholders remained fairly consistent, though the CM varied the most. In the results for respect, the CM was clearly the most sensitive stakeholder. Thus, the circumstances that led to the team’s early rating decreases may have been related to the CM.

5.4.3 Conclusions: 360 Team Evaluation Survey Performance

The 360 survey results further indicated that the design-build team’s behaviors and relational performance varied over the course of the project. Certain attributes, such as communication, were less varied and thus less affected by outside factors. Respect and other attributes were more vulnerable to
those same factors. Although these factors were clearly present in the CM’s ratings, the survey results did not identify them.

For the targeted project, the 360 results reinforced the team environment results’ indications: relational performance gradually improved over the course of the surveys. Ratings of 4/5 and 5/5 were the most common for both teams, suggesting that neither cited any overtly problematic attributes or issues. However, these results alone were not enough to verify that there were no significant problems. The success criteria for 360 surveys led to the following conclusions:

1. On the design-build and target project, 4/5 and 5/5 were the most common survey ratings for all stakeholders.

2. Based on average ratings, the facilitated teams were most distinguished in terms of communication and respect. Within the DB team, communication was relatively consistent while trust fluctuated considerably. For the target team, both metrics were stable and increased from the first to last survey period.

3. The DB team’s stakeholder results showed that contractor and CM ratings generally decreased from the early to latter surveys across all metrics; owner and A/E ratings increased to a lesser extent. For the target team, contractor, designer, and owner results improved for most of the metrics.

5.5 RFI Performance

Request for Information (RFI) logs were obtained from each team’s construction management firm. RFIs were organized by the project month in which they were resolved, and by their review durations in workdays. This information measured relational performance by showing whether the teams needed frequent design and construction clarifications, thus indicating relative cohesion. Review durations showed whether such clarifications were promptly dealt with, indicating how efficiently teams communicated.
5.5.1 Defining Relational Success: RFI Performance

RFI performance was analyzed according to the DB team’s original goal: to resolve 90% of all RFIs within three workdays. However, this figure was likely set as an ambitious goal and not as a benchmark for minimum expectations. RFI performance, much like the survey results, was intended to be a motivator, conversation-starter, and self-assessment tool.

No goals were set in terms of accumulation rates or total project RFIs. Of the three case studies, the historical case most resembled the owner’s “typical” construction project. Once again, the historical team’s total RFIs and accumulation rates were used as minimum expectations for the facilitated teams. Thus, relational success in terms of RFIs was defined by these questions:

1. How closely did the teams’ 3-day review performance approach the 90% goal?
2. How quickly did the facilitated teams’ RFIs accumulate, relative to the historical team?
3. Based on appropriate projections, how many total RFIs would the facilitated teams have by the end of construction? How do they compare to the historical team?

5.5.2 Analysis: RFI Performance

Section 4.2.3 highlighted the critical RFI data. The historical team set a fairly low precedence for RFI responses with only 27.6% resolved within three days. The DB team more than doubled this value, with 55.8%. Contrary to expectations, only 16.8% of the target team’s RFIs were answered within three days. Neither team achieved the 90% goal. The historical and targeted team had comparable results in the 4-day, 5-day, 6-day, and greater-than-6-day durations, suggesting that the two similar teams did not change behaviors and communication processes from the first project to the second.

Table 4-13 in Chapter 4 showed that the facilitated teams had fewer RFIs than the historical team. However, since the facilitated teams are still ongoing, the final outcomes have yet to be determined. Table 4-13 also showed that in terms of RFI accumulation rates, the historical project set expectations at 0.75 RFIs per workday, the DB team was slightly higher at 0.79, and the target team was lower at 0.65. These rates were calculated by dividing the total number of RFIs by the total number of completed workdays as...
of March 2014 (when RFI data collection ended). Thus, a lower rate would equate to fewer RFIs per workday, indicating that less clarifications were needed in the field.

Figure 5-6 further details how the teams performed. Project durations were split into four quarters starting from the first month that RFIs and submittals were processed, and ending at the completion of construction. Construction end dates were based on projections for the facilitated projects and actual dates on the historical project. In the figure below, the “quarters” of the project timelines are distributed from left to right per review duration. For instance, in the DB team’s data on the left, the bars show the percentage of RFIs resolved within three days in the first quarter, second quarter, third quarter, and the totals for the entire project. Since the ongoing projects’ have not yet begun their fourth quarters, those bars were omitted.

![Image of bar chart showing RFI review durations per project “quarter.”]

Approximately one-fourth of the historical team’s RFIs were resolved within three days, but most required six days or more. The design-build team’s results were more concentrated on the two shortest durations: three days or less and four days. Focusing on the durations alone, the target team and historical team were not clearly differentiated: in both cases, the shortest and longest durations measured (three days or less, and greater than 6 days) were the most prevalent. Quarterly results, however, made the differences more discernible. The target team had many 3-day reviews in the first quarter, but the second
and third quarters saw an increase in the longer durations and a decrease in the shorter durations. The target team required more time to review RFIs as the project progressed, whereas the historical team gradually needed less time.

RFI response timeliness is further visualized in Figure 5-7. Two lines were plotted for each project: one for RFI creation dates (left side) and one for resolution dates (right side). On the graph, the horizontal distance between each pair of creation and resolution lines is the review duration for a given RFI. The projects’ differences are apparent. The historical results show wide gaps between the created and resolved dates, especially in the first half of the project. In the design-build results, the two lines are very closely aligned meaning most RFIs were promptly resolved. The target results show some separation between the created and resolved dates, especially towards the latter end of the project, but not to the extent of the historical project.

![RFI Review Durations](image)

Figure 5-7: RFI review durations versus project timelines.
5.5.3 Conclusions: RFI Performance

RFI performance indicated relational success that aligned with the study’s expectations: the historical team set average expectations, the DB team exceeded them, and the target team outperformed them to some degree. The following conclusions were based on the aforementioned RFI success criteria:

1. Neither team came close to resolving 90% of all RFIs within three days. At just under 60%, the DB team was closest yet still was only two-thirds of the goal. The historical team’s delayed responses might have indicated faulty communication, or might have been the result of process changes that allowed the facilitated teams to close RFIs much quicker. Quantitative results alone could not determine this.

2. The target team had the lowest accumulation rate at 0.65 RFIs per completed workday, followed by the historical team (0.75) and the design-build team (0.79).

3. According to the researcher’s previously-defined project quarters, data was collected on approximately three-fourths of the DB project and one-half of the target projects. Extrapolating from the collected data, the DB project was on pace to finish with 551 RFIs and the target project with 392. While both projections are lower than the historical team’s total of 560, they are estimations. RFIs are more common towards project commencement, when team members are still acclimating to the design documents and more clarifications are needed.

