Collaborative Project Delivery Governance and Shared Leadership in AEC Building Virtual Teams

Kirk Hochstatter

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Reading Committee:

Carrie Sturts Dossick, Chair

Bill Bender

Timo Hartmann

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Abstract

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Kirk Hochstatter

Chair of the Supervisory Committee:

Carrie Sturts Dossick

Department of Construction Management

The emergence of collaborative project delivery (CPD) methods in the architect, engineering, and construction (AEC) industry has brought a focus on how teams can better work together to achieve common goals. Whether it be through multi-party agreements, lean construction tools, or empowerment of decision-making, these projects have leveraged supporting the collaborative behaviors of their stakeholders to lead to better outcomes. A critical part of creating a culture of collaboration on these projects is the role of leadership that is played out by multiple individuals that can also be described as shared leadership (SL). If these projects are intended to create a culture of SL on their projects, what mechanisms should be used to meet these objectives? This research seeks out to address what mechanisms are impacting the formation of SL on CPD projects by examining the informal governance (IG) of the mechanical, electrical, plumbing, fire protection, structural engineering, and architectural (MEPFSA) coordination team. Through a

case study approach of a project's MEPFSA coordination team, I developed five focused case analyses where I could examine their unique CPD IG and assess the emergence of SL. The IG examination was accomplished through qualitative methods that consisted of interviews with individual MEPFSA coordination team members and field observations to witness their practices in real time. To identify the emergence of SL, a quantitative survey, the Shared Leadership Questionnaire (SLQ), I was distributed to the MEPFSA coordination team. Based on the findings from these case studies, this research was able to suggest that there is evidence that the IG of the MEPFSA coordination teams impacted the formation of SL and dives into how the IG elements of team organization, decision making, team building, communication systems and workspaces played a role. Specific insights into the impacts of IG on SL formation included the role of a facilitator that can lead the technical aspects of MEPFSA BIM coordination as well as guide the team through the selected project delivery approach, how CPD governance can influence the formation of SL, and how SL uniquely appears in AEC building construction teams.

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Dedication

This dissertation is dedicated to my three children, Lucille, Alix, and Hank, who remind and motivate me to be the best version of myself. I love you more than life itself.

I'd also like to dedicate this to Dr. Bob Mugerauer who still means so much to me and many PhD graduates in the College of Built Environments.

And lastly, I'd like to dedicate this to my friend and former colleague, Jack Avery. You moved the industry forward and you are greatly appreciated for that.

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I also would like to extend thanks and gratitude to the rest of my committee members, Dr. Timo Hartman and Dr. Steve Muench. I am grateful to get to know you two throughout this journey and I look forward to continuing to collaborate with both of you in the future. I need to share my gratitude to the staff and faculty in the construction management department and College of Built Environments who have supported me throughout this journey. A special thank you to Dr. Yong-Kim Woo who was my masters thesis chair and introduced me to research at this level and continues to influence my interest in CPD and lean subject matter.

A big thank you to all the industry professionals who participated in this study and helped me gather the data I needed to complete this dissertation. It was my pleasure to meet you all and I thank you for all the hope you've given me that we in this industry are better builders when we can cooperate and collaborate. Individual shout outs to Kyle Cummings for your patience and

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To all my friends who never doubted me, even when I was in my darkest moments. Whether you got to know me when I was an undergraduate at the Oregon State University, as a graduate student at the University of Washington, or sharing laughs as we navigated the challenges of working in the field, you are forever a part of my life. A very special thanks to Carrie Cassidy who has supported me and so many others by making us better builders and better people. And to all the people I'm forgetting who will undoubtedly remind me that I missed them when they pick up this dissertation, thank you.

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Chapter 1: Introduction

Over the past three decades, the application of collaborative project delivery (CPD) methods in architectural, engineering, and construction (AEC) projects has drawn attention to how teams operate, particularly through practices such as performance-based contracting and lean construction tools. Research has focused on how leadership approaches influence the implementation of these systems (Kim and Hochstatter 2016) (Hochstatter, Transformational Leadership and Lean Construction Implementation 2013). As we've entered an era where remote work is not only possible, but necessary to deliver a complex product, like an AEC building project, the understanding of how to best lead these teams becomes more critical in these evolving times.

Shared leadership (SL) offers a framework for understanding collective team leadership, contrasting with traditional hierarchical models often used to manage teams. This SL approach has become appealing to those who desire experts to make decisions where a hierarchical approach may not be seen as effective, and applications of this approach have grown in certain industries looking to unlock the benefits. As SL gains appeal in AEC teams using CPD method (Appelman, Chandler and Hill 2019), there is an opportunity to explore how this has been applied in other settings. One of the better understood applications of the SL approach comes from the virtual team, where researchers have examined effectiveness and structural supports that lead to team effectiveness (Hoch and Kozlowski 2014). As we have learned more about these SL applications that are playing out in other industries, this research has taken this knowledge and made it applicable to AEC project teams.

Governance on a project has been defined as a framework that guides collective decision-making through established rules and formalized structures (Chen, Manley, et al., Procurement and Governance Choices for Collaborative Infrastructure Projects 2018) (Ansell and Gash 2007). Within the AEC context, each project incorporates a unique combination of formal and informal governance (IG) mechanisms and the actions they support (Chen and Manley, Validation of an Instrument to Measure Governance and Performance on Collaborative Infrastructure Projects 2014). Formal mechanisms primarily operate through contractual governance—structuring transactions, defining obligations, and allocating risk and reward—while informal mechanisms address the non-contractual dimensions of collaboration, including leadership practices, team workshops, communication systems, and relationship management (Chen, Manley and Lewis, Exploring Governance Issues on Collaborative Contracts In The Construction Industry 2012) (Chen and Manley, Validation of an Instrument to Measure Governance and Performance on Collaborative Infrastructure Projects 2014) (Chen, Manley, et al., Procurement and Governance Choices for Collaborative Infrastructure Projects 2018). Informal mechanisms are particularly critical in CPD environments, where they foster mutual trust, facilitate open communication, enable cooperation, and promote knowledge sharing (Chen and Manley, Validation of an Instrument to Measure Governance and Performance on Collaborative Infrastructure Projects 2014). These relational and behavioral foundations provide the conditions under which collaborative behaviors can develop and influence how leadership is shared within AEC project teams.

While SL can be applied across the diverse configurations of AEC project teams, the focus of this research was to find a group with structural support that best meets the criteria of

the virtual teams where evidence showed the SL approach to be effective. That team became the mechanical, electrical, plumbing, fire protection, structural and architectural (MEPFSA) BIM coordination team, who work in remote and virtual spaces as well as having its own structural supports existing in its project specific governance (The American Institute of Architects 2007). These MEPFSA coordination teams—critical to successful project delivery under CPD methods—served as the unit of analysis for this case study approach to better understand how to develop a SL culture utilizing project governance.

1.1 Research Objectives

My research presented the opportunity to examine the subjects of IG, SL and virtual teams within the context of an AEC project organization utilizing collaborative project governance and strategies. The ability to work remotely allows organizations, groups, and individuals to better utilize resources that would not be otherwise available if they were working in a physical office together. As these emerging virtual teams adapt to the changes in workspace, leadership approaches that support efficient teamwork required to meet the demands of the project will need to be better understood.

Leadership in the construction industry is traditionally hierarchical, with deeply embedded power structures guiding decision-making and existing power structures are heavily embedded in the culture of management and decision making. With shifts in project delivery models to more collaborative and inclusive partnerships, how do these traditional leadership approaches impact the understanding of how to manage these teams? Do we expect managers to adjust tacit approaches to leading teams that match the project requirements being put forward

that can include a more cooperative risk and reward structure and realignments of working groups and spaces to encourage openness to sharing information that traditionally has been restricted? Compounding these challenges facing leadership has been the recent COVID-19 pandemic and the shift to working virtually and reimagining how we maintain team efficiency in these possibly new and unfamiliar spaces. As many in the industry continue to invite disruption through changes to project delivery and implementation of cutting-edge technology, understanding how leadership impacts these efforts will better inform the actual viability of these methods and approaches as well as the appropriate leadership model for these new and unique situations.

The body of knowledge about leadership in AEC would be expanded by examining SL and how it develops in project teams. With research suggesting that antecedent conditions (Carson, Tesluk and Marrone 2007), and influences of trainings, facilitators, resources, and rewards systems that support the applications of SL (Bergman, et al. 2011) (Hoch and Kozlowski 2014), there is an opportunity to examine this subject within the context of an AEC project organization. This opportunity has never been more present with the sudden onset of the COVID-19 pandemic and the technological advances that have enabled the formation of virtual teams. It goes without saying that the challenges of exploring this topic will be dominated by the complicated and unique characteristics that every AEC project organization possesses but by identifying a commonly utilized group, like the MEPFSA coordination team, I am able to isolate specific nuances that communicate boundaries and common applications. With this deeper focus on a virtual team utilizing BIM within the AEC project organization, the specific criterion for selecting the leadership of these teams becomes clearer. Whether it be defining the skills and/or

the experienced desired, this research was able to examine specific conditions of how governance impacts the ability to form a SL approach. While some projects may not explicitly formalize these selection processes, CPD projects may possess governance mechanisms that can be examined that can impact the development of SL within virtual teams. Given these considerations, I developed this research question to help further inform the body of knowledge addressing AEC teams and the formation of SL.

Research question

This research will examine the governance of CPD projects to explore how it impacts the formation of shared leadership within virtual teams utilizing BIM technologies.

This research will focus on identifying SL within AEC project organization that are utilizing CPD methods, with its' unit of analysis being a project's MEPFSA coordination team. It expressly attempts to determine how governance systems create SL and how it can be accounted for by assessing the people who are assuming leadership responsibilities within a group. The MEPFSA coordination teams that utilize the Building Information Modeling (BIM) platform offered an ideal group to observe as the nature of their work being interdependent with the others using the model matches conditions of parallel research that have shown evidence of SL in virtual teams in other industries (Northouse 2018) (Hoch and Kozlowski 2014) (Bergman, et al. 2011). The intent of examining MEPFSA coordination teams within project organizations utilizing CPD methods was not meant to constrain the range of projects that can be examined but rather capture systems of governance being used on certain project types that intend to create

more collaborative behaviors including multi-party risk-profit sharing agreements, lean construction approaches, and shared technology platforms, to name a few.

To research these highly complicated topics and maintain rigor and discipline to create knowledge that will become useful, a mixed-methods case study approach will be applied. Therefore, the unit of analysis for the case studies being examined will be the projects MEPFSA coordination teams utilizing a common BIM platform on CPD projects and their IG systems that could lead to SL amongst their certain group. Applications of IG leading to SL outcomes on CPD projects will be examined through interviews and observations of individuals and their MEPFSA teams and SL will be assessed through a survey that can identify appearance of SL. Findings will be developed to address the IG strategies employed by the project and how they are related to the formation of SL.

My decision to focus on identifying the presence of a SL phenomenon is purposeful in that it does not discriminate with preferred personality styles but simply counts how many people are participating in leadership activities in a team. It is believed that the power of explicit governance can be linked to the emergence of multiple leaders and once this has been established, project organizations can organize their project systems that best create this phenomenon.

The skills needed by the next generation of leaders will be different when tackling the challenges we will face in our future. The ability to learn through repetitive actions is constrained in AEC projects due to the uniqueness of each product that is delivered to the market and this

will become more difficult as our built environments will need teams that can overcome the great challenges of climate change, technology shifts and offsite construction to name a few. Gaining access to a diverse range of ideas that will be needed in solving all these seemingly impossible problems will require companies to trust the experts that may not reveal themselves using traditional methods of project delivery. This research will help the AEC industry by expanding knowledge of SL and IG when employing CPD.

1.2 Research Scope

The scope of this research is an exploration of the leadership strategies that have been developed to create a cohesive and effective team in the AEC community. This examination will focus specifically on CPD strategies and its governance influencing the emergence of SL within AEC project organization's virtual teams employing BIM. This relationship between project governance and SL has the potential to suggest how specific strategies lead to higher participation of individuals in leadership activities and a more inclusive virtual team leadership approach.

The starting point for exploring SL in AEC project organizations and how its governance influences the culture of collaboration was at the MEPFSA coordination team level and this would identify as the meso-level (project team) in the I-M-O-I model show in the table below. From here, inputs and moderators can be isolated and focused on as it relates to the teams being examined. This model also allows for examination of factors that could be influencing the team outside the meso-level as research has shown that external factors that occur at the individual and organizational level impact the development of SL as a whole (Scott-Young, Georgy and

Grisinger 2019). Knowing this, any specific project context, organizations and individuals create challenges in creating a one-size-fits all recommendation from these findings are impossible and ill-advised.

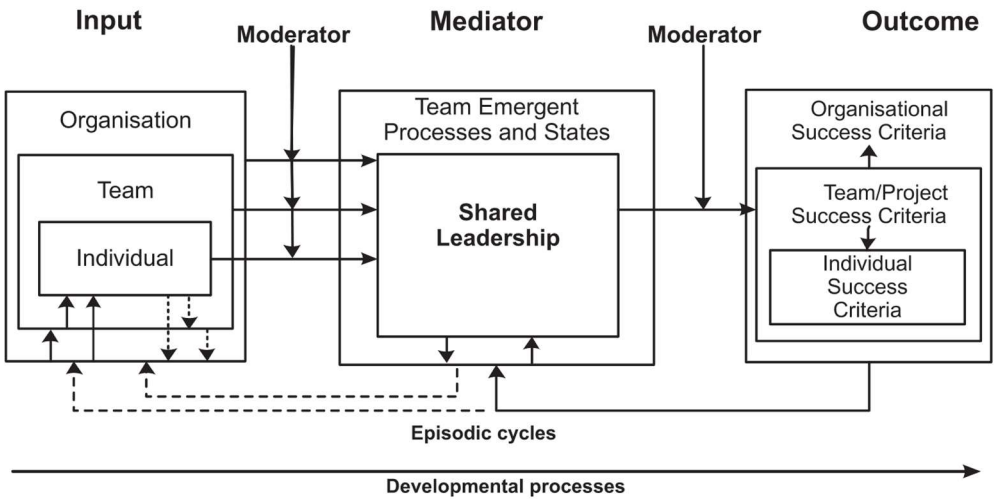

Figure 1 - Proposed multi-level systems of model of shared leadership in project teams (Scott-Young, Georgy and Grisinger 2019)

1.3 Definition of Terms

Virtual Design and Construction (VDC). A common term used in the design and construction industry describes the group using digital design tools that assist with the construction coordination of building activities.

Collaborative Project Delivery (CPD). A project delivery approach that emphasizes early stakeholder involvement, joint decision-making, transparent information sharing, and aligned incentives to foster cooperation and shared responsibility. Unlike traditional models that are often transactional and adversarial, CPD integrates design, construction, and operations expertise to reduce fragmentation, manage risk collectively, and improve project outcomes.

Building Information Modelling (BIM). Commonly seen as a multidimensional tool that supports several needs in the architectural, engineering, construction, and operations (AECO) industry

Mechanical Electrical Plumbing Fire Structural Architectural (MEPFSA). This is the coordination team that is being examined in this research. This group could also be considered the VDC or BIM coordination team but for the sake of this research, I will refer to them as the "MEPFSA coordination team."

Informal Governance (IG). This type of governance focuses on non-contractual mechanisms, such as leadership, team workshops, communication systems, relationship managers, and design integration. In this research, I refined these descriptions for form five IG elements that include team organization, decision making, team building, communication systems and workspaces.

Shared Leadership (SL). This term has been described in many ways, including being called team leadership. Simply defined, SL is the idea that several members of the team are included in leading the team.

1.4 Overview of Study

This research developed five case studies to address the research question's inquiry into IG and SL and each case study represents a different MEPFSA coordination team on a different project. The first three case studies come from a single general contractor (GC) organization and utilize individual interviews to examine the IG utilized within each project and the SLQ to

address the formation of SL. The last two case studies are two different GC organizations and include field observations as well as interviews to examine the IG on each project.

1.5 Summary of Chapters

Chapter 2 – Literature Review

This chapter outlines the literature reviewed for this research. There are five literature review topics included in this chapter that cover leadership, team formation, BIM based technologies, governance & AEC organizations, and CPD. Each topic was recapped as it relates to this research and provides and covers their points of departure.

Chapter 3 - Methodology

The methodology for this research is detailed in chapter three including the methodological approach, operationalized definitions, data collection and analysis methods, and reliability and validity.

Chapter 4 - Findings

The findings for all the case studies are covered in chapter 4 and outlines the results from the interviews, observations, and SLQ conducted on each of these projects, with a focus on how IG impacts the formation of SL.

Chapter 5 - Discussions

In this chapter I discussed the influences that IG has on the formation of SL within each case study presented. Each case study discussed presents the uniqueness of their project delivery approaches and how they influenced the IG.

Chapter 6 - Conclusions

The last chapter concludes this study by providing a research summary, detailing the contributions to the body of knowledge, the potential impacts to industry, research limitations, and the next steps/future studies.

Chapter 2: Literature Review

The literature reviewed for this research proposal was selected during multiple document searches utilizing databases that include the UW Libraries, ASCE, IGLC and Google Scholar. The searches focused on individual and combined keywords and phrases that included team formation, construction management, SL, governance, culture, collaboration, CPD, BIM, virtual teams, and collective leadership. To refine the numerous results, the publications were mostly limited to peer reviewed journals that were available online and books that covered larger topics like leadership, CPD, team formation. This literature review will be organized in the following categories to discuss the current body of knowledge and potential gaps to be explored through this research. Leadership in AEC, SL, Virtual Teams, AEC Project Governance, CPD, and AEC Team Formation.

2.1 Leadership /Shared Leadership

Leadership has long inspired scholars to explore the skills, behaviors, and approaches that enable individuals and organizations to achieve collective goals. Understandings of leadership are inherently shaped by the complexity of the specific organizational or team context under investigation. The ability to create reliable knowledge is contingent on how to clearly articulate the case and its details being examined. The context of this research is a focus on leadership in the AEC industry and the organizations formed to develop a more collaborative leadership approach to project delivery. This research explores how SL is established in the digital spaces and virtual teams using interdependent and frequently remote teams using BIM.

Although the influence of leadership in AEC project organizations is widely acknowledged, the academic literature on leadership in the AEC industry remains relatively underdeveloped compared to other sectors (Chan and Chan 2005). The role of leadership in the AEC industry as individuals are expected to meet the host of challenges whose responsibility includes creating and guiding people toward a clear objective, clear communication, and help with identifying strengths and weaknesses to be worked on (Schaufelberger 2009). Decision making is a critical role for leaders of AEC organizations and projects. Leadership is often defined by organizational hierarchies, with limited instances of power being shared when formal empowerment mechanisms are available (Schaufelberger 2009). Leadership responsibilities in AEC teams are distributed across organizations, individuals, technical experts, senior personnel, and even through consensus. However, the initial decision regarding the project delivery method significantly influences the leadership structure and team dynamics (Fischer, et al. 2017).