5.6 Submittal Performance

RFIs were used to explain relational performance because they indicate how timely each team communicated and how frequently clarifications were needed between individual team members. Submittal performance also indicates communication habits and was used to describe both team and project-level performance. Submittals define functional and aesthetic requirements. As a quality control measure, approved submittals are meant to guarantee that the finished product will conform to the designer’s specifications, thus indicating project success.
5.6.1 Defining Success: Submittal Performance

Within its collaboration charter, the DB team established the following goal for submittal performance: 90% of all submittals should be approved within 10 workdays of reaching the design team. As with previous data metrics, the researcher applied this goal to all three cases to create consistent comparisons. The following criteria were used to assess each project’s submittal performance:

1. How closely did the teams’ 10-day submittal performance approach the 90% goal?
2. Which review durations were most prevalent on each project?
3. Relative to each project’s timeline, when were most submittals resolved?

5.6.2 Analysis: Submittal Performance

As with RFIs, submittal data was split into four quarters starting from the first month that RFIs and submittals were reviewed (whichever was first), and terminating at the end of construction. A total of seven review durations were used to determine how quickly submittals were approved and returned to the CM: 10 workdays or less, 11 days, 12 days, 13 days, 14 days, 15 days, and greater than 15 days. All submittals marked “Approved” or “Approved as Noted” were aggregated as approved for the purpose of this study. Submittals marked as “Rejected” or “Revise and Resubmit” were grouped together, regardless of the review duration. All other submittals, including those marked as “No Action Taken” or “NAT,” were omitted from the collected data.

Chapter 4 summarized the submittal results. Below, Figure 5-8 shows that the historical team required more than 15 workdays to approve most submittals, and a substantial percentage were rejected altogether. Most of the DB team’s submittals were approved within the targeted 10 days and very few rejected. The target project had a substantial percentage of 10-day submittals; both 15-day and rejected submittals were less common than the historical team, but more common than the DB team.
Figure 5-8: Quarterly Submittal review durations, by percentage.

Figure 5-9: Approved Submittal review durations versus project timelines.

Figure 5-9 shows the start and end dates for all approved submittals. As with RFI, horizontal distances between each pair of lines represent review durations. Both facilitated projects had more approved submittals than the historical project even though they were still under construction. For the
historical team, review durations were noticeably wide across the entire project timeline. The DB team’s submittals, with the exception of a few outliers, had very closely aligned start and end dates. The target team had comparably short durations, although they increased towards the end of the timeline. In terms of accumulation, the historical and design-build projects had similar curves denoting steady accumulation. Contrastingly, the target project had very slow accumulation early on followed by rapid accumulation later.

5.6.3 Conclusions: Submittal Performance

The facilitated teams’ greater number of approved submittals was a prominent difference. The historical team might have used a different method for grouping multiple submittals, or the facilitated projects might have simply required more individual submittals. The quantitative data alone could not explain this difference. Based on the established success criteria, the following conclusions were made:

1. As with RFIs, neither team achieved the 90% goal for approved submittals. The design-build had the most quickly-approved submittals and the fewest rejected submittals, followed by the target team and the historical team.

2. For the facilitated teams, most approved submittals were returned within 10 workdays; the historical team required more than 15 days for most.

3. The historical and DB teams had similar, steady accumulation rates while the target team saw a rapid increase in submittals over several months.

5.7 Collaboration Document Reviews

Section 4.2.6 of the data collection chapter discussed how collaboration-specific contract documents were evaluated and categorized according to their content. The historical team did not incorporate such a document; hence meeting minutes from an early partnering session were analyzed instead. These reviews were not intended to provide strict standards for relational or project-level success. Instead, they were meant to contextualize the effectiveness of each team’s efforts based on the goals, requirements, and conditions they created for their own collaboration initiatives. Each team’s agreement
was created for a different purpose. Depending on what they aspired to achieve, their collaboration documents might define team success, project success, both, or neither.

5.7.1 Defining Success: Collaboration Documents

The following questions were used to contextualize each team’s formal collaborative efforts, based on the contents of their agreements:

1. By establishing a collaboration agreement and participating in the owner’s initiatives, did each team aim to improve relational performance, project outcomes, or both?
2. What were the common themes amongst the collaboration documents?
3. Did the teams typically abide by their own terms and requirements?

5.7.2 Analysis: Collaboration Documents

The collaboration documents’ contents were organized accordingly: document type and length, document developers versus participants in the initiative, general goals and objectives, team requirements (and whether they were fulfilled), key concepts, performance metrics and categories, suggested tools, consequences for non-compliance, team meeting characteristics, and additional terms. Participation was fairly consistent across the three teams. The historical team did not develop a collaboration agreement, but representatives from all four stakeholders participated in the partnering session. For the DB project, all four stakeholders contributed to the collaboration document and participated in the initiative. All stakeholders participated in the target team’s initiative, but the contractors were not involved in the document’s development.

Team goals and objectives were similarly consistent. The historical team emphasized broad goals such as safety, finished quality, and supporting the owner’s mission; relational objectives included “reasonable foresight, honed communication, and fair decision-making.” The DB team’s collaboration document combined project-wide goals, such as improving indoor environmental quality and producing defect-free work, with relational aspirations like continuous improvement and promoting a “creative learning environment.” Goals and objectives for the target team were primarily relational: enabling open
communication, aligning key personnel and decision-makers through collocation, ensuring real-time problem solving, and creating an informal partnership. Overall, the DB collaboration document had the most comprehensive list of goals and objectives.

Team requirements further distinguished the collaboration documents. The historical team members agreed to participate in the benchmark survey, complete “expectation matrices” to align individual needs and promises, and complete DISC (dominance, inducement, submission, and compliance) personality tests. All three tasks were completed prior to the partnering session, with results reviewed during the meeting. Thus, the historical team’s efforts were more focused on a single consultation than on long-term ambitions and commitments. Of the two long-term requirements established, one was not adhered - no follow-up surveys were completed. The researcher could not any evidence to suggest that the second required tool (using a matrix-like problem solving process) was used beyond the partnering session.

Collaboration requirements for the design-build team were more widespread. Of the 20 requirements identified in the collaboration charter, the researcher found that 13 mostly task-based requirements were satisfied. These included establishing collaboration-specific meetings, using processes similar to target value design and pull scheduling, and establishing project team communication procedures. Three of the 20 requirements were based on relational functions like cooperation, promoting harmony, and sharing ideas, which were subjective therefore challenging to be deemed “satisfied” or not. The four remaining requirements were unsatisfied, mostly due to the exclusion of the shared savings program and related changes that were made.

The researcher identified eight requirements in the targeted team’s collaboration document. All eight were considered to be task-based, although one mentioned that team members should collaborate during project meetings. Specific mandates included the use of the shared trailer, the designation of the CM as the project coach and coordination leader, and the use of pull planning techniques. Contractors were required to move their staff into the shared trailer within 10 days of contract award; this was the only condition that was not met exactly as stated, as nearly all of the contractors moved in, though after
10 days. Additionally, contractors were to assign management-level staff to the trailer to ensure proper decision-making authority, but one contractor assigned an intern.

All three documents had similar relational concepts and themes: teamwork, interpersonal skills, communication, and collaboration were strongly emphasized. Each document combined broad team-based concepts with everyday tasks and requirements, presumably to align the end goal (efficient, cohesive teams) with the means to achieve that goal. Performance categories were not mentioned in the historical team’s document, but were closely aligned within both facilitated teams: safety, workmanship, cost, schedule, and team performance.

Since the historical team did not have any formal collaborative efforts beyond an initial partnering session, they did not have terms for non-compliance. In both facilitated teams’ documents, non-participants could be penalized financially. For the DB team, participants that deviated from the agreed upon work sequences would be liable for the associated rework and additional costs. The target team agreed that the owner could remove any non-participating team members from the job, or assign monetary fines.

5.7.3  **Conclusions: Collaboration Document Analysis**

1. All three teams emphasized relational performance more than achieving specific project outcomes. Their collaboration agreements centered on improving group relationships and dynamics, with the inference that such improvements could lead to better project outcomes.
2. Collaboration, teamwork, reliable commitments, communicative environments, and Lean construction practices were the most common concepts amongst the documents.
3. The historical team did not continue its team-building efforts throughout the course of their project. The facilitated teams abided by most of their own functional requirements.

5.8  **Meeting Observations**

Meeting observations allowed the researcher to determine whether the facilitated teams’ behaviors gradually changed as a result of their efforts. Since the historical project was already
completed, there were no opportunities to observe meeting behaviors. On the design-build project, the researcher joined meetings reserved specifically for team-building purposes. The target team had fairly typical job conferences focused on coordination issues, although time was reserved for some interpersonal discussions. Through their discussions of recently collected data, the facilitated teams addressed whether their collective efforts were affecting costs, deadlines, quality, or other project-level outcomes.

5.8.1 Defining Success: Meeting Observations

Observations were exploratory since the owner had no completed facilitated projects to reference. Thus, there were no specific expectations for team behaviors during team-oriented meetings. It was therefore impractical to determine whether each team behaved “successfully” during such meetings. Instead, the criteria below were used to contextualize how teams reacted to the collaboration initiative and whether interactions evolved over time. The observations could potentially define team and project-level success, depending on the contents of the conversations:

1. In terms of participation and topics of conversation, which types of interactions were most common?
2. How do each team’s first and last meetings compare?
3. How did the teams’ discussions indicate the value of the collaboration initiative?

5.8.2 Analysis: Meeting Observations

Figure 5-10 shows the total number of positive, neutral, and negative topics per observed meeting as defined in the methodology chapter. The values shown include all topics, regardless of whether they were individual-led or group discussions. Although the DB project began construction before the target project, collaboration-specific meetings were more sporadic due to schedule conflicts. Consequently, five meeting observations were made over a period of 18 months whereas on the target project, eight observations were made over seven months. These meetings occurred during the construction phase when all four stakeholders were actively involved with their respective jobs. The following analyses will focus on the design-build team first, followed by the target team.
The DB team’s collaboration charter mandated team-building meetings. These were led by the project coach and typically focused on current industry issues, recent survey and communication data results, and stakeholder concerns. Since the meetings were held specifically for relational purposes (as opposed to coordination or project updates), team members were generally more likely to engage in interpersonal dialogue. They were also more willing to discuss the efficacy of their ongoing collaborative efforts.

Group discussions were more common than single-person discussions. The coach often started the interactions by introducing a particular subject, such as the team’s latest submittal results, which then generated feedback. Since most interactions began very broadly, participants could add their input without waiting to be asked directly.

Figure 5-10 shows that most of the DB team’s interactions involved neutral topics, with slightly fewer positives and much fewer negatives. Neutral topics included opinions, responses to other team members’ remarks, anecdotes from previous experiences, and reviews of industry issues. Positive topics consisted of recent successes (generally, or in terms of the data results collected), and beneficial team efforts. Negative topics included declining metric performance and current obstacles.

![Figure 5-10: Comparison of positive, neutral, and negative topics per meeting.](image)

On the target case, discussions were often driven by the CM staff asking for the contractors’ opinions on relational topics. For instance, contractors were often asked about the benefits and
shortcomings of the overall initiative. The first observed meetings included general skepticism, especially since some contractors agreed that the historical project had been relatively successful without formal collaboration. In subsequent meetings, participants hesitated to directly answer questions regarding the efficacy or need for formal collaboration.

Individual-led discussions were the most common during the target team’s meetings, which was somewhat expected since the CM coordinated and led them. Group discussions were more common in the latter meetings as the CM encouraged contractor participation and, presumably, as they became more comfortable contributing. Meeting notes showed that even in the latter conferences, the contractors mostly joined conversations after their scopes became involved.

The majority of the targeted team’s discussions involved neutral and positive topics, as shown in Figure 5-10. Neutral topics primarily included coordination, updates and upcoming events, and reviews of the latest issues in Autodesk BIM 360. Positive topics included safety performance, the effectiveness of the team’s efforts, and collectively setting short-term goals and commitments at the pull-planning boards. Negative topics included reoccurring safety issues, unresolved coordination, and specific field concerns.

5.8.3 Conclusions: Meeting Observations

1. Most of the DB team’s interactions involved multiple team members; most of the target team’s interactions involved a single person, although group discussions increased as the project progressed. In regards to content, positive and neutral topics were the most common in both cases. The design-build team had more neutral topics and the target team had more positive topics overall.

2. The DB team’s first observed meeting centered on the latest survey rating declines and a video about workplace innovation. In the final meeting, team members openly debated broad topics about the industry, Integrated Project Delivery, and the need for team metrics. The target team’s first observed meeting had sparse contractor participation and primarily focused on raising awareness about the latest issues. In the final observed meeting, the target team had
more collective participation, discussed recent successes, and made commitments and compromises to each other.

3. The DB team frequently discussed how the metrics, particularly the surveys, allowed them to identify underlying problems and deal with them in an open environment. When asked to speak about the collaboration initiative, the target team was typically skeptical or nonresponsive.

5.9 Semi-structured Interviews

Semi-structured interviews were conducted to identify individual perceptions of the collaboration initiative: its effectiveness, deficiencies, and overall value. Interviews were structured so as to avoid simply asking the three research questions, which could have unduly influenced the responses. Instead, the questions were broad enough to allow the respondents to elaborate on their own. This allowed the themes of the research questions (i.e. the effects of the initiative on project outcomes and relational performance, and the initiative’s overall value) to be mentioned only if the interviewees felt that they were applicable. Interview responses could therefore define project success and team success.