Several publications have focused on the project organization as a whole and can be applied in developing best practices and recommendations for certain types of project delivery methods like the collaborative forms of project delivery (R. Cheng 2016) (Charles Pankow Foundation, CIDCI, IPDA 2019) (Molenaar, et al. 2014) (R. Cheng 2015). There have been efforts to examine specific theories such as transformational leadership (Chan and Chan 2005) and some have brought that focus to the subject of implementing collaborative forms of construction such as Lean (Kim and Hochstatter 2016). It is apparent that these efforts are forming knowledge of leadership and collaborative forms of project delivery and a similar effort can be found in the exploration of SL as well.

SL has been conceptualized in various ways, with applications observed in both traditional organizations and digitally enabled teams. The term "SL" is closely related to concepts such as team leadership, distributed leadership, collective leadership, and empowering leadership, each emphasizing non-hierarchical, collaborative team dynamics (Northouse 2018) (Avolio, Walumbwa and Weber 2009) (Scott, et al. 2018) (Hill and Bartol 2016) (Gronn 2002) (Hoch and Kozlowski 2014) and one of the most widely cited definition of SL, by Pearce and Conger, have described it as "a dynamic, interactive influence process among individuals in groups for which the objective is to lead one another to the achievement of group or organizational goals or both." (Avolio, Walumbwa and Weber 2009) SL has also been positioned as a contrast to more traditional, vertical, or hierarchal models of leadership and requires time to develop as teams coalesce (Avolio, Walumbwa and Weber 2009) (Scott, et al. 2018) (Hoch and Kozlowski 2014) (Scott-Young, Georgy and Grisinger 2019). Relatively few studies have attempted to measure SL (Avolio, Walumbwa and Weber 2009) and the few that have targeted measuring the team itself have rated individual leadership traits like transformational leadership, transactional leadership, (Avolio, Walumbwa and Weber 2009), cognitive, affective, and behavioral dimensions, member-member exchange, (Hoch and Kozlowski 2014), a social network approach (Carson, Tesluk and Marrone 2007), and combinations of leadership behaviors (Imam 2021). Despite the limited consensus around a singular, standardized definition of SL, there is consistency in the ideas that center around multiple members within a group that act as leaders, emergence over time, and that it can be contrasted to hierarchal/vertical forms of leadership structures. Understanding this subject further can be expanded by research with consideration of project related boundary conditions, multi-level and cross-level contexts, and

longitudinal design that respects SL and teams development over the timeline of a project (Scott-Young, Georgy and Grisinger 2019).

As organizations increasingly embrace remote work through technological advancements, virtual teams have emerged as a valuable context for exploring SL. These emerging spaces have enabled communication across time and space that offer access to global talent while reducing travel and facility spaces but also face the challenges of these remote teams lacking trust, sub-group formation, and more conflict (Northouse 2018). There is evidence to suggest that the application of SL in these geographically dispersed teams has lessened conflict, created greater consensus, cohesion, and higher intragroup trust verses teams that have not (Bergman, et al. 2011) (Imam and Zaheer 2021), and have fostered effective collaboration and team performance (Hill and Bartol 2016) (Hoch and Kozlowski 2014). Research has also found that these SL approaches can better leverage a culture that shares knowledge, help with problem solving, goal-setting and effective decision making (Imam and Zaheer 2021), and increase team effectiveness over those who may overlook this source of leadership (Bergman, et al. 2011).

The topic of SL can be found in the AEC industry as well, as researchers have collected data to understand how SL fulfills individuals' psychological needs, such as competence, relatedness, and autonomy (Imam 2021) and examined the relationship of SL and team creativity on construction projects (Ali, et al. 2020). These efforts to explore the subject of SL have created momentum to understand the impacts leadership has in the AEC industry and inspire confidence to apply applications of SL being explored in other industries.

The body of knowledge about leadership in AEC would be expanded by examining SL and how it develops in project teams. The research that has examined antecedent conditions (Carson, Tesluk and Marrone 2007), and the influences of trainings, facilitators, resources, and rewards systems that support applications of SL (Bergman, et al. 2011) (Hoch and Kozlowski 2014), could be applicable in an AEC project organization. As AEC project teams are becoming more remote due to technological advances and the sudden onset of COVID-19, researching this subject will provide knowledge on the emergence of remote work and a bounty of case studies for examination.

2.2 Team Formation and Virtual Teams

Several key factors must be considered when examining SL in the AEC industry, particularly those related to team formation and the dynamics of virtual teams. The diverse organizations, groups, and individuals involved in AEC projects present unique challenges that influence how SL emerges and functions. The existing knowledge of virtual teams will need to be examined so that it respects the complexity of the situation involved. This will include how to identify work groups and teams in organization, how to examine a multi-level team, understanding the formation of an AEC team, and better define the virtual team.

The teams that are created within an AEC project organization are a complicated, temporary partnership of multiple organizations, groups, and individuals who are working to achieve a collective goal. AEC project organizations often form as “temporary partnerships” (R. Cheng 2015), and understanding the complex interplay of organizations, groups, and individuals is critical to examining leadership structures (Kozlowski and Bell 2001) (Scott-Young, Georgy

and Grisinger 2019). Research shows that these temporary groups commonly work in an environment of low trust between partners but the development of swift trust in these short-term projects helps in developing cooperation and collaboration (R. Cheng 2015). Given the complexity of these temporary arrangements, developing strategies to foster trust is essential. Trust-building efforts must be tailored to the specific group dynamics at play (Kramer and Tyler 1996). Similarly, data collection and analysis must align with the appropriate level of inquiry—organizational, group, or individual—to ensure theoretical consistency (Scott-Young, Georgy and Grisinger 2019) and develop appropriate findings (Kozlowski and Bell 2001). With a clear demarcation of the levels, like organization, teams, and individuals, found in AEC project organizations and the conditions of a temporary partnership, researchers can better understand the hierarchy of decision making, leadership impact, and related organizational structures.

The inherent complexities of AEC partnerships offer a rich foundation for understanding team functioning. As R. Cheng (2016) noted, several key ingredients shape these collaborations. The way the people and their work are organized will impact their abilities to function as a team (Fischer, et al. 2017). The strategies found in IPD have been adopted by several AEC project organizations to better position themselves by forming a more cohesive team that can address these inherent challenges like trust and alignment of objectives (Charles Pankow Foundation, CIDCI, IPDA 2019). To help foster cooperation between the groups, multi-party contracts are developed to share the risk and rewards between the owner, designer and constructor. Organizations and lean construction tools are implemented that are intended to create a culture of mutual trust and respect, shared values and an alignment of goals (Fischer, et al. 2017) (Charles Pankow Foundation, CIDCI, IPDA 2019). The development of the team is highly considered

with a keen awareness of leadership roles when building trust within the project and its composition of groups (Fischer, et al. 2017). A noted group that is seen as a critical factor in the success of a CPD project is the development of the BIM team (The American Institute of Architects 2007) (Charles Pankow Foundation, CIDCI, IPDA 2019) (R. Cheng 2015) (Fischer, et al. 2017) This BIM team not only has to overcome the nature of AEC partnership, but must also work in the digital work space that as a virtual team.

A virtual team is typically defined as a group of two or more individuals working remotely toward a shared goal, with communication occurring primarily through electronic means and potentially across different time zones (Hertel, Geister and Konradt 2005). Fueled by advancements in technology that have expanded flexibility in working arrangements, there has become a significant growth in the formation of virtual teams over the past 20 years (Maynard, et al. 2017) (Hoch and Kozlowski 2014). The COVID-19 pandemic significantly accelerated the adoption of virtual work environments across industries, including AEC. The changes have been welcomed in service/knowledge-based environments that are becoming more complex and dynamic (Bell and Kozlowski 2002) as well as teams facing similar challenges in the AEC industry. Early research on virtual teams often relied on comparisons to face-to-face (FtF) teams. More recently, the concept of "team virtuality" has emerged to provide a more nuanced continuum of remote collaboration (Maynard, et al. 2017). The research reviewed by Maynard et al. discovered several conceptualized dimensions of virtuality including spatial (geographic) dispersion, extent of FtF meetings, time dispersion, diversity, organizational boundaries, work practices, technology usage, and type of technology used (2017). While this definition provides a

foundational understanding, the rapid growth in virtual team research underscores its evolving nature—particularly as applications vary widely across industries.

This shift to a virtual working environment can also be found in the AEC industry, as the emergence of visualization and digital communication platforms have led to improvements in the coordination of design and work activities (Dave, et al. 2015). These recent advancements of Information and Communication Technologies (ICT) have led to the increased use of the virtual organization and inter-enterprise collaboration and has enabled participants that are globally dispersed to come together quicker to share ideas and propose solutions (Lu, et al. 2014). Emerging as one of the most popular ICT technologies that can be operated within a virtual team is the BIM platform. These multi-dimensional consolidated models have coupled highly interdependent participants together and have made explicit the intersections of scope required to be coordinated (Dossick and Neff 2010). While this technology can be used with collocated teams and is a common platform for coordinating planning and design tasks for global engineering projects (C. S. Dossick 2014), BIM models, are increasingly being shared through cloud-based servers that can allow for individual users to work remotely (Alreshidi, Mourshed and Rezgui 2018). Virtual teams using BIM technologies, despite their collaborative intent, inevitably encounter cultural and organizational barriers that are endemic to the AEC industry (Dossick and Neff 2010).

The dynamics that constitute a team and the individuals who use the BIM model to design and plan activities can be considered a virtual team. The knowledge of leadership and

organizational structures found in these virtual teams can be used to address the challenges of developing SL for the AEC industry.

2.3 BIM Based Technologies

BIM is widely recognized as a multidimensional tool that supports various functions across the AECO industry. While this definition provides a broad overview, deeper insight into BIM's interactions within the historically complex AEC industry is essential for researchers seeking to generate actionable knowledge. This section of the literature review addresses research methods related to BIM, its role within AEC organizations and teams, and its function in collaborative and integrated project delivery (IPD).

The emergence of BIM has transformed technical approaches to the delivery and operation of facilities within the AEC industry. As researchers advance knowledge in this rapidly evolving field of building design and management, understanding the interacting policies, processes, and technologies will be critical to examining in a case study. A highly cited article by Succar (2009) offers a systematic investigation of BIM's divergent fields, defining its knowledge components and delineating their expanding boundaries. The frameworks created by Succar offer several domains within the AECO industry, including BIM fields (technology, process, and policy), interactions, and field overlaps, that can allow for systematic investigation to provide actionable deliverables (Succar 2009).

As BIM becomes a standard digital tool in AEC project delivery, the boundaries between its applications continue to blur, necessitating greater rigor in how its use is reported and

analyzed. Consequently, research on BIM applications must clearly define topic boundaries to effectively apply this framework. Without attention to this detail, narrow interpretations of knowledge could become the victim of broad and unrelated applications of this technology.

2.4 Governance and AEC Organizations

The literature reviewed on governance in construction management focused primarily on its application within CPD models. This review revealed definitions of governance mechanisms relevant to case study exploration. Although governance is widely studied across industries and societal contexts, its application within the AEC industry remains relatively underexplored (Zheng, Lu and Chang 2019). Digital databases of the ASCE, and the International Group for Lean Construction (IGLC) were utilized for topics related to governance and collaborative forms of project delivery. The reviewed literature revealed that governance mechanisms are frequently defined in terms of their influence on project behavior and performance (Chen, Manley and Lewis 2012) (Chen and Manley 2014) (Zheng, Lu and Chang 2019).

The concept of "Lean Governance" was introduced to expand understanding of inter-organizational relationships and collaborative project environments (Banihashemi and Liu 2012). Contemporary terms like "e-governance" have been adopted to explain shifts in technology and official processes found in certain regions (Daramsis, et al. 2018). Some researchers describe IPD as an "Integrated Governance Model" to examine how shared understanding facilitates value generation (Tillmann, et al. 2012). These efforts underscore the importance of clearly defining the governance phenomena under investigation. This research adopts the terminology developed by Chen, Manley, and Lewis.

When examining value for money and the governance structures of collaborative contracts, Chen, Manley, and Lewis identified formal and IG mechanisms that influenced project performance (Chen, Manley and Lewis 2012). In examining collaborative infrastructure projects, Chen and Manley (2014) identified formal governance mechanisms—such as collective cost estimation, risk and reward sharing, and design integration—and informal mechanisms, including leadership, team integration, workshops, and communication systems. The informal mechanism of leadership included the boards and project management teams formed by the participating organizations and the people who occupy these positions based on their project experiences and skills (Chen and Manley 2014). Team integration discusses the management of relationships and culture and the team forming process within the available resources of the participating project organizations (Chen and Manley 2014). Chen and Manley have continued to examine governance, performance, and collaborative partnerships (Manley and Chen 2017) (Chen, Manley, et al. 2018) and these contributions have furthered the understanding of governance mechanisms and behaviors (Zheng, Lu and Chang 2019).

Notably, Chen and Manley categorize leadership as an IG mechanism, typically emerging from participating organizations based on individuals' experience and skills. While this may apply to their case studies, AEC project teams are often formed through formal selection criteria defined in project governance documents. While the selection of AEC project teams can be determined by the lowest cost by a qualified bidder, certain project organizations, specifically CPD methods, will select teams based on skills and experienced of the organizations and individuals. Such processes may be explicitly outlined in governance frameworks and embedded

in contractual language that shapes team behavior. These specific criterions found in these types of projects are worthy of further examination and will help with understanding of how leadership is formed through its governance.

2.5 Collaborative Project Delivery (CPD) and Integrated Project Delivery (IPD)

AEC project organizations are complex networks of interdependent companies, disciplines, and individuals working together to deliver a unique product. The individuals tasked with managing and leading these project teams will have at their disposal a selection of strategies, systems, and resources decided to be the most appropriate of their specific project and desired outcomes. As project complexity increases—through factors such as building type, size, risk, cost, and schedule—organizations increasingly adopt CPD strategies to structure and guide project teams.

A CPD approach integrates people, systems, structures, and practices into unified processes that collaboratively harness the expertise of all participants to optimize the project results including an increased value to the owner, the reduction in waste and maximize efficiency throughout the duration of the project organization (The American Institute of Architects 2007). Although specific CPD strategies and methods may vary across projects, they share a common goal: to foster a culture of collaboration and transparency. This includes partnering agreements intended to create an integrated team of key project participants. Multi-party agreements are often used to share risk and profit among cross-functional project teams, including architects, engineers, GC, and facility managers. By including and empowering key stakeholders, CPD facilitates distributed decision-making that leverages diverse expertise across the team. Such

organizations aim to generate greater value by accessing a broader range of knowledge within their teams. They believe these strategies are effective in exchanging information, problem solving, collaborating, and coordinating complex projects.

CPD project types represent a departure from traditional delivery models such as design-bid-build. The formation of the project teams can be fragmented by the phase of the project and defined by their individual transactional contracts with the owner, which is then subcontracted through design disciplines and trade contractors. In traditional models, such as design-bid-build, design and construction are often siloed, with limited mechanisms for risk sharing, collaborative profit distribution, or open information exchange. It is not to say that traditional industry practices are antithetical to creating a collaborative culture of a project team, but it does present a notable difference in how leadership and sharing is intended and formed its project organization.

Leadership structure plays a critical role in cultivating the collaborative culture required for CPD projects. This is achieved by integrating team members early and aligning roles with project values and goals (The American Institute of Architects 2007). In this research, SL is defined as "multiple people engaging in the role of leadership within a group," contrasting with traditional hierarchical systems characterized by a command-and-control dynamic (Avolio, Walumbwa and Weber 2009). This distributive approach of multiple people occupying leadership roles within a team is very similar to the SL strategies described in several publications. Evidence suggests that teams utilizing a SL approach are more effective and facilitate greater trust and cohesion compared to their hierarchal counterpart (Hoch and

Kozlowski 2014) (Avolio, Walumbwa and Weber 2009), and appear to identify key features that could describe the intended characteristics of IPD teams.

IPD frameworks similarly emphasize collaborative outcomes and stakeholder inclusion in decision-making processes. However, the systems and strategies can vary widely across projects regardless of the organizational familiarity. While these inconsistencies in strategy can create a challenge in understanding how it supports the intended collaborative outcomes, the intention to create a SL approach could be more apparent. Researchers have identified conditions that promote the development of SL (Carson, Tesluk and Marrone 2007) as well as systems that support it in virtual teams (Bergman, et al. 2011) (Hoch and Kozlowski 2014), in the fields of organizational behavior, team science, and project management.

AEC project organizations—and CPD environments in particular—offer an ideal setting for studying SL. CPD settings encompass both formal and IG mechanisms, including contractual agreements, strategic planning, training, resource allocation, and facilitation, and possibly the key ingredients in the AEC project organization that lead to the development of SL.

Chapter 3: Methodology

In this chapter, I explain my research methodology including the mixed methods approach, boundaries and project selection for case study analysis, research design + strategy, data collection, data analysis, and research method limitations and reliability + validity that helps me address my research question.

3.1 Research Methodology

This research aimed to examine CPD governance and its influence on the formation of SL within MEPFSA coordination teams. To achieve this, the study focused on the perspectives and lived experiences of individuals working within MEPFSA coordination teams and a mixed method case study analysis was selected to examine the complex nature of the AEC project organization and the social phenomena of leadership. Careful consideration of the case was required to ensure the group that was being selected was bound to the uniqueness of the governance that is developed during a CPD project. These boundaries guided project selection and informed the research strategy, data collection, and analysis, enabling a focused investigation of the central research question.

3.1.1 Methodological Approach – Mixed Methods Case Study Analysis

The purpose of this study is to examine the IG mechanisms within CPD methods and how they influence the emergence of SL in virtual teams utilizing BIM technologies. Investigating the relationship between governance and SL contributes to understanding how to intentionally shape project team culture—a finding with potential applications for broader organizational context. These project teams under examination consist of varied complex

network organizations, roles, trades, and disciplines whose work becomes the federated model that supports the execution of the building teams in the field.