5.9.1 Defining Success: Semi-structured Interviews

The criteria below tied the responses to the study’s research questions:

1. What was the consensus regarding the initiative’s effects on project outcomes?
2. What was the consensus about its effects on behaviors and relational performance?
3. What was the consensus about the overall value of the team’s formal collaborative efforts?

5.9.2 Analysis: Project Coaches’ Interview Responses

Of all of the institutional owner’s ongoing projects, there were four active coaches at the commencement of this study. All four were contacted for potential interviews and three responded. Of the three, one of the interviews was omitted from the collected data due to the coach’s close involvement in this study and the potential for bias. This analysis is thus based on the responses of two coaches: that of
the target team, and a coach from another project not included in the study. The latter project did not involve collocation, a collaboration agreement, or continued collaborative efforts and therefore will be referred to as the semi-facilitated project. The discussions below are grouped according to the themes of the interview questions: the collaboration initiative and role of facilitation, team interactions and collocation, implementing the initiative by measuring performance, implementation buy-in and success, and the coaches’ experiences and lessons learned. Interview responses from the coaches will be discussed first, followed by the stakeholder responses.

The coaches’ participation varied: the semi-facilitated project coach was only involved during the planning and design phases, while the target team’s coach was involved from planning through construction. Both defined their coaching roles similarly: as facilitators leading team conversations about collaboration, creating a team-wide definition of success, and working to improve team performance to produce better project outcomes.

When asked to compare their team’s interactions to those on typical projects, the semi-facilitated coach stated that communication and inter-organizational barriers were the same as usual. The target coach stated that interactions were much more frequent and less formal than on typical projects. Collocation was not possible on the semi-facilitated project due to budget and schedule constraints. On the target project, collocation was cited as the initiative’s most worthwhile aspect because it spawned more social, informal communication.

Project success was defined as the “right solution” by the semi-facilitated coach, and as “team development and enjoyment” by the target coach. Regarding the initiative and team buy-in, both coaches cited difficulty in knowing whether explicit, contractual requirements for collaboration were beneficial or necessary. The semi-facilitated team developed a collaboration charter early on, but external pressures led them to abandon the initiative and focus on cost and schedule performance instead. The target team’s collaboration agreement focused on mandating collocation, which was considered the starting point for the entire initiative. Both coaches agreed that collaboration needs to be forced to some extent, to ensure participation. They also agreed that in order to improve buy-in, team initiatives have to be serious,
adopted early, and consider the participants’ feedback. Neither team implemented financial performance-based incentives.

The semi-facilitated team initially developed its own metrics as part of its collaboration charter. Although neither was implemented, the coach felt that team metrics and performance reviews would have been beneficial. The target team established basic team expectations and reviewed survey, RFI, and submittal performance; the primary benefit was having conversations about expectations and progress, which might not have occurred otherwise.

Coaching experiences and lessons learned were comparable. Both coaches felt that their teams responded well to their efforts. Periodic meetings amongst the four project coaches revealed that they all had similar experiences and challenges, especially in regards to dealing with non-participators. While the semi-facilitated coach has similar roles on other current projects, the target team’s coach had never performed such a role before.

5.9.3 Analysis: Project Stakeholders’ Interview Responses

Stakeholder interviews were analyzed according to the following categories: the collaboration initiative and role of facilitation, team interactions and collocation, implementing the initiative by measuring performance, implementation buy-in and success, and the perceived benefits of the overall initiative. All interviewees were team members from the design-build and target project.

All of the design-build participants were well acquainted with the designated project coach and the terms of their collaboration charter. When identifying the leader of the collaborative efforts, answers were diverse: some felt that there was no single leader since collaboration was a collective endeavor, while others named specific stakeholders as leaders. All interviewees interacted with the coach to some degree and described the role as someone who motivated, facilitated open discussions, and challenged the team to be innovative. Overall, the majority of the interviewees felt that facilitation was beneficial.

The target team had a considerably different coaching experience. Although most of the interviewees were aware of the designated project coach, they repeatedly identified a member of the CM as their informal coach and leader of the collaboration initiative. Similarly, all interviewees were aware of
the contractual collaboration requirements. When asked to define the designated coach’s role and contributions, most of the target team replied that they had not interacted enough to answer definitively. Of those who did answer, the consensus was that the coach contributed by defining the collaboration initiative, listening to the team’s concerns, and helping to develop and track team performance.

The design-build team was asked whether their interactions differed from those on typical projects. Some felt that their interactions were not typical since communication was streamlined, negotiations were more reasonable, and electronic correspondence was less common than face-to-face conversations. Others stated that interactions were typical, and that the only difference was the formal nature of the initiative. Collocation affected the team by increasing daily interactions, reducing isolation, providing a structure for the informal aspects of the job, and replacing emails and phone calls with face-to-face communication. Disadvantages included limited trailer space for each participant, privacy, and fewer benefits for non-collocated team members.

Target team interviewees described their interactions fairly similarly. Positive answers included improved communication, coordination, scheduling, trust, team efforts, and individual empowerment. Some interviewees felt that too much time was spent on meetings; some stated that daily interactions were typical, and others believed that team cohesion was expected since they had worked together on the historical project. Positive aspects of collocation included improved communication, streamlined site management, allowed better face-to-face interactions, quicker conflict resolution, and less team separation. Drawbacks included limited space for individual team members, less freedom to speak honestly amongst themselves, and difficulties adjusting to the shared trailer.

Once again, suggestions for improving participants’ commitment to team-based approaches varied. DB interviewees stated that financial incentives, adopting the initiative as early as possible, recognizing and rewarding the field crews’ efforts, and further educating the team about the collaboration initiative could improve buy-in and commitment. Others stated that financial incentives might not have made a difference. All interviewees were aware that the collaboration charter originally contained performance incentives, and that the funding was not approved.
Conversely, most of the target project’s interviewees agreed that for those with decades of industry experience, the cultural change needed to adopt team-based approaches was difficult to overcome. Buy-in could possibly improve by demonstrating the benefits of collaboration on previous projects, or by allowing the initiative to be optional for each team member. Half of the interviewees were unaware of any discussions regarding financial incentives, and the other half were aware that incentives were not feasible due to public funding constraints. Overall, the interviewees indicated that incentives would not have had a major impact on team performance.

Both facilitated teams participated in the researcher’s periodic surveys, as well as the researcher-led reviews of survey, RFI, and submittal data. When asked whether the data results represented the true project environment, most of the DB interviewees stated that their results were accurate, and all agreed that performance reviews enabled open discussions and self-assessment. A few stated that the data results seemed to be inflated. Some believed that additional metrics were unnecessary, while others mentioned that more emphasis should be placed on the discussions than on the numeric results. Performance indicators derived from change orders, profitability, payment applications, and schedule completion were listed as viable alternative metrics.

The target team’s interviewees were divided: four of eight felt that the metric results represented the true team, especially the surveys. Three interviewees could not definitively answer. The eighth interviewee thought that the purpose of the initiative was to reduce RFIs and other informal communication with face-to-face communication, but there was no such reduction. Most of the respondents felt that performance reviews were beneficial because they showed team progress. Suggested metrics for future facilitated teams ranged from profitability and labor efficiency to weekly goals and schedule performance.

The final category of stakeholder interview questions related to the overall effectiveness of the collaboration initiative. Accordingly, the researcher asked interviewees whether the focus on the team was beneficial to them, whether they had noticed gradual changes in team behaviors, whether collaboration should be a contractual requirement, and whether they would choose to work with the same
team members on future projects. All of the design-build interviewees felt that the team focus was beneficial for the aforementioned reasons. Regarding behavioral changes, several felt that behaviors were dependent on the state of the project and the problems that arose. Others felt that a single project could not change individual behaviors, and that multiple projects or an industry-standard approach could produce long-term changes. The need for contractually-required collaboration was another divided issue. Some felt that either a contractual or non-contractual approach could work under the right circumstances; some felt that a contractual agreement should set expectations and goals; others felt that collaboration should not be an explicit requirement. All interviewees were willing to work with each other again.

Seven of the eight target team interviews agreed that their efforts improved communication, coordination, relationship-building, and the other previously-mentioned relational characteristics. Of the target team members that had worked on the historical project, all but one stated that collaboration, communication, and team cohesion were better than before. Most interviewees agreed that the team gradually became more comfortable with the initiative. Several noted that one particular team member was very opposed to the initiative early on, and was now fully participating. Seven of eight team members believed collaboration should be a contractual requirement, and the eighth felt it should be optional. All of the target team’s interviewees were willing to work together on future projects.

5.9.4 Conclusions: Semi-structured Interview Responses

1. When asked about the effects and benefits of their formal collaborative efforts, neither team cited improved cost or schedule performance. The target team did mention, though, that their version of pull-scheduling and weekly goal-setting was very beneficial.

2. In both cases, most team members noted that communication, accountability, relationship-building, and other relational aspects had improved through their efforts. Collocation, participating in team surveys, and performance reviews were mentioned specifically by both teams. The DB team also agreed that the coach’s role and the facilitation process were similarly beneficial. The target team’s coach was not as actively involved, and thus was
perceived to have a minimal impact on the team’s relational efforts over their “informal coach.

3. Of the 16 stakeholders interviewed across both facilitated projects, 15 mentioned that their formal collaborative efforts were beneficial in one way or another. The benefits and improvements mentioned were unanimously related to team performance, not project outcomes.

5.10 Identifying Differences in Project and Relational Performance

Using the previously-established success criteria for each data source, the researcher identified noticeable differences in project outcomes and relational performance amongst the historical and facilitated projects. Major differences are summarized below.

5.10.1 Summary: Project Performance

The facilitated project outcomes differed from the historical project in terms of projected cost and schedule growth, submittal approval rates, and submittal and RFI review durations. Both projects were projected to have less cost growth and less schedule growth than the historical benchmark. Additionally, submittals were approved more often and required shorter review periods.

5.10.2 Summary: Relational Performance

The relational performance metrics further differentiated the facilitated and historical teams. Cooperation, timeliness, and other relational attributes for both the overall teams and individual stakeholders were consistently rated at 4/5 and 5/5, whereas the historical benchmarks ranged from 3 to 3.4 out of 5. Quantitative communication data showed that the facilitated teams had less need for design and construction clarifications, provided acceptable submittals more frequently, and required less time to respond to both RFIs and submittals.

Only the facilitated teams adopted contractual commitments, which primarily focused on improving team effectiveness and creating collaborative environments. Through meeting observations, the researcher learned that different levels of facilitator participation produced different results, and that
each team acclimated itself to the initiative at its own pace. Lastly, semi-structured interviews indicated that the collaboration initiative was impactful, and that the biggest benefits to team dynamics were observed through collocation, performance reviews, and open team discussions.

5.10.3 Conclusions: Assessing the Value of the Collaboration Initiative

This study’s third and final research question sought to define the value of an institutional owner’s collaboration initiative. According to the analyses above, the value was the potential to integrate project teams by improving communication habits, allowing underlying problems to be identified and resolved, and providing a means to reduce inter-organizational barriers. These attributes can produce more effective teams, which have the potential to exceed relational expectations of traditionally-delivered construction projects.

5.11 Chapter 5 Summary

This chapter presented analyses based on each data type’s potential to define team and project-level success. Success criteria were primarily based on the historical team’s benchmark results, and were then applied to the facilitated projects to identify improvements and declines. Specific project outcomes such as cost and schedule growth were not emphasized by the facilitated teams, and thus could not be conclusively tied to their formal collaborative efforts. Through the use of relational tools, such as collocation, anonymous surveys, self-assessments, open discussions, and mutually-established collaboration agreements, both facilitated teams exceeded the expectations of the owner’s typical construction project.
CONCLUSIONS AND CONTRIBUTIONS

6.1 Research Conclusions

This study used exploratory case studies to indicate the effects of formal collaboration initiatives on relational and project-level performance of construction project teams. Two teams used collocated spaces, contractual commitments, designated coaches, and emphases on relational concepts to distinguish themselves from typical team environments, as defined by a comparable historical project. Of the data collected, cost, schedule, and submittal outcomes were used to indicate project performance. According to the collaboration agreements and the interview responses of the participants, the overall purpose of the team-oriented approaches was more about improving team environments than achieving specific project results. Consequently, multiple data collection methods indicated that the facilitated teams’ formalized collaborative efforts had positive impacts on relational performance.

6.1.1 Research Conclusions: Project Performance

The facilitated cases’ projected outcomes demonstrated less cost and schedule growth than what the historical project experienced. Cost growth was 15.7% for the historical project, and projected to be 8.1% for the design-build project and 11.2% for the target case. Construction schedule growth was 6.2% for the historical project, and projected to be 0% for the design-build project, and 1.2% for the target case. The researcher’s project timelines, ranging from the first-processed submittals and RFIs to the end of construction, showed that the target and design-build projects were 50% and 75% complete, respectively. With such a considerable amount of work remaining, the cost and schedule outcomes still had potential to change before the projects ended. Regardless, the projections indicated that the facilitated projects were trending to outperform the historical benchmarks.

Workmanship is another often-used metric for project success. Submittals ensure that the built assemblies conform to the owner’s needs as described by the designer’s specifications. Thus, successful
communication and clarity in this area for a project would be indicated by a high percentage of quickly-approved submittals. For both facilitated cases, the shortest measured review duration (10 workdays or less) was the most common duration (57% of all DB case submittals and 36% of all target case submittals), and rejected submittals were uncommon (11% and 28%, respectively). By contrast, most of the historical project’s submittals were utterly rejected (40%) or were approved within the longest measured duration (greater than 15 workdays; 40%).