A case study methodology was selected to explore the complex dynamics of AEC project organizations and the social phenomenon of leadership. This approach allowed for an in-depth examination of the small group behavior, the life cycle of the project, and organizational and managerial processes (Yin 2018) and examined the factors that impacted the real issues of the AEC project (Taylor, Dossick and Garvin 2011). This approach was well-suited to addressing the "how" and "why" of the research topic (Yin, 2018) This approach was well-suited to addressing the "how" and "why" of the research topic (Taylor, Dossick and Garvin 2011). This allows for in-depth focus on the case and examine the group behavior and organizational processes that are at the heart of the research question at hand (Yin 2018). This would apply to the cases that consist of building construction project teams that utilize a BIM digital tool to assist in the MEPFSA coordination process and CPD methods such as IPD, design-build, and CM/GC at risk. With the existence of complexity within the framework of the project, a case study approach to examine the research question of IG and the formation of share leadership was warranted.

While the case study approach was appropriate for exploring the project-level phenomenon, a more comprehensive understanding required multiple methods to address the nuances of the research topic (Leedy and Ormrod 2019). With the main topics of this research being SL and governance, the methods used to examine each of them are quantitative and qualitative. To capture the lived experiences and perspectives of MEPFSA coordination team

members, qualitative methods such as interviewing individuals and conducting ethnographic observations of the MEPFSA coordination team, to understand the how and why (Yin 2018) of the IG developed and its relationship with SL were utilized. The interview protocol was designed to elicit insights about project governance and team collaboration, both of which may reflect elements of the project's IG system. The responses from the individuals being interviewed will be examined for themes that have an association with SL and collaborative project governance. Additionally, ethnographic observations of coordination meetings will take place to help further identify themes of project governance being used in the team's efforts to complete the coordinated federated model for construction.

To assess SL, the widely adopted Shared Leadership Questionnaire (SLQ) was distributed to MEPFSA team members (Fausing, et al. 2015) (Grille, Schulte and Kauffeld 2015) (Serbon and Roberts 2016) (J. E. Hoch 2013). The evaluation of SL will be conducted via a questionnaire/survey that will be distributed to each of the members of the BIM/virtual construction team and the instrument of evaluation is done through the SLQ. This questionnaire was created to assess both SL and hierarchical leadership based on terms of transformational, transactional, directive, empowering, and aversive leadership behaviors (Hoch, Dulebohn and Pearce 2010). Each leadership category includes 4–6 items, rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), evaluating perceptions of team members' leadership behaviors (Hoch, Pearce and Welzel 2010). This assessment will then be discussed in relation to the responses from the individual interviews that address collaborative project governance and validation of SL.

These mixed-method approaches enabled each case study to identify patterns in SL and collaborative governance, forming the basis for discussion and future research directions.

3.1.2 Bounding the Case Study

By defining the boundaries of this case study, the scope of research on SL within MEPFSA coordination teams was clarified, allowing for an effective and appropriate approach to data collection through archival analysis, field observations, interviews, and surveys. These boundaries were established to enable meaningful comparisons between selected cases and to bridge existing knowledge of SL with observed practices in MEPFSA coordination teams.

While the focus on CPD projects established a primary boundary, additional factors—including project size, type/purpose, location, budget, schedule, and project phase—were also considered. Because this research depended on the participation of willing organizations, project characteristics varied based on availability. However, a baseline level of commonality was required to ensure comparability across cases.

Organizations were initially identified for participation based on their history with CPD methods and involvement in professional groups such as the Lean Construction Institute (LCI) or the Design-Build Institute of America (DBIA). Final case selection for interviews and survey distribution was limited to projects that met defined criteria: active use of CPD methods, involvement of key stakeholders (owner, designer, GC, and trade partners), and the formation of an MEPFSA coordination team.

3.1.3 Selecting Case Studies

Case studies were selected based on project characteristics that aligned with the research boundaries and the availability of participants. With the unit of analysis defined as the MEPFSA coordination team, the research sought to identify participants from organizations actively using CPD methods and participating in BIM coordination.

Selection was limited to participants who served on the MEPFSA coordination team, ensuring they had relevant experience with both the virtual coordination process and the shared governance structures required in CPD environments. Participant eligibility also required that the project teams operate within an integrated virtual environment and use BIM coordination practices as part of project delivery.

Additional criteria for selection included a demonstrated willingness to participate in research, the availability of digital coordination records and project artifacts, and access to virtual coordination meetings. These factors were essential for understanding both the formal and informal mechanisms of SL and governance. Ultimately, participants were selected to ensure data could be triangulated across interviews, surveys, and document analysis, thereby increasing the validity of the case study findings.

3.2 Research Design + Strategy

Five case studies were selected that met the criteria for examination, and each of their unique settings is described in the following sections. The case study identification system used two numbers: the first indicating the GC and the second indicating the specific project. For

example, 1-1 indicates GC 1 and its first project included in the study. This research ultimately included three GC and five separate projects; the research settings, participants, and sampling are described in the following subsections.

3.2.1 Case Study 1-1: CM at Risk/GMP - Data Center

This is the first of three projects associated with a GC active in the western United States and experienced with CPD. Case Study 1-1 focused on a data center project that utilized a construction manager (CM) at risk/guaranteed maximum price (GMP) delivery approach to manage the MEPFSA coordination team, aligning with the study's objective of examining the research question.

3.2.1.1 Case Study 1-1: Research Setting

This case study was conducted within the framework of CPD, using the CM at risk/GMP approach and a MEPFSA coordination team that operated both virtually and in person. The CM at risk/GMP approach was considered a form of CPD in this research because it allowed the GC to participate in preconstruction as the construction manager and incentivize the cost savings through the GMP approach. This approach enabled the development of a MEPFSA coordination team during preconstruction to produce a coordinated federated model that the same organizations would later execute during construction. Interviews and surveys were conducted online using Zoom and Google Forms, respectively. Interview sessions were recorded and transcribed using Zoom, and survey results were collected online. At the time of data collection, the project was approaching the start of construction activities, and the MEPFSA coordination team had been collaborating throughout preconstruction.

3.2.1.2 Case Study 1-1: Participants and Sampling

The "population" for the mixed-method case study approach centered on individuals participating in MEPFSA coordination, including those directly responsible for developing the federated model and those involved in coordinating and executing the associated MEPFSA scopes. Although team composition may vary, the list of roles provided to all GC leads across the case studies was based on previous research (Khanzode, Fischer, and Reed 2008) and included owner representatives; architects; GC project managers, engineers, and coordinators; MEPF trade project managers, engineers, and detailers; and MEPS design engineers (Khanzode, Fischer and Reed 2008). The research participants for this case study were both employees of the GC's organization: one from the field supervision team, who worked directly with the MEPFSA BIM coordination team, and the VDC coordinator, who facilitated the MEPFSA coordination and executed the BIM plan for this and other projects within the organization. Both the field supervisor and the VDC coordinator were interviewed to explore the project's IG elements; only the field supervisor completed the SLQ. Participants were recruited through the GC's VDC coordination leadership, with the goal of identifying MEPFSA coordination team members from the GC, design team, trade contractors, and any other organizations involved in MEPFSA coordination meetings.

3.2.2 Case Study 1-2: Progressive Design-Build – Campus Capital Project

The second case study associated with this GC organization focused on a campus capital project utilizing a CPD approach known as progressive design-build. Case Study 1-2 is the first

of two projects using the progressive design-build approach with the same owner; the other is described in Case Study 2-1 and involves a different GC.

3.2.2.1 Case Study 1-2: Research Setting

This case study was conducted within the framework of CPD, using a progressive design-build approach and a MEPFSA coordination team that operated both virtually and in person. The progressive design-build approach was considered a form of CPD in this research due to the direct contract between the integrated design-build team and the owner, as well as the use of tools and methods associated with IPD and lean construction. Interviews and surveys were conducted online using Zoom and Google Forms, respectively. Interview sessions were recorded and transcribed using Zoom, and survey responses were collected online. At the time of data collection, project construction was nearly complete, and the majority of the MEPFSA coordination team had finished their scopes of work.

3.2.2.2 Case Study 1-2: Participants and Sampling

Research participants in this case study included employees from both a design organization and the GC. The designer was directly involved in developing the federated model and coordinating their design scopes and construction activities. The GC participant was the same VDC coordinator from Case Study 1-1 and held the same responsibilities on this project. Both the designer and the VDC coordinator were interviewed to explore the project's IG elements, but only the designer completed the SLQ. Participants were recruited through the GC's VDC coordination leadership, with the goal of identifying MEPFSA coordination team members from the GC, design team, trade contractors, and any other participating organizations

3.2.3 Case Study 1-3: Progressive Design-Build – Public Works Capital Project

The third case study associated with this GC organization focused on a large, multi-phased public works capital project utilizing a CPD approach known as progressive design-build, like case studies 1-2 and 2-1.

3.2.3.1 Case Study 1-3: Research Setting

This case study was conducted within a CPD framework using the progressive design-build approach, with a MEPFSA coordination team that worked both virtually and in person. The progressive design-build approach was considered a form of CPD in this research due to the direct contact between the integrated design-build team and the owner, as well as the use of tools and methods associated with IPD and lean construction. Interviews and surveys were conducted online using Zoom and Google Forms, respectively. Interview sessions were recorded and transcribed using Zoom, and survey results were collected online. At the time of data collection, the project was in the middle of a multi-phased effort, with MEPFSA coordination ongoing and the team already well established.

3.2.3.2 Case Study 1-3: Participants and Sampling

Participants in this case study included employees from both the design organization and the GC. The designer was directly involved in developing the federated model and coordinating their design scopes and construction activities. The GC participant was the same VDC coordinator from Case Study 1-1 and held the same responsibilities for this project. Both the designer and the VDC coordinator were interviewed to explore the project's IG elements; only

the designer completed the SLQ. Participants were recruited through the GC's VDC coordination leadership, with the goal of identifying MEPFSA coordination team members from the GC, design team, trade contractors, and other participating organizations.

3.2.4 Case Study 2-1: Progressive Design-Build – Campus Capital Project

This is the only case study associated with this GC organization, focusing on a campus capital project that utilizes a progressive design-build approach. This is the second case study involving this project delivery approach and project owner. The Western U.S.-based GC is highly experienced with CPD projects and leading VDC coordination for MEPFSA teams.

3.2.4.1 Case Study 2-1: Research Setting

This case study was conducted within the framework of CPD, using a progressive design-build approach and a MEPFSA coordination team that operated both virtually and in person. The progressive design-build approach was considered a form of CPD in this research due to the direct contract between the integrated design-build team and the owner, and its use of tools and methods associated with IPD and lean construction. Interviews and surveys were conducted online using Zoom and Google Forms, respectively. Interview sessions were recorded and transcribed using Zoom, and survey results were collected online. At the time of data collection, the project was nearing completion of the federated BIM model, and preconstruction activities were also nearly complete.

3.2.4.2 Case Study 2-1: Participants and Sampling

Participants in this case study included employees from design and trade organizations who were directly involved in developing the federated model and coordinating their design scopes and construction activities. Of the five participants, three were interviewed, and four completed the SLQ.

3.2.5 Case Study 3-1: IPD - Healthcare

The final case study in this research focuses on a healthcare project utilizing an IPD approach and is the only case associated with this GC organization. This is the only case study using the IPD approach. Both the project owner and the Western U.S.-based GC are highly experienced with IPD projects and VDC coordination for MEPFSA teams.

3.2.5.1 Case Study 3-1: Research Setting

This case study was conducted within the framework of CPD using the IPD approach, with a MEPFSA coordination team that worked primarily in person, with virtual capabilities. The IPD approach was considered a form of CPD in this research due to the multi-party contract among the GC, designers, selected trade contractors, and owner, as well as the intentional use of lean construction tools. Interviews, observations, and surveys were conducted online using Zoom, Microsoft Teams, and Google Forms, respectively. Interview sessions were recorded and transcribed using Zoom, and survey results were collected online. Observation notes were recorded in a spreadsheet, and meeting screenshots were saved locally on my computer. At the time of data collection, the project was nearing the end of MEPFSA coordination for the second

phase of this multi-phased project, while construction activities had already begun on the previous phase.

3.2.5.2 Case Study 3-1: Participants and Sampling

Research participants for this case study included three GC employees and a field supervisor from the trade contractor. All four individuals were directly involved in developing the federated model and coordinating construction activities. Two individuals and the trade contractor's field supervisor participated in interviews. The remaining GC employee, who was not interviewed, completed the SLQ. Participants were recruited through the GC's project and VDC leadership, with the goal of identifying MEPFSA coordination team members from the GC, design team, trade contractors, and other participating organizations.

3.3. Data Collection

Data collection for this research followed a mixed methods approach that included two qualitative methods and one quantitative method. These methods included participant interviews, field observations, and the SLQ. Collecting data through interviews and field observations required developing and defining IG elements based on a literature review and operationalized definitions of how governance manifests in MEPFSA coordination teams using CPD, Additionally, SL was operationalized to explore its correlation with the IG elements. All three methods used in these case studies support the construction of external validity, internal validity, and reliability. Since each method was developed in relation to SL, findings are considered valid and reliable if the sources converge on similar conclusions (Yin 2018). The reasoning and justification for each method and its application are explained in the sections below.

Data Collection Methods – Reasoning and Justification

The following sections describe the reasoning and justification for the chosen data collection methods, including the creation of IG elements and the operationalization of CPD and SL.

Creating IG Elements and Operationalizing CPD and SL – Reasoning and Justification

As outlined in the literature review, knowledge surrounding SL, CPD, and project governance is widely defined across various industries but may not be easily recognizable during fieldwork for these case studies. To identify how these concepts manifest within the AEC industry, IG elements were created using operationalized definitions of governance, CPD systems, and SL that would be recognizable within the context of the MEPFSA coordination team. These IG elements and operationalized definitions emerged from the need to understand how governance and SL appear in CPD projects. This approach was necessary to recognize these concepts in real-world settings during quantitative research (Leedy and Ormrod 2019). Once the IG elements were operationalized, interview questions were developed.

The first step in creating the IG elements was to synthesize findings on project governance from the literature review. This process focused on the work of Chen, Manley, and Lewis, who categorized governance mechanisms in AEC projects as either formal or informal. Formal mechanisms consist of contractual incentives for clear and equitable risk allocation. These include collective cost information, negotiated cost, commercial frameworks, risk and reward sharing regimes, design integration, qualitative performance measurement, collaborative

multi-party agreements, and early contractor involvement. Informal mechanisms include non-contractual incentives designed to enhance mutual trust, enable cooperation, facilitate open communication, and promote knowledge sharing. These mechanisms include leadership, team integration, team workshops, communication systems, and relationship management (Chen, Manley and Lewis, Exploring Governance Issues on Collaborative Contracts In The Construction Industry 2012) (Chen and Manley, Validation of an Instrument to Measure Governance and Performance on Collaborative Infrastructure Projects 2014) (Chen, Manley, et al., Procurement and Governance Choices for Collaborative Infrastructure Projects 2018). Based on this understanding of IG, these elements were selected to address the research question, which was subsequently refined to emphasize IG throughout the remainder of the study.

Operationalizing CPD Governance and SL – Reasoning and Justification

The next step was to operationalize CPD governance systems and approaches used by MEPFSA coordination teams, which should be considered forms of project governance. To create these terms, the research focused on literature detailing CPD approaches, including the 2014 paper by Molenaar et al., "Examining the Role of Integration in the Success of Building Construction Projects," and the 2017 textbook by Fischer, Ashcraft, Reed, and Khanzode, Integrating Project Delivery. The operationalized terms developed included: participation in BIM planning, BIM implementation strategy, design charrettes, processes for defining project objectives and joint goal-setting, goal quality, creation and quality of team co-location and shared workspaces, team formation, mentoring, facilitation, team size, team composition and cohesion, team training, decision-making, team development, team effectiveness, BIM utilization, BIM group cohesiveness, team tools and software, team support, and team

constraints. These operationalized CPD system terms were then paired with the IG elements described in the previous section.

To examine how governance influences the formation of SL, operationalized definitions of SL were developed to help identify associations between the two concepts. The reviewed literature led to a set of operationalized SL terms, including: Leadership Participation, Clear Objectives and Goals, Unified Commitment, Competent Team Members, Collaborative Climate, Standards of Excellence, External Support and Recognition, Focus on the Goal, Ensuring a Collaborative Climate, Building Confidence, Demonstrating Technical Competence, Setting Priorities, Managing Performance, Leadership Behaviors, Self-Managing/Coordinating, Leadership Clarity, Project Value and Goals, Team Dynamics, SL Empowerment, Coordinating with Teams, and Team Continuity (Northouse 2018) (Fischer, et al. 2017) (Bergman, et al. 2011) (Morgeson, DeRue and Karam 2010) (Pearce, Manz and Sims, Is Shared Leadership the Key to Team Success? 2010). With project governance, CPD systems, and SL operationalized, the next step was to select definitions that would inform the creation of governance elements used to shape interview questions and field observations.

Developing New IG Elements Definitions – Reasoning and Justification

By focusing on the informal mechanisms of project governance and using operationalized definitions of VDC governance and SL, this research developed a set of project-specific IG elements. The five IG elements were defined and developed based on their relationship to SL and include operationalized definitions used to guide interview question development and field observations.

1. Team Organization: How people meet up and work together

This element was developed from the informal mechanisms of leadership, relationship management, and team integration. Its connection to SL includes external support and recognition, as well as leadership participation. The operationalized IG elements include clearly defined team roles and the presence of an assigned team facilitator.

IG Element Defined	IG Element Operationalized	How Does This Relate to SL?
Team Organization: How people meet up and work together	Team Roles are Clearly Understood	External Support and Recognition
	Assigned Team Facilitator	Leadership Participation

Figure 2 -IG Element Defined: Team Organization

2. Decision Making: How decisions are made

This element was derived from team integration and relationship management. Its connections to SL include the presence of multiple leaders within a group, leadership behaviors and clarity, team coordination, SL empowerment, team dynamics, goal orientation, and alignment with project values. The operationalized IG elements focus on participation in planning and goal-setting exercises, decision-making, and the use of established processes.

IG Element Defined	IG Element Operationalized	How Does This Relate to SL?
Decision Making: How Decisions are Made	Participation in BIM Execution Planning	Multiple Leaders in a Group, Shared Leadership Empowerment
	Participation in Pull Planning Exercises	Multiple Leaders in a Group, Shared Leadership Empowerment
	Participation in Goal Setting Exercises	Focus on the Goal, Project Value and Goals
	Allowed in Decision Making	Multiple Leaders in a Group, Shared Leadership Empowerment
	Allowed to Change Goals as the Project Moves Forward	Focus on the Goal, Project Value and Goals
	Decisions Are Made with Plurality of Team Members Present	Multiple Leaders in a Group, Shared Leadership Empowerment, Coordinating with Teams, Leadership Behaviors and Clarity
	A Decsion Making Process that Has Been Developed or Agreed Upon By the Team	Coordinationg with Teams, Team Dynamics

Figure 3 - IG Element: Decision Making

3. Team Building: Activities that build team rapport

This element was developed from team integration, relationship management, and team workshops. Its relationship to SL includes unified commitment, team dynamics, competent team members, and team continuity. The operationalized IG elements include participation in team training exercises, team-building "boot camps," engagement in non-work-related activities, and interest in working with team members on future projects.

IG Element Defined	IG Element Operationalized	How Does This Relate to SL?
Team Building: Activities that Build Team Rapport	Team Participation in Training Exercises	Competent Team Members
	Team Building "Boot Camp"	Competent Team Members, Team Dynamics, Team Continuity
	Team Members Participate with Each Other for "Non-Work" Activities	Unified Commitment, Team Dynamics, Team Continuity
	Desire to Work on Future Projects with Team Members	Unified Commitment, Team Dynamics, Team Continuity

Figure 4 - IG Element: Team Building

4. Communication Systems: How you document decisions and goals

This element was derived from communication systems. Its relationship to SL includes a collaborative climate, clear objectives and goals, performance management, and external support and recognition. The IG elements operationalized focused on open, honest and hard conversations taking place, team performance is measured, and access to decision making platforms.

IG Element Defined	IG Element Operationalized	How Does This Relate to SL?
Communication Systems: How You Document Decision and Goals	Open, Honest, and Hard Conversations Take Place	Collaborative Climate, External Support and Recognition
	Team Performance is Measured	Clear Objectives and Goals, Managing Performance, External Support and Recognition
	Access to Decision Making Platforms	Clear Objectives and Goals, Managing Performance, External Support and Recognition

Figure 5 - IG Element: Communication Systems

5. Workspaces: Where you work

This element was developed from team integration and communication systems. Its relationship to SL includes team coordination, maintaining a collaborative climate, and fostering team dynamics. The operationalized IG elements include the use of common or integrated BIM technologies and clearly defined workspaces dedicated to the project team.

IG Element Defined	IG Element Operationalized	How Does This Relate to SL?
Work Spaces: Where You Work	Common/Integrated BIM Technologies	Ensure a Collaborative Climate
	Defined Work Spaces Specifically for Project Teams/Work Groups	Ensure a Collaborative Climate, Team Dynamics

Figure 6 - IG Element: Workspaces

Participant Interviews – Reasoning and Justification

With the IG elements defined, the focus shifted to identifying appropriate methods for collecting data from the case study–specific MEPFSA coordination teams within the context of their CPD project. I decided that interviewing individuals from the MEPFSA coordination teams would allow me to examine the more complex emergence of project governance and suggest the hows and whys of key events (Yin 2018). Through these interviews, I will be able to ask questions related to facts, feelings, motives, people's beliefs and perspectives, and present and past behaviors (Leedy and Ormrod 2019). With this in mind, I set out to develop a set of questions that would meet the parameters of my interview guidelines.

As in previous research on SL, the goals of the interviews were to address team context—specifically participation, strategy, external influences, facilitation, and decision-making

processes—and to explore how participants would describe SL behaviors such as initiating structure, consideration, envisioning, and spanning, as discussed in prior research (Bergman, et al. 2011). Based on this objective, and in setting parameters for a productive interview, I decided that each session should last no longer than one hour. I chose to conduct interviews via Zoom to provide accessibility for participants, accommodate my inability to travel for in-person sessions, enable recording and transcription capabilities, and support a conversational flow through general guiding questions (Leedy and Ormrod 2019). Of the five IG elements defined and eighteen IG elements operationalized; I created seventeen interview questions to guide the discussions. After sending the questions to AEC industry and academic professionals not involved in the case studies for proofreading and feedback, I incorporated the suggested revisions and prepared to begin interviewing participants. Each question corresponds to a specific operationalized IG element, as listed in Appendices A and B.

Direct Observations – Reasoning and Justification

A multitude of factors influence the development of SL in virtual teams, and the workplace environment should not be overlooked. Observing the immediate environment in which individuals work can reveal the culture of the project organization and offer deeper insight into how CPD governance is applied in the field (Yin 2018). These observations can be made in virtual spaces where team members meet, as well as in physical workplaces such as project and organization offices. (Direct observations of work-from-home offices will not be conducted, though knowing where people work remains valuable.). With this understanding, I used the IG elements and their operationalized definitions as a guide for what to observe during these visits.

The Shared Leadership Questionnaire – Reasoning and Justification

I used the SLQ to assess SL in the MEPFSA teams. This Likert-scale survey, which includes six categories and 26 rated items, has demonstrated excellent measurement quality and reliability (Hoch, Dulebohn and Pearce 2010). The six categories are labeled as transformational leadership, transactional leadership, directive leadership, empowerment (individual), empowerment (team), and aversive leadership. Items in these categories are rated by participants on a scale of: strongly disagree, disagree, neutral, agree, and strongly agree, with each rating corresponding to a numerical value from 1 to 5, respectively. Each case study will report average scores and standard deviations, with results broken down by overall score, category, and item. The survey was expected to take no more than ten minutes to complete and was made available online through a Google Form created using my UW account.

Case Study Data Collection Recap

Data collection for the case studies began in September 2024 and concluded in April 2025. Each volunteer participant was informed of the study's purpose and the tasks they would be asked to complete, and their consent was obtained prior to providing any data. Each case study included at least one participant interview. For case studies 1-1, 1-2, and 1-3, the responses from the VDC coordinator were applied across all three. Interviews lasted between 45 and 60 minutes and were conducted online via Zoom, which also recorded and transcribed them.

A total of seven field observations were conducted for case studies 2-1 and 3-1, with none for case studies 1-1, 1-2, or 1-3. Field observations of MEPFSA coordination meetings typically lasted between 60 and 90 minutes. Two in-person field observations were conducted for

case study 2-1, including a project Big Room meeting held immediately before the VDC coordination meeting. The number of participants in each field observation varied, ranging from approximately 13 to 30.

There were eleven responses to the SLQ, with each case study receiving at least one response. Case studies 1-3 and 2-1 had the highest number of responses, with four each, while case studies 1-1, 1-2, and 3-1 each had only one response. The survey was created in Google Forms and emailed to participants after they provided consent. The table below summarizes the data collection for each case study, detailing the number of interviews, SLQ responses, field observations, and the data collection date range.

Table 1 - Case study recap of data collection

Case Study ID	Interview Responses	# of SLQ Responses	Field Observations	Data Collection Period
CS 1-1	2	1	0	Fall 2024-Winter 2025
CS 1-2	2	1	0	Fall 2024-Winter 2025
CS 1-3	2	4	0	Summer 2024-Winter 2025
CS 2-1	3	4	3	Summer 2024-Fall 2024
CS 3-1	3	1	4	Winter 2025-Spring 2025

3.4 Data Analysis

The data collected through participant interviews, direct observations, and the SLQ will be sorted by case study, with qualitative coding strategies and quantitative statistical analysis used to examine IG and SL.

To review interview responses and field notes from direct observations, qualitative coding analysis will be used to meaningfully dissect the data while preserving the relationships between components (Miles and Huberman 1994).

My coding approach for both direct observations and interviews is similar, as the codes and themes I analyzed in field notes and responses were developed based on the IG elements and their operationalized definitions. As part of developing the IG elements and their operationalized definitions, I posed the question, "What is the goal of this question?" These guiding questions can be found in Appendix A. Each of the 18 IG elements' operationalized definitions included this guiding question, which was then used to identify themes in interview responses.
Similar to the approach used for coding interviews, I reviewed the direct observation notes and assigned any descriptions that aligned with the goal of a question to the corresponding operationalized IG element for further analysis. Direct observation field notes could also be coded to multiple operationalized IG elements.

Once interview responses were coded for themes, I generated a takeaway for each and compiled them in a spreadsheet that allowed each response to be reviewed alongside others within the same case study. I then described these takeaways in the findings for each case study and included an overall finding for each IG element examined.

A similar process was applied to the direct observation field notes. However, while the interview themes aligned with 17 questions tied to the same operationalized IG elements, the coding of field observation notes was more scattered and limited to fewer IG elements. For each

case study, the number of observations was recorded, along with descriptions of the observations and how they related to the goal of the corresponding operationalized IG element.

The SLQ required a quantitative analysis that examined statistical averages to assess the presence of SL within each case study team. Each case study was assigned an overall SLQ score based on all 26 items, along with average scores for each of the six categories. Each item was rated on a Likert scale, where 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Average scores were then calculated to assess SL. Simply put, an average score above 3.00 suggests the emergence of SL. The closer the average score is to 5.00, the stronger the indication of SL. Standard deviation values help reveal discrepancies among responses, indicating potential disagreement within the sample. Data for each category and item was also analyzed for outliers that could indicate specific aspects of SL occurring within these AEC projects, which are characterized by the complex and unique makeup of temporary teams (R. Cheng, Integration At Its Finest: Success in High-Performance Building Design and Project Delivery in the Federal Sector 2015) (Cheng, et al. 2016) (Kramer and Tyler 1996).

3.5 Research Method Limitations and Reliability + Validity

Limitations to Mixed-Methods Case Study Research

The benefits of using a mixed-methods approach in case study research include the ability to interpret both quantitative and qualitative data as a cohesive whole (Leedy and Ormrod 2019). However beneficial this is to the research, there are limitations specific to the case study approach, as well as the qualitative, quantitative, and overall mixed-methods components.

Traditional concerns surrounding the case study approach often focus on its perceived lack of rigor, confusion with "nonresearch" case studies, and questions about its comparative advantage (Yin 2018). Concerns about the rigor of the case study approach include the potential for researcher sloppiness and the significant effort required to draw meaningful conclusions (Yin 2018). While this research is not exempt from these concerns, efforts were made to bound the case within the study environment, and a structured research design was developed. Regarding concerns about being mistaken for a "nonresearch" case study, this research follows a clearly stated methodology. The final concern involves the argument from some quantitative scholars who claim their methods are more reliable, yet these methods require more controlled environments to yield such reliability. If their methods were solely applied to the problems explored in this research, the data would likely be unreliable due to the complexity of the social environment under study.

The mixed-methods approach raises credibility concerns related to how the qualitative and quantitative components are integrated. I address these concerns by ensuring that the samples are sufficiently similar to justify comparisons between the qualitative and quantitative data, and by evaluating whether data from both methods are equally relevant and lead to similar conclusions (Leedy and Ormrod 2019). This overarching strategy addresses concerns with the mixed-methods design by continually evaluating what the data mean in relation to the research question (Leedy and Ormrod 2019). Throughout this research process, I was mentored to develop the habit of consistently asking, "How does this relate to my research question?" This

discipline ensured that all methods were framed within that context, leading to a straightforward analytical approach that has been documented throughout this paper.

Triangulation of data also helps balance the insights gained through data collection, as the weaknesses of one method can be mitigated by the strengths of another. For example, the SLQ provides an indication of SL formation through a Likert scale, but lacks the "why" that interviews can reveal. When response bias potentially affects interviews, I understood that this cannot always be avoided in a phenomenological study, which intentionally seeks personal perspectives to address a particular situation. Even with that understanding, I used data from direct observations to determine whether participants' actions aligned with their descriptions during interviews (Leedy and Ormrod 2019). This triangulation leverages the disadvantages of one method against the advantages of another to enhance the validity of the findings and further supports the mixed-methods approach used in this research.

A significant limitation of the quantitative data gathered is the small sample size. The observed teams typically consisted of 15 to 30 members, and when sample sizes are fewer than 100, the entire population should ideally be surveyed (Leedy and Ormrod 2019). This posed a significant challenge at the outset of the research, as it is difficult to secure participation from busy professionals who are often working overtime to complete their core responsibilities. To address this, I met with the GC contact for each case study and provided a list of relevant team roles. I also prepared an introduction to myself and the research, which the GC contact would then email to the MEPFSA coordination team. While some projects responded promptly, the number of survey participants remained lower than the number of individuals I observed

attending coordination meetings. I continued a strategy of gentle persistence, encouraging interviewees to share the survey with their peers, but response rates eventually declined to a trickle. This limitation significantly affects the credibility of the SLQ findings and is further addressed in the conclusions.

There were also limitations in the decisions I made when developing the IG elements, including both the governance mechanisms I chose not to include and the breadth of the elements I did select for examination. The term governance itself is difficult to define, as its wide-ranging use and terminology have been a barrier to theory building (Ansell and Gash 2007). My application of governance in the AEC context was largely informed by the publications of Chen, Manley, and Lewis, who distinguished between formal and informal mechanisms, further defined as contractual and non-contractual governance. While there is reason to believe that formal mechanisms may also influence the formation of SL, I chose to focus on informal mechanisms, as I believed they would be more directly applicable to shaping the culture of SL. Even within this narrower focus, I refined the list of IG elements further—for example, combining leadership and relationship management into team organization, and grouping team integration within decision making. Ultimately, I developed five IG elements that formed the basis of my interview questions and field observation strategy.

The methods used to define and refine these five elements created a limitation in themselves. By examining multiple elements, I traded depth for breadth, potentially overlooking the deeper insights that might have been gained from a more concentrated focus on a single IG

element. These methodological choices shaped the knowledge I was able to access and, at the same time, constrained what could have been discovered had the scope been different.

In addition, while the SLQ provided a valuable tool for assessing perceptions of SL and offered internal validation through its multidimensional design, its application in this research was constrained by the number of responses obtained in each case study. The limited sample size reduces the ability to generalize results and raises the possibility that individual responses disproportionately influenced findings. Thus, although the SLQ strengthened triangulation with interview and observation data, its validation properties cannot fully offset the limitations posed by response variability and sample size.

Lastly, I cannot overlook my own researcher bias, which may predispose me to favor certain variables and influence the conclusions I draw (Leedy and Ormrod 2019) I have worked for over 25 years in the construction industry and currently own a consulting company involved in all facets of construction management, with a specific focus on supporting CPD approaches. My role often involves facilitating pull planning meetings and implementing Last Planner™ System practices for both office and field activities. I have also worked for one of the GC organizations and continue to admire and adopt many of their approaches in my own consulting practice. I acknowledge my own phenomenological lens and have approached this research with a commitment to reflexivity—first by recognizing this bias and then by explicitly communicating these challenges. I ensured the accuracy and completeness of all qualitative data by maintaining detailed transcripts, and I explained my background to participants—not only to foster transparency, but also to encourage the use of familiar industry jargon. I also took deliberate

precautions not to leverage contacts in GC firms who might have authority over these teams, as doing so could compromise the ethical integrity of the research. While this may have limited data collection opportunities, upholding the highest standards of research integrity was paramount. Given these considerations—and the responsibility of producing knowledge through rigorous methods—maintaining integrity has remained my top priority throughout this research.

Despite the limitations outlined above, this study is strengthened by my extensive professional experience in the construction industry, which provides a unique lens for examining the subject matter. I have facilitated dozens of pull-planning exercises and design coordination efforts, as well as led Big Room sessions and subcontractor/foreman meetings, enabling me to recognize and appreciate the efforts of the facilitators I interviewed. I have also worked with VDC teams responsible for MEPFSA coordination, with experience extending back to before BIM modeling was widely used to coordinate these trades. In addition, I have worked on projects that employed CPD approaches, where I was directly responsible for implementing Lean construction tools. These and many other industry experiences have shaped my understanding of governance and SL in construction project teams. While such experience may introduce certain limitations, it also provides a distinctive perspective that strengthens the study by grounding the research in practical knowledge and enhancing its relevance to industry practice.

Chapter 4: Findings

In this chapter, I present the findings obtained from five projects using interviews, observations, and the administration of a survey called the SLQ. As outlined in the table below, the first three case studies—Case Study 1-1, 1-2, and 1-3—involve different projects managed by the same GC. The remaining two case studies, Case Study 2-1 and Case Study 3-1, are each associated with a different GC and their respective projects.

Table 2 - Case Study ID and Description

Case Study ID	GC ID	Project ID	Project Description - Project Delivery Method
CS 1-1	1	1	Data Center - GMP/CM Risk
CS 1-2	1	2	Campus Capital Project - Progressive Design-Build
CS 1-3	1	3	Public Works Capital Project - Progressive Design-Build
CS 2-1	2	1	Campus Capital Project - Progressive Design-Build
CS 3-1	3	1	Healthcare - IPD

These findings aim to illuminate the projects' IG systems and the formation of SL within their virtual design and construction (VDC) teams, which are responsible for coordinating mechanical, electrical, plumbing, fire protection, structural, and architectural (MEPFSA) systems across multiple projects in the State of Washington. Specifically, the findings presented in this chapter are organized to answer the following research question:

This research will examine the governance of collaborative project delivery methods to explore how it impacts the formation of shared leadership within virtual teams utilizing BIM technologies.

The findings for IG are presented across five elements—(1) Team Organization, (2) Decision-Making, (3) Team Building, (4) Communication Systems, and (5) Workspaces—which are further refined into operationalized indicators used to create specific interview questions (see Table 2). Case Studies 1-1, 1-2, and 1-3 include only interview data for IG, while Case Studies 2-1 and 3-1 incorporate both meeting observations and interviews. Each case study also includes findings for SL, which were developed using the SLQ. The SLQ's 26 questions are organized into five categories that structure the presentation of results (see Table 3).

Table 3 - IG Elements & Operationalized Definitions Recap

Informal Goverance Element	IG Element Operationalized
1. Team Organization: How people meet up and work together	1.1: Team roles are clearly understood
	1.2: An assigned team facilitator
2. Decision Making: How decisions are made.	2.1: Participation in BIM execution planning
	2.2: Participation in pull planning exercised
	2.3: Participation in goal setting exercises
	2.4: Allowed in decision making
	2.5: Allowed to change goals as the project moves forward
	2.6: Decisions are made with pluruality of team members present
	2.7: A decision making process that has been developed or agreed upon by the team.
3. Team Building: Activities that build team raport.	3.1: Team participation in training exercises
	3.2: Team building "boot-camp"
	3.3 Team members participate with each other for "non-work" activities
	3.4: Desire to work on future projects with team members
4. Communication Systems: How you document decisions and goals.	4.1: Open, honest, and hard conversations take place
	4.2: Team performance is measured
5. Workspaces: Where you work	5.1: Common/integrated BIM technologies
	5.2: Defined work spaces specifically for project teams/work groups

Table 4 - SLQ Categories & Question Topics

Shared Leadership Categories	Shared Leadership Question Topic
Transformational Leadership	Vision
	Idealism
	Inspirational Communications
	Intellectual Stimulation
	Intellectual Stimulation
	Perfomrance Expectations
Transactional Leadership	TRK1 - Transactional
	Material Rewards
	Two Questions Related to Personal Rewards
Directive Leadership	Four Questions Related to Participative Goal Setting
Empowerment (individual)	Two Questions Related to Independent Action
	Self-Development
	Self-Reward
Empowerment (team)	Four Questions Related to Teamwork
Aversive Leadership	Three Questions Related to Intimidation
	Reprimand

Across the five case studies, several consistent patterns emerged regarding how IG structures influenced the development of SL within MEPFSA coordination teams. In the category of team organization, all teams demonstrated a clear understanding of their roles and responsibilities in supporting BIM coordination efforts. The consistent presence of a facilitator—most often the VDC coordinator—proved instrumental in guiding teams through the coordination process, bridging technical expertise with collaborative decision-making, and fostering team alignment. While some teams demonstrated strong mutual recognition of how individual contributions supported others (e.g., Case Studies 1-2 and 3-1), others (e.g., 2-2) exhibited less evidence of this reciprocal awareness, suggesting that role clarity does not always translate into cross-functional appreciation.