Thus, according to the limited project performance data available, the facilitated projects showed better performance in terms of cost growth, schedule growth, submittal approval rates, and submittal review durations. In all instances, the design-build project outperformed both the target and historical projects, suggesting structural efficiencies in the organization enable greater impact for the performance targets, in line with previous delivery methods research.

It is worth reiterating that none of the project-level performance indicators were expected to provide unequivocal evidence of project outcomes, or of the relationship between such outcomes and the use of formalized collaboration. The researcher instead gathered this data to create side-by-side comparisons of facilitated and non-facilitated projects and to infer, overall, whether the processes aligned with outcomes that trended differently. The strength of these comparisons relied on the similarities of the projects, including the same institutional owner, geographic location, relative size (over $10M), and project constraints. These similarities suggest that each project had the same basic success requirements, and thus any marked differences in outcomes or team effectiveness could be attributed to a narrowed set of factors, such as formal collaboration.

6.1.2 Research Conclusions: Relational Performance

Periodic surveys, RFI and submittal quantities and review durations, collaboration document reviews, meeting observations, and semi-structured interviews all indicated differences between historical and facilitated team performance. In nearly all comparisons, the relational expectations set by the historical team were exceeded by the target team and substantially exceeded by the design-build team.
Team environment and 360 survey results were very similar across both facilitated teams based on average ratings per metric. This indicated that, most likely, both teams approached the survey results in a similar manner, and that individual ratings were not made arbitrarily. Additionally, survey ratings tended to be more cyclical as the number of completed surveys increased, further indicating the reliability of the results. 4/5 and 5/5 ratings were consistently the most common amongst the facilitated teams’ surveys, and were higher than the historical team’s benchmark results. Declines in overall team ratings could be tracked to specific groups at different stages of the projects, allowing the facilitated teams to confront stakeholder-specific issues. Even when survey respondents believed the results to be inaccurate, most agreed that simply creating an iterative process for discussing team expectations and progress was beneficial.

RFI and submittal data provided quantitative evidence of communication habits. Both facilitated teams had fewer total RFIs (413 for the DB team and 196 for the target team) than the historical team (560), and were projected to finish with less as well (551 and 392). This suggests that the facilitated teams’ daily face-to-face interactions, through collocation, made formal communications more clear and concise as conversations and subsequent decisions could be made reducing the quantity of formal communication. Both facilitated teams’ submittal approval rates (89% for the DB team and 72% for the target team) were above the historical benchmark (60%), and approved submittals were reviewed more quickly (percentages shown in section 6.1.1). This inferred that the contractors had a better understanding of the design intent, ostensibly through increased exchanges with design team members and owner representatives, which reduced the need for iterations of review or time-consuming comments to request revised submittals.

Collaboration documents were studied to better understand the purpose of the teams’ formal collaborative efforts. Ideally, the use of a standard form agreement would have simplified project-to-project comparison. Funding constraints limited the use of such contractual documents, compelling the teams to form their relational terms based on their own priorities and limitations. The target team’s document was a specification for the use of a “collaborative field office,” developed by the owner,
construction manager, and the design team. While members of all four stakeholders participated in the initiative, the terms of the agreement primarily applied to the contractors. The majority of the document focused on contractors’ acknowledgment of the collocation requirement as well as the intent of the collocated space. The design-build team created a longer, more comprehensive agreement that outlined team expectations, roles and responsibilities, potential integrated strategies, performance metrics, and Lean construction principles. While the target team emphasized collocation, the design-build team did not explicitly require it and instead focused on specific definitions and procedures. Both collaboration documents favored pragmatic over aspirational terms.

Team meetings revealed gradual shifts in participant behaviors. On the target project, interactions did not typically include socio-emotional content or team-building discussions. During initial meetings, the team simply acknowledged that coordination discussions needed to occur eventually. In subsequent meetings, contractors collectively made commitments to better align each other’s work, as opposed to having separate discussions on their own. The design-build team’s behaviors shifted from complacency and limited participation in the early team-building meetings to open discussions of team performance and industry topics during the last observed meeting. These observations were performed over a seven-month period on the target project and 18 months on the design-build project. Behavioral changes were therefore expected once the teams had sufficient time to adjust to each other’s work habits. However, prior studies found that the majority of construction team interactions during project meetings are task-oriented, and thus relational discussions were not guaranteed to be prioritized. Multiple sources indicated that the facilitated teams’ environments promoted such interpersonal interactions.

Semi-structured interviews revealed that nearly all participants valued the use of formal collaboration initiatives (15 of 16 interviewees). Even those who believed that interactions and team relationships were not markedly different from typical projects found specific sections of the initiative to be beneficial: collocation, team surveys and metric-based reviews, pull-scheduling, direct access to key stakeholder personnel, interpersonal discussions, and mutual team goals were most commonly noted. Participants also identified areas for improvement such as the spatial and privacy limitations of
collocation, the use of a truly integrated approach as opposed to “IPD-lite,” the creation of incentives to drive performance-based behaviors, and the commencement of the initiative before contracts are awarded. Still, interview responses indicated that the overall initiative encouraged teams to recognize traditional problems and behaviors, allowing them to avoid such outcomes. The ability to identify and confront commonly-ignored relational problems was perhaps the principal benefit of implementing formal collaborative strategies.

### 6.1.3 Impacts of the Collaboration Initiative

The abovementioned differences between the project and team-level performance of facilitated and non-facilitated project teams indicated the efficacy of the collaboration initiative. Throughout this study, the following question was repeatedly raised: would the facilitated teams have achieved the same results without the use of facilitation, collocation, or collaboration agreements?

The collective findings did not conclusively answer this question. However, several inferences could be made. First, the interview responses (and the apparent need for coaches to provide leadership and guidance) indicated the teams’ inexperience with collocation, facilitation, and similarly formal collaboration. Thus, instances of above-average results could potentially be linked to the use of such a considerably different approach to project management.

Secondly, the formal aspect of the collaboration initiative and the owner’s extensive participation presumably raised performance expectations. For instances in which various team members are not contractually obligated to work together or even coexist, expectations can drive the individuals’ efforts. By formally agreeing to participate in the initiative, and by implicating contractual relationships through the collaboration agreements, the facilitated teams set high expectations for themselves. Additionally, periodic reviews of the survey and communication data results meant that each team’s progress would be public within the team. While these considerations do not guarantee improved results through formal collaboration, they indicate that all involved parties were expecting their efforts to produce such results.
6.2 Research Contributions

This research contributed to AEC academia by studying the collaboration initiative of a large institutional owner. Many studies generalize about the effects of collaborative efforts across multiple projects with different owners. This study’s literature review and interview responses defined the owner’s involvement as a key element of success, since the owner sets expectations for team efforts and project outcomes. On this particular owner’s facilitated projects, collaborative approaches could only be enforced to a certain degree, thus making the owner’s involvement even more critical for ensuring earnest participation. Without considering owner involvement, researchers could potentially be comparing projects with concerted team-based efforts to projects on which relational performance was not prioritized. This research focused on one institutional owner and considered owner involvement, thereby improving the validity of the case study comparisons.