Decision-making practices revealed both strengths and limitations in fostering SL. In all cases, opportunities existed for team members to engage in BIM execution planning, with

varying degrees of inclusivity in pull planning and goal-setting activities. Collaborative decision-making processes were evident in multiple cases, often guided by project-specific structures or the BIM Execution Plan. In the strongest examples (e.g., 3-1), decision-making was observed to be intentional, cooperative, and guided by a shared understanding of decision authority. Access to decision-making power was generally widespread but could be influenced by contractual boundaries, role authority, or organizational culture. The ability to adjust project goals was present in several cases, although often requiring owner authorization or adherence to established organizational procedures.

In the team building category, there was varied evidence across cases as some teams (e.g., 2-2 and 3-1) engaged in structured team-building and project-specific training to enhance collaboration. Willingness to work together on future projects was consistently high, though in some cases, this enthusiasm was tied more to prior working relationships than to project-specific IG initiatives. The findings suggest that intentional, early-stage team-building can strengthen rapport and enhance the sustainability of SL practices, while its absence may leave teams dependent on preexisting interpersonal dynamics.

Communication systems also played a significant role in supporting SL. Open, honest, and sometimes difficult conversations were observed or reported across all cases, though these were occasionally constrained by contractual relationships or organizational boundaries. Communication of team performance varied, with some teams employing a broader range of performance indicators—including KPIs and health surveys—while others relied primarily on traditional schedule and budget metrics. Coordination meetings frequently served as platforms

for documenting and communicating decisions, often through integrated BIM tools that tracked issues and resolutions.

In terms of workspaces, remote collaboration was a common feature across cases, with proficiency in virtual tools and breakout spaces observed in several teams. While most teams reported minimal challenges with BIM technology integration, others encountered alignment issues that required collaborative problem-solving. Preferences for in-person collaboration were evident in some cases (e.g., 3-1), though virtual platforms provided necessary flexibility and accessibility for geographically dispersed members.

The SLQ scores across the five case studies ranged from 3.27 to 4.27, with all scores exceeding the neutral threshold of 3.00 once the lowest-rated category, Aversive Leadership, was removed. Higher scores were generally associated with teams that demonstrated strong facilitation, intentional decision-making processes, and structured team-building efforts. Collectively, these findings suggest that while CPD IG frameworks provide a foundation for SL, the realization of its full potential depends on how IG elements—particularly facilitation, decision-making inclusivity, and early-stage team building—are applied and sustained throughout the project lifecycle.

The SLQ results across the five case studies provide a measure of internal validation for the broader findings of this research. Although the number of responses varied by case, all reported scores exceeded the neutral threshold of 3.00 when the aversive leadership category was removed. This consistency suggests that, despite contextual differences between projects,

participants recognized the presence and development of SL within their teams. Moreover, the higher scores observed in cases with strong facilitation, intentional decision-making processes, and structured team-building activities align closely with themes that also emerged from interviews and field observations. In this way, the SLQ not only functioned as a stand-alone instrument but also reinforced the validity of qualitative insights, offering convergent evidence that IG elements contributed to the development of SL in MEPFSA coordination teams.

4.1 Case Study 1-1 Findings

4.1.1 Case Study 1-1 Background

This case study focuses on a project's IG approaches and how these contribute to SL outcomes within VDC teams coordinating MEPFSA systems. The project is a data center located in the western United States, delivered under a CM at risk/GMP project delivery method, with the GC and design team contracted separately by the project owner. Two individuals were interviewed for this case study: a field supervisor and a VDC coordinator, both employed by the GC. While the VDC coordinator's responses partially pertained to the specific project, they primarily described how their organization implements IG systems more broadly. No field observations were conducted for this project, and therefore no findings are provided for IG Indicator 4.3: Access to Decision-Making Platforms. One SLQ response was collected for this case study, submitted by the same GC field supervisor who participated in the interview.

4.1.2 Case Study 1-1 Findings

The findings of this case study are presented according to the IG definitions and indicators, as well as the results of the SLQ. The SLQ findings are reported based on the overall score, the overall score excluding the Aversive Leadership category, and the individual scores for each SLQ category and their corresponding topics.

4.1.2.1 Case Study 1-1 Informal Governance

1. Team Organization: How people meet up and work together

1.1: Team Roles are Clearly Understood

Each person interviewed had a clear understanding of their role on the project. How they used BIM and participated in the VDC coordination process varied depending on their position. For example, a field supervisor used the tool to plan the physical construction work, while a VDC facilitator—who worked across several projects—described their role as "not being the expert in the room," but rather as "somebody who kind of musters everyone together" to enable knowledge sharing among the experts. Overall, each individual demonstrated a strong grasp of their responsibilities, how those responsibilities contributed to model coordination, and how their role supported others in the coordination process.

1.2: Assigned Team Facilitators

The role of VDC facilitators was clearly evident, and their value to the individual projects was widely recognized. The GC's field supervisor praised the facilitators' skillsets, noting that developing a working relationship with them opened up a wealth of knowledge that benefitted both themselves and their team. Their contributions were also acknowledged in the context of leading coordination meetings and resolving issues within the model. As the field supervisor noted, "everybody was really… invested in this and understood the scope of the project." The VDC coordinator echoed this sentiment, stating, "It's always great getting the opportunity to build those relationships on every project," and this project was no exception. By leveraging the team's knowledge, VDC coordinators drive the BIM coordination effort in a way that ultimately supports field execution and installation.

2. Decision Making: How decisions are made

2.1: Participation in BIM Execution Planning

Participation in BIM execution planning varied depending on the individual's role within the project. The field supervisor viewed their role more as a conduit between design and construction and did not consider themselves a necessary participant in the BIM execution planning process. In contrast, the VDC facilitator was deeply involved and saw themselves as ultimately responsible for developing the BIM execution plan, beginning with the very first project meeting. This initial meeting, which they described as a project kickoff, was used to review the specifics of the BIM execution plan with all team members. These findings suggest that while multiple team members can participate in BIM execution planning, involvement is limited by role and the timing of when individuals join the project.

2.2: Participation in Pull Planning Exercises

There appears to be a culture of pull planning within the GC organization that is implemented across projects in varying phases and with different levels of facilitation. While most of the pull planning meetings the field supervisor participates in are not directly connected to the VDC coordination team, they recognize that the schedules developed in these meetings influence and inform the VDC effort. The VDC facilitator was not responsible for leading any pull planning sessions, instead deferring that role to superintendents and project managers due to their focus on scheduling outcomes. The findings suggest that individuals on these projects are given opportunities to participate in pull planning, and that this practice is likely driven by the leadership and governance structures established by the GC.

2.3: Participation in Goal Setting Exercises

The discussion on participating in goal-setting exercises focused more on establishing schedule milestones rather than defining specific project goals. The field supervisor noted that the goals they develop are tied to the overall project schedule created through pull planning, rather than directly to the VDC team. However, as mentioned in response to an earlier question, they do recognize how their schedule supports the VDC effort, which could, in turn, be integrated into broader goal-setting exercises. The VDC facilitator explained that, "at the end of the day, it's… did we hit our deadlines?" and added, "if we didn't cost anybody any money, we've done a good job with it." These findings suggest that participation in goal-setting exercises is closely tied to how an individual's role and responsibilities contribute to scheduling and cost-related project outcomes.

2.4: Allowed in Decision Making

Access to decision-making depends on both an individual's role and the specific project context. The field supervisor was granted decision-making authority primarily due to their assigned leadership role and responsibilities in managing construction operations, rather than involvement in clash coordination. In contrast, the VDC coordinator did not view themselves as a decision-maker, but rather as someone responsible for facilitating the process and ensuring that the appropriate individuals were engaged to make informed decisions. These findings continue to provide evidence of collaborative decision-making efforts but also highlight that access to such authority is often contingent on one's formal role and whether a facilitator is present to help delegate decisions to the appropriate subject matter experts.

2.5: Allowed to Change Goals as the Project Moves Forward

The ability to change project goals depended on both the nature of the goals in question and the specific project context. Unfortunately, this question was not asked during the interview with the field superintendent, so there are no findings to report from their perspective. The VDC coordinator's responses focused on project goals related to schedule and budget, noting that changes to these elements required coordination and approval from the project owner. This finding suggests that altering major project goals typically cannot occur without explicit authorization from ownership.

2.6: Decisions are Made with the Plurality of Team Members Present

Responses regarding decision making involving a plurality of team members varied depending on the individual's role and the specific project. The field supervisor acknowledged that while there was no formal, project-specific decision-making process in place, decisions were often made collectively: "I would say 95% of the time, if there's a group setting, the group is making that decision." They noted that while they empower others to build a case for a particular decision, they still must be persuaded before giving approval. The VDC coordinator emphasized their role as a facilitator of decision making and pointed to the BIM execution plan as a useful tool for preventing stakeholders from revising deliverables that have already been signed off. The field supervisor's response may reflect a broader understanding of IG that incorporates their field construction responsibilities, while the VDC coordinator's response highlights how decision making is formally structured through the BIM execution plan. Taken together, these findings provide evidence of a project-specific approach to collective decision making, influenced by both role-based authority and structured coordination practices.

2.7: A Decision-Making Process that has been Developed or Agreed Upon by the Team

Responses regarding the decision-making processes for these teams varied. The field supervisor reported not being involved in any formal decision-making process, which they noted was typical of the projects they've worked on within their organization. They explained that decision making generally "falls into that hierarchy," relying on those in leadership positions to empower subordinates as needed. This perspective contrasts with that of the VDC coordinator, who previously referenced the existence of a BIM execution plan. As discussed in the previous indicator, this discrepancy may stem from the field supervisor's blended role supporting both VDC and field construction teams. As such, it is likely that a decision-making process has been developed or agreed upon by the team, but individual access to or awareness of that process may vary. In such cases, participants may default to their organization's standard, which could follow a more traditional hierarchical structure.

3. Team Building: Activities that build team rapport

3.1: Team Participation in Training Exercises

Participation in team training exercises depended on the specific project. The field supervisor did not mention any project-specific team training, noting instead that such exercises are typically driven by their organization. The VDC coordinator explained that training is conducted if the project requires it, with an assessment made at the project's outset to determine the necessary tools and bring the team up to speed. This training could be as simple as reviewing a YouTube video or delivered in person. These responses suggest that team participation in training exercises is contingent on project-specific needs—and it remains unclear whether this particular project required such training.

3.2: Team Building “Boot-Camp”

Similar to the previous operationalized elements, this section focuses on the team-building exercises in which individuals may have participated. The field supervisor noted that team members engaged in several informal team-building activities—such as fantasy football, indoor soccer matches, and attending local festivals—though these were generally organized organically by individuals who were not local to the project and looking to build relationships. The VDC coordinator pointed out that the remote nature of MEP coordination teams made attending in-person team-building events difficult, especially during "crunch time." However, they observed that teams often became stronger during these high-pressure periods. They also mentioned exploring options for virtual team-building activities, such as online escape rooms, though none had been implemented. These responses suggest that while team building is valued within individual organizations, no formal team-building initiatives were identified as part of this specific project.

3.3: Team members participate with each other for “non-work” activities.

There is some overlap between participation in team-building and “non-work” activities, and the responses from both individuals follow a similar pattern to the previous two sections. The field supervisor described how some team members made an effort to connect by engaging in early morning activities such as indoor soccer before work. The VDC coordinator noted that participation in non-work activities varies by project, but on this particular project, they were able to build strong relationships with individuals working adjacent to the MEPFSA coordination team. These responses provide evidence that engagement in non-work activities is driven by

personal relationships within the project environment rather than by any formal initiative from the project's IG structure.

3.4: Desire to Work on Future Projects with Team Members

Each individual expressed varying levels of interest in working with others on the project. The field supervisor expressed skepticism during the interview, largely due to being in the early phase of the project and not yet having had the opportunity to get to know the full team. They did express a desire to continue working with individuals they had collaborated with on past projects but noted that building trust with new team members takes time. The VDC coordinator similarly expressed a willingness to work again with colleagues from previous projects, but added, "for every 20 people I get to work with, there's maybe one person I'd be fine never working with again." These responses are unsurprising and reflect the nature of interpersonal relationships within temporary teams, though they appear to be influenced more by individual experience than by the project's specific IG conditions.

4. Communication Systems: How you document decisions and goals

4.1: Open, Honest and Hard Conversations Take Place

Everyone appeared comfortable engaging in open, honest, and difficult conversations with their teammates. The field supervisor expressed no discomfort in having such conversations on any project but did note that contracts are helpful when addressing scope disputes with trades pushing back on work obligations. The VDC coordinator also stated that open and honest conversations come easily to them, but how they handle more difficult discussions often depends on how "to observe contractual relationships." It is notable that both participants referenced

contractual relationships in their responses, which may suggest that governance structures influence the nature and tone of communication on a project.

4.2: Team Performance is Measured

Responses related to team performance focused primarily on their organization's goals in support of overall project success. Both individuals discussed goals such as meeting schedule and budget targets, which aligned with their earlier responses regarding decision-making processes. These organizational goals serve to drive project deadlines and maintain progress. As such, identifying issues that impact schedule and budget allows those responsible for addressing them to take targeted action in support of the broader project objectives.

5. Workspaces: Where you work

5.1: Common/Integrated BIM Technologies

The responses describe organizational efforts to support the use of common or integrated BIM technologies. The field supervisor acknowledged ongoing challenges but emphasized their organization's commitment to ensuring that the various programs "talk to each other." Similarly, the VDC coordinator noted that while integration challenges are present on every project, the primary goal is "at least making sure the right data is translating back and forth." Both responses highlight a focus on organizational responsibility rather than efforts specific to this project.

5.2: Defined Workspaces Specifically for Project Teams/Work Groups

Each individual worked in a different type of workspace. The field supervisor held a position that required in-person attendance and evaluated where others needed to work based on

the tasks at hand. Although they acknowledged that remote work can complicate communication, they also recognized that not everyone can be onsite and that accommodations must be made. The VDC coordinator, who preferred working onsite, needed to work remotely more frequently in order to manage the multiple projects they supported. They appreciated how remote work capabilities improved during the COVID-19 pandemic and used that period to better prioritize their time onsite. These responses suggest that virtual work arrangements are shaped by one's role, the nature of the tasks, and the working relationships among team members.

4.1.2.2 Case Study 1-1 Shared Leadership

To examine SL within this VDC team, the SLQ was distributed and received a single response. The survey was shared through representatives from the GC who were familiar with the project's VDC team. The respondent was the field supervisor who also participated in the interview. The SLQ results are presented in tables showing the overall score across all 24 questions, as well as scores for each of the six SL categories: Transformational Leadership, Transactional Leadership, Directive Leadership, Empowerment (Individual), Empowerment (Team), and Aversive Leadership. Each category and individual question includes an average score and standard deviation. Additionally, an overall SL Score excluding Aversive Leadership is reported to account for its relatively low score, which appeared as an outlier compared to the other categories. Respondents rated each question based on their VDC coordination team's performance using a Likert scale from 1 to 5, where 1 = "strongly disagree," 2 = "disagree," 3 = "neutral," 4 = "agree," and 5 = "strongly agree."

CS2-1 SLQ Overall and Shared Leadership Categories

The tables below present the overall SL scores, both with and without the inclusion of the Aversive Leadership category, as well as the scores for each individual category. The overall SL rating was 3.69; when the Aversive Leadership category was excluded, the score increased to 4.00. Of the six categories, five scored above the "neutral" threshold of 3.00, with Empowerment (Team) receiving the highest rating at 4.50. These results provide evidence to suggest that SL has formed within the team.

Table 5 - Case Study 1-1 SLQ Overall

Category	**Average**	**STDEV**
Shared Leadership Overall	3.69	1.05
Shared Leadership w/out Aversive	4.00	0.62

Table 6 - Case Study 1-1 SLQ Detailed Categories

Category	**Average**	**STDEV**
Transformational Leadership	4.00	0.00
Transactional Leadership	3.25	0.50
Directive Leadership	4.00	0.00
Empowerment (individual)	4.25	0.96
Empowerment (team)	4.50	0.58
Aversive Leadership	2.00	1.41

CS1-1 SLQ – Transformational Leadership

The average score for the SLQ category Transformational Leadership was well above the neutral threshold, with an average rating of 4.00. All six individual questions within this category were rated as "agree."

Table 7 - Case Study 1-1 SLQ Transformational Leadership

Category	Average	STDEV
Transformational Leadership	**4.00**	**0.00**
Vision	4	
Idealism	4	
Inspirational Communication	4	
Intellectual Stimulation	4	
Intellectual Stimulation	4	
Performance Expectations	4	

CS1-1 SLQ -Transactional Leadership

The average score for the SLQ category Transactional Leadership was 3.25, with only one question rated as "agree" and the remaining rated as "neutral."

Table 8 - Case Study 1-1 SLQ Transactional Leadership

Category	Average	STDEV
Transactional Leadership	**3.25**	**0.50**
TRK1 - Transactional	4	
Material Rewards	3	
Personal Rewards	3	
Personal Rewards	3	

CS1-1 SLQ – Directive Leadership

The average score for the SLQ category Directive Leadership was 4.00, with all responses rated as "agree."

Table 9 - Case Study 1-1 SLQ Directive Leadership

Category	Average	STDEV
Directive Leadership	**4.00**	**0.00**
Participative Goal Setting	4	
Participative Goal Setting	4	
Participative Goal Setting	4	
Participative Goal Setting	4	

CS1-1 SLQ – Empowerment (individual)

The average score for the SLQ category *Empowerment (Individual)* was 4.25, with both *Independent Action* questions rated as "strongly agree," while the *Self-Development* question was rated "agree" and the *Self-Reward* question rated "neutral."

Table 10 - Case Study 1-1 SLQ Empowerment (individual)

Category	Average	STDEV
Empowerment (individual)	**4.25**	**0.96**
Independent Action	5	
Independent Action	5	
Self-Development	4	
Self-Reward	3	

CS1-1 SLQ – Empowerment (team)

This category received the highest rating of all, with an average score of 4.50; roughly half of the responses were "strongly agree," and the remainder were "agree."

Table 11 - Case Study 1-1 SLQ Empowerment (team)

Category	Average	STDEV
Empowerment (team)	**4.50**	**0.58**
Teamwork	4	
Teamwork	5	
Teamwork	5	
Teamwork	4	

CS1-1 SLQ – Aversive Leadership

Aversive leadership was by far the lowest-rated category in the SLQ, with an average score of 2.00—except for the question on reprimand, which received a rating of 4.00. The first two of the three questions related to intimidation were rated "strongly disagree," and the third was rated "disagree." The reprimand-related question— "When my work is not up to par, my team members point it out to me"—scored significantly higher than the other questions in this category. While this question may reflect the team's ability to engage in open, honest, and difficult conversations, the remaining questions likely came across as abrasive and misaligned with the collaborative spirit of the team. Because this category appears to be an outlier, it is separated from the overall SL score, a trend that will continue across the remaining SLQ results.

Table 12 - Case Study 1-1 SLQ Aversive Leadership

Category	Average	STDEV
Aversive Leadership	**2.00**	**1.41**
Intimidation	1	
Intimidation	1	
Intimidation	2	
Reprimand	4	

4.1.3 Case Study 1-1 Conclusion/Case Study Overview

This case study set out to explore how the governance of a project utilizing CPD methods impacts the formation of SL within virtual teams using BIM technologies. The findings fall under two main themes: IG and SL. Below is a recap of the key findings, organized by IG categories:

1. Team Organization: How People Meet and Work Together
    - Teams clearly understood their roles, how they supported model coordination, and how they supported others in the coordination process.
    - Having a facilitator was instrumental in leveraging the team's knowledge. Their work helped drive the BIM coordination effort, which in turn influenced execution in the field.

2. Decision Making: How Decisions Are Made
    - Participation in BIM execution and pull planning exercises was limited by role.
    - Goal setting did occur, but participation depended on one's responsibilities and how their tasks aligned with broader project goals.
    - Access to decision-making power varied by role, authority, and the ability to delegate that authority.
    - Changing project goals required owner authorization.
    - Decision-making by plurality was evident within the VDC team but could vary when working with other teams that operate under different governance models.

- Although a decision-making process exists within the BIM execution plan, it may not fully cover interactions with other teams governed differently.

3. Team Building: Activities That Build Team Rapport
    - It was unclear whether team training occurred specifically for the VDC team unless initiated by the GC's organization.
    - Team-building activities were not driven by project-specific IG but were instead the result of pre-existing relationships or informal efforts to get to know others.
    - Willingness to collaborate on future projects was often tied to past working relationships and individual comfort levels based on prior experiences.

4. Communication Systems: How Decisions and Goals Are Documented
    - Open, honest, and difficult conversations were common, though they were influenced by contractual relationships.
    - Team performance was primarily measured using traditional metrics like schedule and budget, and these were communicated to help guide decisions.

5. Workspaces: Where You Work
    - Challenges with integrated BIM technologies were seen more as organizational issues than project-specific ones.
    - Virtual collaboration was role-dependent, and how individuals functioned in these spaces varied based on their responsibilities and experience.

The SLQ score, based on a single response from the field supervisor, was 3.69. When the lowest-rated category, Aversive Leadership, was excluded, the score increased to 4.00. All categories except Aversive Leadership scored above the neutral threshold of 3.00, providing evidence of the development of SL within the team.

4.2 Case Study 1-2

4.2.1 Case Study 1-2 Background

This case study focuses on a project's IG approaches and how they influence the development of SL within VDC teams coordinating MEPFSA systems. The organization examined is a GC with an internal VDC department specifically assigned to projects utilizing BIM technologies for MEPFSA coordination. The project itself is a campus development located in the western United States, operating under a progressive design-build delivery method in which the GC and design team are contracted together under a single agreement with the project owner. Two individuals were interviewed for this case study: a designer from the design firm and a VDC coordinator from the GC. While the VDC coordinator's responses were partially related to this project, they primarily reflected their organization's general approach to implementing IG systems. No field observations were conducted for this project, and therefore no findings are presented for IG indicator 4.3, Access to Decision Making Platforms. Only one response was recorded for the SLQ, provided by the designer who was also interviewed.

4.2.2 Case Study 1-2 Findings

The findings of this case study are presented according to the IG definitions and indicators, as well as the SLQ results. The SLQ findings include the overall score, the overall score excluding the Aversive Leadership category, and the scores for each of the SLQ categories and their corresponding items.

4.2.2.1 Case Study 1-2 Informal Governance

1. Team Organization: How people meet up and work together

1.1: Team Roles are Clearly Understood

Everyone interviewed demonstrated a clear understanding of their role on the project. The designer was well aware of their responsibilities, the progressive design-build approach, and their leadership role in guiding the design effort through BIM model coordination. The VDC coordinator described their role as a facilitator, emphasizing their responsibility for "gap management" to ensure all scopes were addressed within the model. Overall, both individuals showed a strong understanding of their roles, how they contributed to model coordination, and how their work supported the efforts of others involved in the coordination process.

1.2: Assigned Team Facilitators

The role of VDC facilitators is clearly established within this organization, and their value to individual projects was consistently recognized. The design team member noted that "...the collaborative effort was really pretty good," highlighting the contributions of the VDC facilitators. The VDC coordinator reinforced their role as a facilitator, stressing the importance of team building: "It's really just building that strong team to go successfully coordinate a project." These responses provide evidence that the project had an assigned facilitator and underscore the added value that role brings to the project team.

2. Decision Making: How decisions are made

2.1: Participation in BIM Execution Planning

Participation in BIM execution planning depended on the individual's role within the project. The designer was actively involved in the development of the BIM execution plan, as their organization contributed valuable expertise and experience that was ultimately incorporated into the project's final plan. The standards they proposed were adopted by the entire team to establish an efficient process and a shared model space accessible to all. The VDC facilitator also played a central role, viewing themselves as ultimately responsible for developing the BIM execution plan, starting with the project's initial meeting. Overall, there is evidence to suggest that multiple team members participated in the BIM execution planning process, each contributing based on their role and expertise.

2.2: Participation in Pull Planning Exercises

There was an opportunity to participate in pull planning exercises on this project, but neither of the individuals interviewed reported direct involvement. The designer was not included in the initial pull planning sessions but was permitted to update and adjust activities as the design development progressed. The VDC facilitator was not responsible for conducting pull planning meetings, delegating that responsibility to the superintendents and project managers due to their focus on scheduling outcomes. These findings suggest that while team members may have opportunities to participate in pull planning, involvement may be limited depending on role and project phase.

2.3: Participation in Goal Setting Exercises

The discussion on participating in goal-setting exercises ranged from establishing schedule dates to defining more specific project objectives. The VDC coordinator described their

involvement in developing goals related to schedule and cost. The designer shared a different experience from one of the GC's projects, where the owner facilitated goal-setting exercises during the first 10 months of the project. These included workshops and exercises conducted in a Big Room format, involving designers, the GC, and MEP teams, and fostered a sense of "bringing everyone along." These findings provide evidence that multiple team members on this project participated in goal-setting activities.

2.4: Allowed in Decision Making

Access to decision-making depends on both the individual's role and the nature of the project. The designer described their ability to make decisions during the coordination process but emphasized that, even then, decisions were made collaboratively as a team. The project's decision-making body included a broad group of individuals, such as project managers and superintendents, but the process remained team-driven. The VDC coordinator did not see themselves as a decision-maker, but rather as someone responsible for bringing the right people together to make informed decisions. These responses suggest the presence of a decision-making system that emphasizes team participation and collective input.

2.5: Allowed to Change Goals as the Project Moves Forward

The ability to change project goals depended on both the individual's role and the specific goals in question. The VDC coordinator saw their role as supporting the team in adjusting goals related to schedule and cost. The designer emphasized the collaborative effort that went into initially developing the project goals and noted that any changes would require re-engaging the original stakeholders to ensure alignment. This process would help prevent goals

from being altered unilaterally or for self-serving reasons. These responses provide evidence of a team-oriented approach to setting and modifying project goals.

2.6: Decisions are Made with the Plurality of Team Members Present

As with many previous questions, responses about decision making with the plurality of team members present depended on the individual's role and the specific project. The designer explained that group decisions were made by considering who would be impacted and who needed to be involved in the process. This was very much a team-oriented effort, driven by the owner and supported by the design-build team. The VDC coordinator emphasized their role in facilitating decision making and using the BIM execution plan to guide the team toward final sign-off on their deliverables. These responses provide evidence of team participation in decision making through project-specific approaches.

2.7: A Decision-Making Process that has been Developed or Agreed Upon by the Team

This project employed a clearly defined decision-making process. The designer noted that although the project was not formally an IPD project, its progressive design-build approach adopted similar practices—such as the use of Project Working Teams (PWTs)—to facilitate decision making, a structure that was initiated and driven by the owner. While the team did not create the specific process themselves, participation in the decision-making approach was required of them.

3. Team Building: Activities that build team rapport

3.1: Team Participation in Training Exercises

The team had access to project-driven training exercises, though participation may have been limited based on one's role. The designer, who worked on the design-build project, described participating in team training sessions designed to familiarize the team with owner-mandated systems and programs. The VDC coordinator explained that training needs were typically addressed at the beginning of a project, but their comments focused more on organization-wide training initiatives. These responses provide evidence that deliberate training exercises were implemented for this specific project, although not all members of the MEPFSA coordination team may have been included.

3.2: Team Building "Boot-Camp"

Similar to the previous operationalized elements, this section focuses on team building exercises in which individuals may have participated. The designer noted that the project hosted local gatherings at the beginning to help team members get to know one another. However, their participation was limited due to their organization's office being located thousands of miles from the project site and the timing of the project coinciding with the COVID-19 pandemic. The VDC coordinator also highlighted the challenge of attending such gatherings because of the virtual nature of their work. While remote work posed logistical barriers to in-person team building, the responses indicate that the project valued and made efforts to host these types of events.

3.3: Team members participate with each other for "non-work" activities.

The designer on the design-build project described limitations in participating in "non-work" activities due to their remote location from the project site. However, when they were in town, they were frequently invited to join activities such as golf outings, group meals, and "fun

runs." They clarified that these events were typically organized and driven by the GC rather than being project-specific. The VDC coordinator noted that participation in non-work activities varied by project and often included attending professional sporting events hosted by vendors with whom they had longstanding relationships. While the responses suggest a more organizationally driven approach to non-work events, there is evidence that participation in these activities is shaped by project-specific relationships—whether due to remote work, a design-build partnership, or established vendor collaborations.

3.4: Desire to Work on Future Projects with Team Members

Everyone expressed a range of interests in working with individuals on the project. The designer expressed a strong desire to work with their project team again, offering high praise for the GC and emphasizing the trust that had been developed. While the VDC coordinator did not reference this project specifically, they shared that, in general, they enjoy working with the vast majority of their colleagues. Overall, there is a clear and positive willingness to collaborate with team members on future projects, likely attributed to the trust and rapport built during this project.

4. Communication Systems: How you document decisions and goals

4.1: Open, Honest and Hard Conversations Take Place

Everyone appeared comfortable having open, honest, and difficult conversations with their teammates. The designer suspected that such conversations likely occurred on their design-build project and stated that if the need arose, they would "feel pretty comfortable about it." While the VDC coordinator did not speak specifically to this project, they expressed general ease

with having open and honest conversations, noting the importance of being mindful of contractual relationships. The designer's response suggests that project team members were willing to communicate openly, even when the message was not positive.

4.2: Team Performance is Measured

The findings related to team performance were primarily provided by the designer. The VDC facilitator did not specifically address this project but referred generally to the use of traditional performance metrics such as schedule and cost. The designer, who worked on the design-build project, described how their team tracked revisions to RFIs and submittals and emphasized how their collaborative relationship with the GC helped streamline potential issues that could lead to revisions. By aligning their work with project-specific goals, they were able to proactively address revisions that could affect their shared responsibilities—particularly with regard to schedule and budget. This response provides evidence of how team performance measurements, in conjunction with contractual relationships, can guide and prioritize project tasks.

5. Workspaces: Where you work

5.1: Common/Integrated BIM Technologies

The integration of BIM technologies on the project was primarily led by the GC, who managed the coordination efforts. The designer did not report any issues with the systems in place, which effectively supported both 3D and 2D design scopes. The VDC coordinator focused more on the broader organizational challenges and how their role supported field implementation rather than discussing project-specific issues. These responses suggest that there were minimal

problems with the common or integrated BIM technologies, and that any challenges were more organizational in nature rather than specific to this project.

5.2: Defined Workspaces Specifically for Project Teams/Work Groups

Both individuals primarily worked in virtual environments. The designer operated remotely from their East Coast office but traveled to the project site monthly to attend Big Room meetings. While onsite, they shared an office with the MEP trades, which was especially helpful when materials arrived for installation. This project also took place during the COVID-19 pandemic, when remote work was mandated. The VDC coordinator, although preferring to work onsite, needed to work remotely to manage the multiple projects they supported. These responses indicate that the project team operated mostly in a remote capacity, influenced by various factors including geography, project responsibilities, and the pandemic.

4.2.2.2 Case Study 1-2 Shared Leadership

To examine SL within this VDC team, the SLQ was distributed and received a single response. The survey was administered through representatives from the GC who were familiar with the VDC team on the project. The respondent was a VDC coordinator employed by the GC who was not among those interviewed. The tables below present the overall SLQ score across all 24 questions, as well as the scores for each of the six SL categories: Transformational Leadership, Transactional Leadership, Directive Leadership, Empowerment (Individual), Empowerment (Team), and Aversive Leadership. Each category and its individual questions include both an average score and standard deviation. A SL Score excluding Aversive Leadership is also provided, given that this category produced substantially lower scores than the

others and is considered an outlier. Respondents were asked to rate each item based on their experience with their project's VDC coordination team using a 5-point Likert scale, where 1 = "strongly disagree," 2 = "disagree," 3 = "neutral," 4 = "agree," and 5 = "strongly agree."

CS1-2 SLQ – Overall and Shared Leadership Categories

The tables below present the overall SL score, both with and without the inclusion of the Aversive Leadership category, as well as the scores for each individual category. The overall SL rating was 3.27, which increased to 3.64 when the Aversive Leadership category was excluded. Of the six categories, five were rated at or above the "neutral" threshold, and one category—Empowerment (Team)—received a perfect score of 5.00. Based on these results, there is evidence to suggest that SL has developed within the team.

Table 13 - Case Study 1-2 SLQ Overall

Category	Average	STDEV
Shared Leadership Overall	3.27	1.15
Shared Leadership w/out Aversive	3.64	0.79

Table 14 - Case Study 1-2 SLQ Detailed Categories

Category	Average	STDEV
Transformational Leadership	3.83	0.41
Transactional Leadership	3.25	0.42
Directive Leadership	3.00	0.00
Empowerment (individual)	3.00	0.00
Empowerment (team)	5.00	0.00
Aversive Leadership	1.25	0.50

CS1-2 SLQ – Transformational Leadership

The average score for the SLQ category *Transformational Leadership* was 3.83, which is well above the neutral threshold. Five of the six individual questions in this category were rated as "agree."

Table 15 - Case Study 1-2 SLQ Transformational Leadership

Category	Average	STDEV
Transformational Leadership	**3.83**	**0.41**
Vision	4	
Idealism	4	
Inspirational Communication	4	
Intellectual Stimulation	4	
Intellectual Stimulation	4	
Performance Expectations	3	

CS1-2 SLQ - Transactional Leadership

The average score for the SLQ category *Transactional Leadership* was 3.25, with only one question rated as "agree" and all others rated as "neutral."

Table 16 - Case Study 1-2 SLQ Transactional Leadership

Category	Average	STDEV
Transactional Leadership	**3.25**	**0.42**
TRK1 - Transactional	4	
Material Rewards	3	
Personal Rewards	3	
Personal Rewards	3	

CS1-2 SLQ – Directive Leadership

The average score for the SLQ category Directive Leadership was 3.00, with the respondent rating each question as "neutral."

Table 17 - Case Study 1-2 SLQ Directive Leadership

Category	Average	STDEV
Directive Leadership	**3.00**	**0.00**
Participative Goal Setting	3	
Participative Goal Setting	3	
Participative Goal Setting	3	
Participative Goal Setting	3	

CS1-2 SLQ – Empowerment (individual)

The average score for the SLQ category Empowerment (Individual) was 3.00, with the respondent rating all questions in this category as "neutral."

Table 18 - Case Study 1-2 SLQ Empowerment (individual)

Category	Average	STDEV
Empowerment (individual)	**3.00**	**0.00**
Independent Action	3	
Independent Action	3	
Self-Development	3	
Self-Reward	3	

CS1-2 SLQ – Empowerment (team)

This category received the highest rating of all, with a perfect score of 5.00, as all questions were rated "strongly agree."

Table 19 - Case Study 1-2 SLQ Empowerment (team)

Category	Average	STDEV
Empowerment (team)	**5.00**	**0.00**
Teamwork	5	
Teamwork	5	
Teamwork	5	
Teamwork	5	

CS1-2 SLQ – Aversive Leadership

Aversive leadership was overwhelmingly the lowest-rated category in the SLQ, with an average score of 1.25. Nearly all responses were rated "strongly disagree," with the exception of one intimidation-related question, which was rated "disagree."

Table 20 - Case Study 1-2 SLQ Aversive Leadership

Category	Average	STDEV
Aversive Leadership	**1.25**	**0.50**
Intimidation	1	
Intimidation	1	
Intimidation	2	
Reprimand	1	

4.2.3 Case Study 1-2 Conclusion/Case Study Overview

This case study set out to explore how the governance of IPD projects impacts the formation of SL within virtual teams utilizing BIM technologies. The research was grounded in the context of an organization's approach to leading VDC coordination and examined across three different projects. The findings fall under the categories of SL and IG, with a summary of the major categories provided in Table [insert table # here]. Below is a recap of the findings by IG category:

1. Team Organization: How People Meet Up and Work Together

- There is clear evidence that team members understood their roles, how those roles supported model coordination, and how they contributed to broader team collaboration.
- The project had an assigned facilitator whose involvement added recognized value to the team.

2. Decision Making: How Decisions Are Made

- Team members were actively involved in developing the BIM execution plan.
- Although participation in pull planning may be limited, there was evidence that individuals had opportunities to contribute.
- Multiple team members participated in goal-setting exercises.
- The decision-making process emphasized team participation.
- Goal setting and revision were approached collaboratively.
- Decisions were generally made with a plurality of team members present, supported by project-specific structures.