Another academic contribution was the emphasis on in-progress data collection, including periodic surveys and communication data. The term “collaboration” is inherently subjective and qualitative, and most collaborative solutions are similarly undefined. Simply measuring team outcomes and project outcomes as a result of collaborative efforts would not have provided an in-depth view of how those efforts affected the teams. The use of in-progress data allowed the researcher to gauge how behaviors and processes changed over time, as opposed to simply acknowledging that they changed. Thus, this study attempted to bridge the gap between quantitative research emphasizing inputs and outcomes, and qualitative research emphasizing context.

This study also contributed to industry knowledge by evaluating the implementation, shortcomings, and benefits of an institutional owner’s collaboration initiative. Facilitation, collocation, and collaboration agreements require time, funding, personnel, planning, and early development. It is in every owner’s best interests to determine the efficacy of an initiative before increasing its scale. By indicating the positive effects of the initiative on relational dynamics, this study enabled the participating owner organization to make informed decisions about future facilitated projects. Other owners
considering similar initiatives can apply the research findings to their circumstances, and plan accordingly.

6.3 Research Limitations

This study compared outcomes from ongoing, facilitated projects to those of a single completed project. The opportunity to examine the same core team members twice, once on a facilitated project and once on non-facilitated project, made the historical case ideal for comparison purposes. Since the facilitated teams’ success were judged relative to the historical case, an underperforming or overachieving historical case would have affected the facilitated teams’ assessments. Without a database of the owner’s previously-completed projects, the exact nature of the historical case as a “typical” project was unknown. The research conclusions were therefore limited by the assumption that the historical case was representative of a typical construction project.

Similarly, more evidence was available to be collected from the in-progress projects, such as since surveys, communication data, and other project data that could be collected periodically. The historical case’s data represented only one stage of the project: project completion. As previously explained, the qualitative and subjective nature of the collaboration initiatives necessitates contextual explanations. Beyond the interview responses of the target team members involved with the historical case, such context was unavailable. Thus, comparisons between facilitated projects and the historical project were limited by the amount and type of available information.

The previous research limitation also extended to the confidence level of the collected data. Historical information represented actual outcomes at the time of project completion. For the ongoing facilitated projects, measures such as cost and schedule growth, RFI and submittal review durations, and survey ratings were based on partial project completion. Final outcomes had not yet been determined, thus leaving potential for the facilitated teams to have different results by the time they concluded. Until these final outcomes were known and evaluated, it was not possible to demonstrably compare facilitated results to historical results.
Finally, this study was performed within a very particular environment, limiting the applicability of the results. As a large institutional owner with in-house management capabilities, the subject of this study could not be considered a “typical” owner. The selected cases were chosen from the same owner and campus location to maintain consistency, but the final conclusions may not be appropriate for all owners or all facilitated projects. Regional differences in organizational structures, contractor characteristics, preferred delivery methods, and cultural attitudes regarding collaboration could lead to different results. The researcher’s interactions with the facilitated teams, as well as the contents of their collaboration agreements, strongly suggested that formalized collaboration must be tailored to each particular project and team in order to be successful. The same concept makes it impractical to overgeneralize project outcomes to other owner organizations and projects.

6.4 Recommendations for Future Research

As an exploratory study, this research provided the foundation for future research as the participating owner expands its pool of facilitated projects. Moving forward, additional historical projects need to be identified to create a broader definition of “typical” team and project expectations. Multiple projects completed within the previous five years could be used to benchmark expectations for teams without formal collaboration, in the same way that this study used a historical case to benchmark facilitated cases. Upcoming non-facilitated projects could also be identified for periodic data collection, including team surveys and communication data, to create a more balanced approach towards facilitated versus non-facilitated comparisons.

Additional facilitated case studies would expand the understanding of how specific variables, such as building types, delivery methods, and project scopes, relate to the intent and relative success of such a collaboration initiative. Future studies could also focus on particular aspects, such as collocation or the use of a collaboration charter, to identify the most impactful elements. Finally, as facilitated projects become more common and better outcomes are expected, researchers could develop methodologies to correlate specific aspects of the initiative with cost growth, schedule growth, and other project success indicators.
A large-scale derivative of this study could expand in several ways. As previously stated, the findings of the cost and schedule data used to compare project-level success were expected to be limited. The sheer number of variables involved with project outcomes, along with the facilitated teams’ emphasis on relational rather than project performance through formal collaboration, reduced the likelihood of major project-to-project outcome differences. Still, cost and schedule improvements were indicated within this study’s findings. A study of dozens or possibly hundreds of facilitated and non-facilitated projects could more precisely define those improvements, and possibly capture trends that explain why collaboration-oriented project teams can produce above-average outcomes. Thus, an expanded study could be used to capture and potentially validate the direction of this study’s results.

Throughout this thesis, collocation was consistently cited as the most impactful element of the collaboration initiative. The close proximity of the team members on a daily basis reduced the chances of major coordination lapses as communication simplified from emails and phone calls to personal conversations. More broadly, the team members were more open to compromise for the sake of mutual benefit. Pull-planning, performance reviews, and other communal tasks seemed to make each stakeholder more aware of the broad implications of their decisions, creating more mature teams. Consequently, an interdisciplinary research approach could expand to study team psychology. This could help identify the exact nature of collocation’s effect on multidisciplinary teams, such as AEC project teams. By understanding how collocation integrates various team members with different objectives, it would be possible to tailor future collocation spaces for maximum benefit.
REFERENCES


APPENDIX A

TEAM ENVIRONMENT AND 360 SURVEY TEMPLATE

Please complete this survey honestly. Individual responses will be kept confidential. (NOTE: all Likert scales are based on 0-5 ratings; only the lowest and highest possible ratings were defined)

1. Which part of the team (company or role) you are a direct member of?

2. Communication between all members is:
Difficult, with frequent disagreements (0); open, honest and free flowing (5)

3. Concerns and problems are acknowledged:
Only when they could not be ignored (0); at first sign (5)

4. Concerns and problems are dealt with in a timely manner:
Never (0); always (5)

5. Cooperation between all team members is:
Nonexistent or adversarial (0); highly productive and cooperative (5)

6. When issues were raised, people:
Said one thing and did another (0); did what they said they would (5)

7. The sense of teamwork between everyone is:
Nonexistent (0); very strong (5)

8. The level of trust between team members is:
Nonexistent (0); very strong (5)
9. The team members’ respect of each other is:

Nonexistent (0); very strong (5)

10. Comments: Feel free to elaborate on any of your answers. Comment on the collaborative efforts on your project (whether it is working or not, and why), being collocated, or any other topic that you would like to discuss.
# APPENDIX B

## COLLABORATION DOCUMENT REVIEWS: DESIGN-BUILD CASE, TARGET CASE, AND HISTORICAL CASE

<table>
<thead>
<tr>
<th>Event</th>
<th>Case</th>
<th>Description</th>
<th>Benefits</th>
<th>Risks</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-21</td>
<td>DBC</td>
<td>Design-construct: 3-year completion</td>
<td>Faster construction process, lower risk of project delays</td>
<td>Higher upfront costs, longer decision-making process</td>
<td>See 3-21 design-construct: 3-year completion for details</td>
</tr>
<tr>
<td>3-22</td>
<td>TCC</td>
<td>Target case: 2-year completion</td>
<td>Lower cost, faster completion</td>
<td>Higher risk of project delays, longer decision-making process</td>
<td>See 3-22 target case: 2-year completion for details</td>
</tr>
<tr>
<td>3-23</td>
<td>HLC</td>
<td>Historical case: 5-year completion</td>
<td>Lower cost, longer completion</td>
<td>Higher risk of project delays, higher upfront costs</td>
<td>See 3-23 historical case: 5-year completion for details</td>
</tr>
</tbody>
</table>

### Design-Build Case

- **Contract Agreements:**
  - Design-Build Contract:
    - Detailed specifications for design, construction, and project management.
  - Construction Contract:
    - Details on materials, labor, and project completion.

### Target Case

- **Project Management:**
  - phased construction: 2-year completion
  - risk management plan

### Historical Case

- **Project Management:**
  - phased construction: 5-year completion
  - risk management plan

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**Product**

- **Document Set:**
  - Construction documents, design documents, project management documents.
- **Review Process:**
  - Peer reviews, quality assurance, quality control.
- **Feedback Mechanism:**
  - Open communication channels, regular status meetings.

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**Project Schedule**

- **Timeline:**
  - Design phase: 3 months
  - Construction phase: 2 years
  - Total: 2 years 3 months
- **Key Milestones:**
  - Design completion: 3 months
  - Construction start: 4 months
  - Construction completion: 2 years 3 months
APPENDIX C

SEMI-STRUCTURED INTERVIEW QUESTIONS FOR PROJECT COACHES: TEMPLATE

1. As a project coach, what are/were your roles and responsibilities?
   1a. To the best of your knowledge, how does your role as a coach compare to the other coaches’ roles?
   1b. How long have you been (or how long were you) involved with your project?
   1c. Overall, how often have you been (or how often were you) in contact with the project team?

2. What was the selection process for your coaching role on this project?
   2a. Does a coach’s affiliation (owner, CM, contractor, designer, consultant) affect his/her role or participation? If so, how?
   2b. Describe the ideal coach/facilitator.

3. In terms of team interactions, how does this project compare to “typical” projects that you have seen or been involved with? What are some specific examples?

4. From your perspective, how has colocation affected this project team? If your project team was not collocated, would colocation have made a difference?

5. If a contract document for collaboration wasn’t included on your project, do you think that such a document would have affected team or project performance? If such a document was included on your project, do you think that a document with more explicit requirements for collaboration would have affected team or project performance?
   5a. If such a contract document was not used, were there any conversations about creating one? If so, why wasn't it implemented?
   5b. In terms of relational contracting, what would improve team members’ “buy-in”?
   5c. Were performance-based incentives ever discussed for this project? If so, why weren’t they used?

6. How has the project team responded to your efforts as a coach?
   6a. How can future coaches and collaboration charters/initiatives be more successful?
7. If metrics such as Team Environment survey results and communication data (RFIs and submittal turnaround times) were presented and discussed for your project, do you think that the team benefited from having and reviewing those metrics? If not, do you think that your team would benefit from having similar metrics?
7a. If team performance metrics were not reviewed on your project, were they ever discussed? If so, why weren’t they used?
8. When building a project team, how important is the owner’s involvement?
8a. Do you think that this owner emphasizes teamwork and is actively involved with your project? Why or why not?
9. How would you define a successful construction project?
9a. How does collaboration relate to that definition?
9b. Is it necessary (or even possible) to “force” collaboration?
10. For project teams and coaches considering adopting a collaboration charter or similar document, what would you advise?
11. How explicit should the contract language be for collaboration-related contract documents? Are most teams only as collaborative as they’re required to be?
12. Does your company have any specific approaches or strategies for team-building, collaboration, and communication?
13. What insight have you gained from the past “Project Coaching/Best Practices” meetings?
14. Have you been in similar coaching positions before? What are some of your “lessons learned”?
15. Additional answers and comments.
APPENDIX D

SEMI-STRUCTURED INTERVIEW QUESTIONS FOR PROJECT STAKEHOLDERS:

TEMPLATE

1. Who is on the core project team that you typically interact with?

2. Does this project differ from "typical" projects in terms of team interactions? If so, how?

3. Has colocation affected how you work on this project? If so, how?

3a. Has colocation affected the overall project team? If so, how?

3b. Hypothetically, would you change anything about your team's use of colocation?

4. Which person/company is leading the collaborative efforts on your project?

4a. What are examples of their collaborative practices?

5. Are you aware of the collaborative initiatives (Charter or Front End Documents) for this project?

5a. Who is leading those initiatives?

5b. How often are you in contact with that leader/coach?

5c. Describe the coach's role on your project.

5d. Has the coach helped the project team meet its goals? How or how not?

6. Team environment surveys and communication data have been collected and periodically presented to the project team. Do those results represent the "true" team environment, as you see it?

6a. Was it useful to see and discuss those results?

6b. What other information should be collected and presented during team meetings?

7. When assembling a project team, how important is the owner's involvement?

7a. Do you think that the owner emphasizes teamwork and is very involved with your project? Why or why not?

8. What would improve everyone’s “buy-in” to the collaborative efforts? Could the focus on collaboration be done differently?
8a. To your knowledge, were performance incentives or shared savings programs ever discussed for your project? If so, why weren’t they used?

9. Overall, has the focus on the team been beneficial or useful to you? Why or why not?

10. Have you noticed any changes in team behaviors over the course of the project?

11. In your opinion, your collaboration be mentioned in the contract documents, or should it just be an implied requirement?

12. What are your project team's biggest obstacles?

13. If you could choose, would you work with the same project team again on future project?

14. Were you (or your company) involved with the previous phase/project? If so, how would you compare the previous phase to the current one?

15. Your project team is doing a few things differently in terms of pull-scheduling, the collaboration meetings, and the shared trailer. What is your overall reaction to all of this? Do you think it is necessary and/or making a difference? Why or why not?

16. Additional answers and comments.