3. Team Building: Activities That Build Team Rapport

- Team training exercises were implemented to support the project delivery approach but may have varied based on team members' roles and onboarding timing.
- Team-building activities occurred but were primarily available to local team members and were constrained by the COVID-19 pandemic.

- Opportunities for non-work activities existed but were limited for remote team members and generally organized by the GC.
- There was strong enthusiasm for working with team members on future projects.

4. Communication System: How You Document Decisions and Goals

- Open, honest, and difficult conversations were occurring, though shaped by contractual dynamics.
- Team performance was measured and aligned with contractual frameworks.

5. Workspaces: Where You Work

- There were minimal issues reported with the integration of BIM technologies established by the GC.
- Much of the work was performed remotely, with limited in-person interaction—likely influenced by the team's distributed nature and the impacts of the COVID-19 pandemic.

The SLQ score for this case study, based on six responses from within the organization, was 3.27. When the lowest-scoring category—aversive leadership—was removed, the average improved to 3.64. Three of the six leadership categories scored above "neutral," with only aversive leadership scoring below. The highest-rated category was team empowerment, with responses consistently indicating "strongly agree."

4.3 Case Study 1-3

4.3.1 Case Study 1-3 Background

This case study focuses on a project's IG approaches and how they influence the development of SL within the VDC teams coordinating MEPFSA systems. The project is a public works project located in the western United States and is being delivered using a progressive design-build model. Only one individual was interviewed for this case study—a VDC coordinator employed by the GC. While their responses partially addressed the specific project, they primarily reflected the organization's broader IG practices. No field observations were conducted for this case study, and as a result, there are no findings related to IG indicator 4.3, Access to Decision-Making Platforms. Four responses were collected through the SLQ, though none of the respondents included the VDC coordinator who was interviewed.

4.3.2 Case Study 1-3 Findings

The findings of this case study are presented according to the IG definitions and indicators, as well as the results of the SLQ. The SLQ findings include the overall SL score, the score with the Aversive Leadership category removed, and the scores for each individual SLQ category and its associated topics.

4.3.2.1 Case Study 1-3 Informal Governance

1. Team Organization: How people meet up and work together

1.1: Team Roles are Clearly Understood

The VDC coordinator oversees several projects in their role and described themselves as "not being the expert in the room," but rather as "somebody who kind of musters everyone together" to bring the experts together so they can share their knowledge.

1.2: Assigned Team Facilitators

The VDC coordinator plays an active facilitation role on every project they are assigned to. For this particular project, they also viewed their role as an opportunity to build long-term relationships with other team members, recognizing the potential for future collaboration with the same client.

2. Decision Making: How decisions are made

2.1: Participation in BIM Execution Planning

The VDC coordinator was actively involved in the BIM execution planning process and viewed themselves as ultimately responsible for developing the plan. At the initial meeting, they led the team through a review of the BIM execution plan's specifics with all participating members.

2.2: Participation in Pull Planning Exercises

As with their other projects, the VDC coordinator was not responsible for running any pull planning meetings, instead deferring that responsibility to the superintendents and project managers due to the emphasis on scheduling outcomes.

2.3: Participation in Goal Setting Exercises

The VDC coordinator explained that they don't necessarily view them as formal goals, stating, "At the end of the day, it's… did we hit our deadlines… it doesn't get more complicated than that."

2.4: Allowed in Decision Making

The VDC coordinator's approach to decision-making was to bring the right people together to make informed decisions, describing their role as someone who helps "guide the team."

2.5: Allowed to Change Goals as the Project Moves Forward

The VDC coordinator referenced project goals related to schedule and budget, emphasizing that changes to these goals required coordination with the project owner. According to them, such changes are only considered after all other options to meet the original goals have been exhausted, and only then do they work with the owner to adjust the goals.

2.6: Decisions are Made with the Plurality of Team Members Present

The VDC coordinator described their role in facilitating decision-making by leveraging the BIM execution plan to guide the team through the sign-off process for their deliverables.

2.7: A Decision-Making Process that has been Developed or Agreed Upon by the Team

There were no findings indicating that a formal decision-making process had been developed or collectively agreed upon by the team.

3. Team Building: Activities that build team rapport

3.1: Team Participation in Training Exercises

The VDC coordinator did not reference any project-specific training exercises, aside from the standard assessment their organization typically conducts at the start of a project to determine necessary training needs.

3.2: Team Building "Boot-Camp"

The VDC coordinator did not mention any project-specific team-building exercises beyond those typically organized through their GC organization.

3.3: Team members participate with each other for "non-work" activities.

The VDC coordinator did not mention any non-work activities specific to this project, but noted that when such activities do occur, they typically involve attending professional sporting events hosted by vendors with whom they frequently work.

3.4: Desire to Work on Future Projects with Team Members

The VDC coordinator expressed a general willingness to work with people they had collaborated with in the past but added, "for every 20 people I get to work with, there's maybe one person I'd be fine never working with again."

4. Communication Systems: How you document decisions and goals

4.1: Open, Honest and Hard Conversations Take Place

The VDC coordinator noted that open and honest conversations are easy for them, but their approach to more difficult discussions often depends on how contractual relationships are observed.

4.2: Team Performance is Measured

The VDC coordinator did not reference any project-specific goals but instead spoke about broader organizational goals, such as schedule and budget, which aligned with their earlier responses related to decision-making.

5. Workspaces: Where you work

5.1: Common/Integrated BIM Technologies

The VDC coordinator discussed the recurring challenges their organization faces on every project but emphasized that the primary goal is "at least making sure the right data is translating back and forth."

5.2: Defined Workspaces Specifically for Project Teams/Work Groups

The VDC coordinator, who prefers to work onsite, had to work more remotely in order to manage the multiple projects they supported.

4.3.2.2 Case Study 1-3 Shared Leadership

To examine the SL of this VDC team, the SLQ was distributed and received four responses. The survey was circulated through representatives from the GC who were familiar with the project's VDC coordination team. Respondents included two GC-affiliated design

managers, a member of the design team, and a detailer from a trade contractor. The results are presented in tables showing the overall SLQ score across all 24 questions, along with scores for each of the six SL categories: Transformational Leadership, Transactional Leadership, Directive Leadership, Empowerment (Individual), Empowerment (Team), and Aversive Leadership. Each category and individual question is reported with its average score and standard deviation. Additionally, an adjusted SL Score that excludes the Aversive Leadership category is included, due to that category's outlier status relative to the other five. Respondents rated each item based on their project's VDC coordination team using a 1 to 5 Likert scale, where 1 = "strongly disagree," 2 = "disagree," 3 = "neutral," 4 = "agree," and 5 = "strongly agree."

CS1-3 SLQ – Overall and Shared Leadership Categories

The tables below present the overall SL score, both including and excluding the Aversive Leadership category, as well as the scores for each individual category. The overall SL rating was 3.57, which increased to 3.90 when the Aversive Leadership category was excluded. Of the six leadership categories, five scored above the "neutral" threshold of 3.00. Notably, the Empowerment (Team) category received the highest score at 4.25.

Table 21 - Case Study 1-3 SLQ Overall

Category	Average	STDEV
Shared Leadership Overall	3.57	1.29
Shared Leadership w/out Aversive	3.90	1.03

Table 22 - Case Study 1-3 Detailed Categories

Category	Average	STDEV
Transformational Leadership	3.92	0.83
Transactional Leadership	3.88	0.72
Directive Leadership	3.56	1.63
Empowerment (individual)	3.88	0.96
Empowerment (team)	4.25	0.86
Aversive Leadership	1.75	1.06

CS1-3 SLQ – Transformational Leadership

The average score for the SLQ category *Transformational Leadership* was 3.92, placing it well above the neutral threshold. Four of the six individual questions were rated 4 or higher, and one respondent rated every question in this category as "strongly agree." Importantly, no question in this category received a rating below "neutral," indicating consistent positive perceptions across the responses.

Table 23 - Case Study 1-3 SLQ Transformation Leadership

Category	Average	STDEV
Transformational Leadership	**3.92**	**0.83**
Vision	4.00	0.82
Idealism	4.00	0.82
Inspirational Communication	4.00	0.82
Intellectual Stimulation	3.50	1.00
Intellectual Stimulation	4.25	0.96
Performance Expectations	3.75	0.96

CS1-3 SLQ -Transactional Leadership

The average score for the SLQ category *Transactional Leadership* was 3.88. Two questions scored above 4.25, while the lowest-rated items were related to material and personal rewards. No respondent rated any question below "neutral," and one individual selected

"strongly agree" for one of the questions, suggesting overall positive perceptions with some variation based on the type of reward discussed.

Table 24 - Case Study 1-3 SLQ Transactional Leadership

Category	Average	STDEV
Transactional Leadership	**3.88**	**0.72**
TRK1 - Transactional	4.25	0.50
Material Rewards	3.50	0.58
Personal Rewards	4.25	0.96
Personal Rewards	3.50	0.58

CS1-3 SLQ – Directive Leadership

The average score for the SLQ category *Directive Leadership* was 3.56, with the highest standard deviation among all categories and most individual questions. This variation was primarily due to one individual rating all questions as "strongly disagree," while the other respondents scored the items as either "agree" or "strongly agree," with one exception rated as "neutral." Although the average score suggests evidence of SL within this group, the outlier response indicates a potential for greater disagreement if a larger sample were available.

Table 25 - Case Study 1-3 SLQ Directive Leadership

Category	Average	STDEV
Directive Leadership	**3.56**	**1.63**
Participative Goal Setting	3.75	1.89
Participative Goal Setting	3.50	1.73
Participative Goal Setting	3.50	1.91
Participative Goal Setting	3.50	1.73

CS1-3 SLQ – Empowerment (individual)

The average score for the SLQ category *Empowerment (Individual)* was 3.88, with three-quarters of the questions receiving an average score of 4.00. Two individuals rated the questions in this category as "neutral" across the board, but no question received a rating below "neutral."

Table 26 - Case Study 1-3 SLQ Empowerment (individual)

Category	Average	STDEV
Empowerment (individual)	**3.88**	**0.96**
Independent Action	4.00	1.15
Independent Action	4.00	1.15
Self-Development	4.00	0.82
Self-Reward	3.50	1.00

CS1-3 SLQ – Empowerment (team)

This category had the highest rating of all the categories, with an average score of 4.25. Of the 16 individual questions rated, half received a "strongly agree" response, while the remaining eight were evenly split between "neutral" and "agree.

Table 27 - Case Study 1-3 SLQ Empowerment (team)

Category	Average	STDEV
Empowerment (team)	**4.25**	**0.86**
Teamwork	4.50	0.58
Teamwork	4.00	1.15
Teamwork	4.00	1.15
Teamwork	4.50	0.58

CS1-3 SLQ – Aversive Leadership

Aversive Leadership was overwhelmingly the lowest-rated category in the SLQ, with an average score of 1.75, except for the question on reprimand, which received a higher score of

3.00. The first three questions in this category—focused on intimidation—were rated "strongly disagree" in 8 out of the 12 total responses, with the remaining responses marked as "disagree." In contrast, the reprimand question, which asked, "When my work is not up to par, my team members point it out to me," scored substantially higher, with two respondents selecting "agree," one selecting "neutral," and one selecting "strongly disagree." The relatively high score of this question may reflect a more constructive aspect of team accountability, as opposed to the other questions in this category that addressed intimidation as a leadership approach. Given the abrasive tone of the Aversive Leadership category and its misalignment with the collaborative nature of SL, this category was separated from the overall SL score, as discussed earlier.

Table 28 - Case Study 1-3 SLQ Aversive Leadership

Category	**Average**	**STDEV**
Aversive Leadership	**1.75**	**1.06**
Intimidation	1.25	0.50
Intimidation	1.25	0.50
Intimidation	1.50	0.58
Reprimand	3.00	1.41

4.3.3 Case Study 1-3 Conclusion/Case Study Overview

This case study set out to explore how the governance of IPD projects influences the formation of SL within virtual teams utilizing BIM technologies. The study was framed around an organization's approach to leading VDC coordination and examined across three different projects. The findings from this case study fall under the broader subjects of SL and IG, with a summary of major categories presented in Table [insert table # here]. Below is a recap of the findings organized by IG category:

1. Team Organization: How People Meet Up and Work Together

- While the structure was not fully clarified, the VDC coordinator played a central role in guiding decision-making toward subject matter experts.
- Evidence suggests the presence of an assigned team facilitator, which is a consistent practice across all projects led by the GC's VDC team.

2. Decision Making: How Decisions Are Made

- The VDC coordinator is organizationally assigned to help develop the BIM Execution Plan at the project's outset.
- Responsibility for pull planning and participation in such sessions remained unclear.
- There was no evidence of participation in formal project-specific goal-setting exercises beyond a general focus on meeting deadlines.
- No project-specific findings indicated who was granted decision-making authority, although the VDC coordinator emphasized their role in connecting decision-making to the appropriate experts.
- No structured approach to changing project goals was identified, aside from the GC organization's process of reevaluating goals once all alternatives have been exhausted.
- Although not directly observed, the VDC coordinator described how the BIM Execution Plan is intended to guide collaborative decision-making.
- No formalized, project-specific decision-making process was identified.

3. Team Building: Activities That Build Team Rapport

- No evidence was found of project-specific training exercises, aside from the GC's general organizational assessments at project initiation.
- No team building exercises were reported for this project.
- The only reference to non-work activities involved vendor-sponsored events, such as attendance at professional sporting events.

4. Communication System: How You Document Decisions and Goals

- The VDC coordinator described open and honest communication as common, though often influenced by contractual relationships.
- No project-specific findings were reported regarding performance measurement, aside from traditional metrics such as schedule and cost.

5. Workspaces: Where You Work

- No project-specific practices were found regarding integrated BIM technologies, though support from the GC was noted.
- The VDC coordinator typically works remotely due to responsibilities across multiple projects.

The SLQ score, based on four responses from individuals within the project team, was 3.57. When the lowest scoring category—Aversive Leadership—was removed, the SL score rose to 3.90. Both scores exceed the neutral threshold of 3.00, providing evidence to suggest the presence and development of SL within this VDC team.

4.4 Case Study 2-1

4.4.1 Case Study 2-1 Background

Three individuals were interviewed for this case study. CS2-1 was a detailer for a trade contractor, CS2-2 was a VDC coordinator for a trade contractor, and CS2-3 was a project architect. There were three observations of coordination meetings where one meetings, CS2VM1 (case study 2, virtual meeting 1) was hosted online and two meetings, CS2IPM2 and CS2IPM3 (case study 2, in-person meeting #) were hosted in-person as well as online. CSVM1 and CS2IPM3 were specifically focused on VDC coordination and CS2IPM2 was a "Big Room" meeting that included an element of VDC coordination.

4.4.2 Case Study 2-1 Findings

The findings of this case study are organized according to the definitions and indicators of IG, as well as the results of the SLQ. The SLQ results are presented by the overall score, the overall score excluding the Aversive Leadership category (due to its outlier nature), and the average scores for each of the SLQ's six leadership categories and their corresponding topics.

4.4.2.1 Case Study 2-1 Informal Governance

1. Team Organization: How people meet up and work together

1.1: Team Roles are Clearly Understood

Interview Findings

The individuals interviewed for this research included an MEP detailer, a VDC manager for a trade contractor, and a member of the design team. All participants demonstrated a clear understanding of their roles and responsibilities on the project and possessed several years of

experience performing these duties. However, despite this clarity, none of the responses addressed how their roles supported or acknowledged the contributions of other team members.

1.2: Assigned Team Facilitators

Interview Findings

The project had an assigned team facilitator—a VDC coordinator employed by the GC—who was responsible for MEPFSA coordination. The detailer described the facilitator as someone "who is running the show" and clarified that "we give our input, but at the end of the day, he gets to help call the shots." The VDC coordinator for the trade contractor noted that their interactions with the facilitator primarily occurred during meetings and involved working together to "bridge functionalities" to ensure the technology functioned properly. While the designer acknowledged that the GC had a team facilitator, their response focused more on their own organization's approach to facilitating clash coordination meetings. Overall, the responses indicate that the assigned facilitator from the GC played a significant role in guiding the team through the coordination process.

Observation Findings

CS2VM#2 - The facilitator coordinated with participants in three key ways: (1) ensuring updated models were posted by the end of the day, (2) presenting, addressing, and resolving clashes with the team, and (3) working with detailers to resolve conflicts prior to the meeting.

CS2IPM#2 - An in-person Big Room session that preceded the clash coordination meeting—I identified 18 instances of facilitation. These included the facilitator leading the coordination

effort, ensuring the appropriate individuals were engaged in the conversation, and either resolving issues directly or assigning responsibility for their resolution.

CS2IPM#3 - Four instances of facilitation were noted. These included a recap of the design clash items at the start of the meeting, as well as moments where the facilitator led the coordination process and ensured responsible parties were actively participating in the discussion.

2. Decision Making: How decisions are made

2.1: Participation in BIM Execution Planning

Interview Findings

Everyone expressed different experiences with participating in BIM execution planning. The trade detailer described past experiences developing schedules with GC, emphasizing themes of input and compromise. This project followed a similar approach, with a focus on schedule alignment and mutual compromise. At the time of the interview, they remarked, *"It is pretty much... exactly where I thought we were going to be."* In contrast, the trade VDC coordinator noted that they are not typically involved in BIM execution planning and, when they are, it is usually limited to the preconstruction phase, working with the GC's estimators and project managers. The designer, however, did attend the project's BIM kickoff meeting, where topics such as level of design, expectation alignment, deliverables, and phases of design were discussed. These responses indicate that BIM execution planning created opportunities for leadership in planning activities for at least two individuals, with schedule alignment emerging as a central theme in their contributions.

2.2: Participation in Pull Planning Exercises

Interview Findings

Opportunities for participating in pull planning exercises varied among the individuals interviewed. The trade detailer described a rushed start to the project in which they immediately began their work, but they did mention negotiating scheduled deliverables with the GC. There was no response from the VDC coordinator on this topic, as the interviewer inadvertently skipped the question. The designer did not participate in the initial pull planning sessions due to their limited role at the time. However, they later contributed to updating the pull plan, which was shared using a "mural board" during Big Room meetings. They noted that this system "worked reasonably well." Based on the designer's account, there is evidence to suggest that pull planning exercises occurred on the project, and participants were given opportunities to amend the plan as the project progressed.

Observation Findings

CS2IPM#2 – Three instances of participation in pull planning exercises were observed during this in-person Big Room meeting. In each case, the facilitator initiated the discussion by referencing the status of the existing pull plan and asked the meeting participants what actions were needed to complete the tasks being tracked. These moments demonstrate the facilitator's role in driving schedule alignment and engaging the team in forward planning.

2.3: Participation in Goal Setting Exercises

Interview Findings

The discussion on participation in goal setting exercises primarily centered around schedule and key deliverables. The trade VDC coordinator stated they did not participate in any goal-setting activities. The detailer, however, emphasized that the project schedule was the primary driver of their work and described collaborating with other detailers to complete tasks in a way that would not delay the project. They explained how problems are resolved through logic—such as determining trade precedence in specific systems or spaces (e.g., mechanical or electrical rooms)—and noted that when consensus cannot be reached, the GC's VDC coordinator steps in to make the final decision. The designer did not recall participating in any formal goal-setting exercises but mentioned contributing to the development of key deliverables, such as permit issuance timelines and identifying "pressure points" related to the authority having jurisdiction (AHJ). While there is some evidence that one participant contributed to goal development, none of the interviewees described engaging in a structured or even informal goal-setting process. Notably, the detailer's framing of the schedule as a functional goal provides insight into how scheduling influences decision-making on the project.

2.4: Allowed in Decision Making

Interview Findings

Everyone reported feeling empowered to make decisions, though the source of that authority varied—ranging from organizational backing to individual expertise. The trade detailer described being empowered by their organization to make decisions that save time and money, which are then reviewed with the company's field supervisors and project manager. On this specific project, such suggestions were welcomed and shared in meetings where decisions could be formally discussed and recorded. Similarly, the trade VDC coordinator noted that their

organization trusts them to make decisions when it benefits field operations, though it was unclear whether this empowerment was project-specific or a general organizational norm. The designer explained that they have the autonomy to make changes within their design discipline and actively coordinate those changes with the broader project team. Overall, there is clear evidence that each team member had the autonomy to make decisions, though the basis for that authority differed. Despite this variation, the shared perception of decision-making empowerment was consistent across all roles.

Observation Findings

CS2VM#1 – Decision-making participation was observed five times during this meeting. These included reviewing resolved tasks, finalizing equipment locations, coordinating electrical conduit and wall conflicts, and allowing team members the opportunity to challenge or question decisions being made.

CS2IPM#2 – Five instances of team-inclusive decision-making were noted. These involved discussions about equipment placement, group review of waterproofing details, clarifying potential changes that could impact design and construction scope, and evaluating the cost implications of various landscape design options across multiple trades.

CS2IPM#3 – Two instances of shared decision-making were recorded. The first involved a discussion on exposed MEP systems and determining who should make the final decision. The second involved a team member seeking clarification on the level of authority they had to make decisions during the meeting.

2.5: Allowed to Change Goals as the Project Moves Forward

Interview Findings

The only person who discussed the ability to update project goals as the project progressed was the detailer, as the trade VDC coordinator stated that they had no goals they could change, and this question was unfortunately skipped during the designer's interview. The detailer explained that they were able to adjust scheduled dates when their trade was impacted, and that this flexibility was largely due to their prior experience working with both the GC and the project owner. While legal precedent supports contractors being compensated for schedule impacts, the detailer credited their ability to make changes to strong working relationships rather than formal claims. This evidence suggests that the project team was empowered to adapt goals through collaboration and mutual trust—an approach that may not be as easily replicated on other projects lacking similar relationships.

Observation Findings

CS2VM#1 – Goals were revised twice during this meeting. One instance involved adjusting a scheduled date that was described as "a little aggressive." In another case, a detailer requested more time to review a design update, stating they needed to "digest it more," with another detailer agreeing with the request for additional review time.

CS2IPM#2 – Two goal changes were observed during this in-person Big Room meeting. The first involved a discussion about moving deliverable dates, which was seriously considered until

it was determined the original deadline could still be met. The second involved updating the sign-off date for a scope coordination milestone.

2.6: Decisions are Made with Plurality of Team Members Present

Interview Findings

The responses regarding decision-making with a plurality of team members present emphasized collaboration, the importance of realistic solutions, and at times, a sense of chaos. Given the pace of changes on the project, the detailer described the process as "chaotic every week," but also highlighted how BIM tools were instrumental in identifying conflicts and presenting solutions. They described the group's ability to make decisions as "powerful." The trade VDC coordinator discussed their role in generating realistic proposals and then engaging in a "give and take process" with others to arrive at a solution, emphasizing the value of maintaining "a good working relationship with the other trades" to get the work done. The designer described a collaborative process between trades and design disciplines to arrive at decisions, which were then reviewed by the GC for cost implications. While decisions could be made during meetings, the designer noted that progress was sometimes hindered when the right stakeholders were not present. These responses suggest that the team was generally able to make decisions collectively, though their ability to do so could be limited by cost considerations and the need for full participation in meetings.

Observation Findings

CS2IPM#2 – Five instances were observed where a plurality of the team resolved issues collaboratively. These included coordination efforts with the MEPF teams, working through landscaping scopes, and conducting an equipment coordination exercise.

CS2IPM#3 – Two instances were noted where multiple stakeholders actively engaged in MEPF coordination tasks. Additionally, the group collectively prioritized meeting time at the end of the session to focus on decisions that required the presence and input of the full team.

2.7: A Decision-Making Process that has been Developed or Agreed Upon by the Team

Interview Findings

The responses regarding the decision-making process for this project team ranged from perceptions of a non-existent process to accounts of a deliberate approach established early in the project. The detailer was unaware of any specific decision-making structure for this project, despite having previously helped develop such processes with this particular owner. They attributed this lack of engagement to the rapid pace of the project and an assumption that the VDC team was already familiar with one another. The trade VDC coordinator suggested that the BIM execution plan might include a decision-making framework but noted that the team appeared to adopt a more informal, flexible approach instead. In contrast, the designer recalled a specific early meeting with the owner, during which the team was introduced to the design-build mentality and engaged in discussions about the needs of project stakeholders across design disciplines. While not all team members were involved in creating a formal decision-making process, likely due to the timing of their onboarding, it appears that such a process was established at the outset. Regardless of individual participation, the team's prior experience with

the GC and owner seems to have informed their understanding of how decisions are made, with collaborative practices continuing throughout the project.

Observation Findings

CS2IPM#2 – A concern was raised about clouding changes in the drawings, prompting a clarification of a prior decision: certain drawings should only be clouded for coordination purposes and not for permit submissions.

CS2IPM#3 – A decision was made during the meeting to stop discussing a specific detailer's coordination issues, as they did not impact other trades or result in a cost add.

3. Team Building: Activities that build team rapport

3.1: Team Participation in Training Exercises

Interview Findings

All respondents indicated participation in training exercises, which primarily focused on bringing everyone up to speed on digital tools such as Revit, Navisworks, and Autodesk Construction Cloud (ACC). The detailer explained that their training centered on transitioning from CAD to Revit and synchronizing models using a Navisworks plugin. Both the trade VDC coordinator and the designer mentioned team training on ACC setups, with the detailer noting that ongoing training is necessary as mastering these tools is a continuous learning process. While this category seeks evidence that the team is prepared to work cohesively, providing consistent training on the platforms used in the project helps align digital workflows and removes potential barriers to efficient task execution.

3.2: Team Building “Boot-Camp”

Interview Findings

Responses regarding participation in team-building “boot camp” exercises varied. Both the detailer and the trade VDC coordinator reported not having participated in any such exercises, although the detailer anticipated future events like meetups and celebrations, including building topping-out ceremonies. The designer, on the other hand, described participating in several team-building activities, such as a kickoff barbecue featuring a trivia competition and a holiday potluck where team members shared childhood photos that were displayed in the Big Room. These responses suggest ongoing efforts to foster team cohesion through these activities. Despite some members not being involved in earlier celebrations, there appear to be opportunities for greater participation as the project progresses.

3.3: Team members participate with each other for “non-work” activities.

Interview Findings

Opportunities to participate in “non-work” activities with other team members varied and appeared to depend largely on their physical workspaces within the project. The detailer and trade VDC coordinator seemed disadvantaged in these activities due to the predominantly remote nature of their work. The designer, who also worked mostly remotely, mentioned having had opportunities to join team lunches to celebrate major deadlines but often had to decline due to workload. While these responses do not directly address whether team members enjoy socializing together, they suggest that limited participation in non-work gatherings is more likely influenced by workspace arrangements and individual responsibilities.

3.4: Desire to Work on Future Projects with Team Members

Interview Findings

Everyone expressed a strong desire to work with their team members on future projects, with praise for the collaborative effort emerging as a common theme. The detailer stated, “I love working with these team members” and expressed a clear intent to continue collaborating with the owner and GC. The trade VDC coordinator described the team as “people who are positive and who can listen and digest what you're telling them.” The designer shared that they "would be happy to work with all these folks again" and appreciated the team’s collaborative approach and collegial atmosphere. These responses provide strong evidence of a shared commitment to future collaboration among the team members.

4. Communication Systems: How you document decisions and goals

4.1: Open, Honest and Hard Conversations Take Place

Interview Findings

The responses regarding open, honest, and difficult conversations indicate that the team was able to communicate candidly, attributing this ability to their work experience and straightforward approach. The detailer reported no issues having open and honest discussions with team members, crediting their familiarity with the group. The VDC coordinator also expressed comfort with candid communication, emphasizing the importance of maintaining respect and professionalism. The designer noted they had not yet needed to engage in difficult conversations, attributing this to the team’s overall openness and honesty. These responses provide evidence of a team culture willing to engage in honest and sometimes challenging conversations, even when the news is unfavorable.

Observation Findings

CS2VM#1 – Two instances of open, honest, and difficult conversations occurred during this meeting. One centered on holding a detailer accountable for missing information needed from their system, and another involved pushing back on a deliverable pending another person's decision before release.

CS2IPM#2 – Three instances of candid and challenging conversations took place. These included clarifying design scope requirements and addressing attendees' needs, an individual explaining outstanding items to a remote participant, and a potential conflict where passive communication was clarified by the responsible person speaking up to ensure clear understanding.

CS2IPM#3 – One open and honest conversation was noted, where a participant expressed appreciation for the facilitation provided and acknowledged the challenge of leading the meeting without breaks. This comment came from someone who had previously been responsible for facilitating this meeting.

4.2: Team Performance is Measured

Interview Findings

Responses regarding the measurement of team performance varied depending on each individual's role. The detailer focused on keeping up with the schedule, managing design changes, ensuring accuracy, proactively coordinating efforts, and making content installable.

Their organization tracked performance by comparing forecasted versus actual hours recorded in a daily journal. The trade VDC coordinator noted that their team's performance was measured by the resolution of clashes and maintaining design and construction sign-off dates. The designer emphasized client satisfaction, the speed of conflict resolution, minimizing cost and schedule impacts, and timely completion of permitted documents. While these responses indicate the team uses various metrics to gauge performance, none suggested that these measures were project-specific; rather, they appear to be common indicators of success in AEC projects.

Observation Findings

CS2VM#1 – Team performance was noted once during this meeting, specifically related to the display of scheduled completion dates critical to the sign-off of specific work zones.

CS2IPM#2 – Team performance was measured during the Big Room meeting by communicating completion dates through the pull plan schedule, which was visible to all participants both in the room and online.

4.3: Access to Decision Making Platforms

Observation Findings

CS2VM#1 – Five instances were noted where the team had access to a decision-making platform, primarily related to sharing the BIM coordination model. Throughout the meeting, the model was displayed for all attendees to view, enabling individuals to see the details of clashing MEP systems, identify responsible parties, and track issue resolution deadlines. Participants

attending the Microsoft Teams-hosted meeting could also directly ping others to collaborate on resolving outstanding issues.

CS2IPM#2 – During this Big Room meeting, the team accessed decision-making platforms three times. These instances involved sharing the active issue-tracking list, communicating look-ahead schedules, and discussing pull plan notes.

5. Workspaces: Where you work

Interview Findings

5.1: Common/Integrated BIM Technologies

Based on the responses, the common and integrated BIM technologies used on this project are Revit, Navisworks, and Autodesk Construction Cloud (ACC). Despite some challenges, the overall opinion is that these tools have worked relatively well. The detailer acknowledged occasional hiccups with Revit and ACC but considered them "not a huge deal." The trade VDC coordinator praised Revit's modeling capabilities as "fantastic" and described the compatibility as "really smooth," despite some coordination challenges and internal information projection issues within ACC. The designer believed the experience was "better than other projects" overall but noted some struggles with navigation and managing multiple models simultaneously. They also echoed concerns about ACC and product ownership similar to those of the trade VDC coordinator, though no significant issues were reported. Overall, the evidence suggests that technology-related challenges were minimal, and the team was able to collaborate effectively within these platforms.

Observation Findings

CS2IPM#3 – One instance was noted during this meeting where common and integrated BIM technologies were discussed. This related specifically to the development of a 4D schedule created across the multiple technologies implemented on the project.

5.2: Defined Workspaces Specifically for Project Teams/Work Groups

Interview Findings

All individuals primarily worked remotely, with periodic visits to the project site. The detailer mostly worked remotely and occasionally conducted job walks on-site to review progress but noted that they had not met the MEP coordination team in person. The trade VDC coordinator also worked remotely and highlighted improvements to Autodesk Construction Cloud (ACC) that enabled them to maximize virtual work by facilitating better coordination ("hugs") and smoother data transfer between the GC's system and their own. The designer similarly worked virtually, noting this had become the norm since the start of the COVID-19 pandemic. These responses indicate that the team primarily operated in virtual environments and, despite challenges, preferred this mode of work for their tasks.

Observation Findings

CS2VM#1 – Three instances were noted during this meeting where a specifically defined workspace was required. These included how the model was constructed for communicating to online observers, creating breakout spaces for smaller groups to coordinate resolutions outside

the main meeting, and dividing meeting time between discussions of clashes and scheduled deliverables.

CS2IPM#2 – During this Big Room meeting, there were ten instances where defined workspaces were necessary. These primarily involved organizing breakout meetings, utilizing specific digital cloud tools to resolve coordination issues, and segmenting the meeting time into phases focused on coordination problems and design clashes.

CS2IPM#3 – One instance was noted where an attendee requested that another designer begin attending a different meeting and coordination workspace.

4.4.2.2 Case Study 2-1 Shared Leadership

To examine the SL of this VDC team, the SLQ was distributed and received four responses. The survey was disseminated through a representative from the GC who was familiar with the VDC team on the project. Among the respondents, two were detailers for trade contractors, one worked for a structural engineering firm, and one for an architecture firm.

The tables below present the overall SLQ score based on all 24 questions, along with scores for the six SL categories: Transformational Leadership, Transactional Leadership, Directive Leadership, Empowerment (individual), Empowerment (team), and Aversive Leadership. Each category and individual question includes an average score and standard deviation.

Because the Aversive Leadership category showed outlier behavior with notably low scores compared to the other categories, a SL Score excluding Aversive Leadership is also provided. Respondents rated each question as it related to their project's VDC coordination team using a 5-point scale: 1 = "strongly disagree," 2 = "disagree," 3 = "neutral," 4 = "agree," and 5 = "strongly agree."

CS2-1 SLQ – Overall & Shared Leadership Categories

The tables below show the overall SL scores both including and excluding the Aversive Leadership category, as well as scores for each individual category. The overall SL rating was 3.39, which improved to 3.67 when the Aversive Leadership category was excluded. Among the six categories, five scored above "neutral," with the Empowerment (team) category achieving the highest score of 4.25. These results provide evidence suggesting that SL has formed within this project team.

Table 29 - Case Study 2-1 SLQ Overall

Category	Average	STDEV
Shared Leadership Overall	3.39	1.14
Shared Leadership w/out Aversive	3.67	0.84

Table 30 - Case Study 2-1 SLQ Detailed Categories

Category	Average	STDEV
Transformational Leadership	3.75	0.74
Transactional Leadership	3.25	1.13
Directive Leadership	3.19	0.66
Empowerment (individual)	3.88	0.72
Empowerment (team)	4.25	0.45
Aversive Leadership	1.88	1.36

CS2-1 SLQ – Transformational Leadership

The average score for the SLQ category, Transformational Leadership, was 3.75, with two of the six individual questions rated 4 or higher. Overall, the responses were fairly consistent, with mild exceptions noted in the areas of vision and performance expectations.

Table 31 - Case Study 2-1 SLQ Transformational Leadership

Category	Average	STDEV
Transformational Leadership	**3.75**	**0.74**
Vision	4.25	0.96
Idealism	3.25	0.50
Inspirational Communication	3.75	0.50
Intellectual Stimulation	3.50	0.58
Intellectual Stimulation	4.25	0.50
Performance Expectations	3.50	1.00

CS2-1 SLQ - Transactional Leadership

The average score for the SLQ category, Transactional Leadership, was 3.25. Three of the four questions received ratings of 3.50 or higher; however, the question related to material rewards scored significantly lower at 1.75. This question—"If I perform well, my team members will recommend more compensation"—was rated "strongly disagree" by two individuals and "disagree" by another.

Table 32 - Case Study 2-1 SLQ Transactional Leadership

Category	Average	STDEV
Transactional Leadership	**3.25**	**1.13**
TRK1 - Transactional	4.00	0.82
Material Rewards	1.75	0.96
Personal Rewards	3.75	0.50
Personal Rewards	3.50	0.58

CS2-1 SLQ – Directive Leadership

The average score for the SLQ category, Directive Leadership, was 3.19, with only two questions receiving ratings of 3.25 or higher. While none of the average scores fell below "neutral," two individual responses were "disagree" and four were rated "agree."

Table 33 - Case Study 2-1 SLQ Directive Leadership

Category	Average	STDEV
Directive Leadership	**3.19**	**0.66**
Participative Goal Setting	3.50	0.58
Participative Goal Setting	3.25	0.50
Participative Goal Setting	3.00	0.82
Participative Goal Setting	3.00	0.82

CS2-1 SLQ – Empowerment (individual)

The average score for the SLQ category, Empowerment (Individual), was 3.88, with two questions receiving an average score of 4.25. The lowest scoring question related to self-reward, with an average of 3.25. Importantly, no responses were lower than "neutral."

Table 34 - Case Study 2-1 SLQ Empowerment (individual)

Category	Average	STDEV
Empowerment (individual)	**3.88**	**0.72**
Independent Action	4.25	0.50
Independent Action	4.25	0.50
Self-Development	3.75	0.96
Self-Reward	3.25	0.50

CS2-1 SLQ – Empowerment (team)

The average score for the SLQ category, Empowerment (Team), was 4.25, with one question averaging 4.50. The responses were very consistent, with four ratings marked as "strongly agree" and the remainder as "agree."

Table 35 - Case Study 2-1 SLQ Empowerment (team)

Category	Average	STDEV
Empowerment (team)	**4.25**	**0.45**
Teamwork	4.00	0.00
Teamwork	4.25	0.50
Teamwork	4.50	0.58
Teamwork	4.25	0.50

CS2-1 SLQ – Aversive Leadership

The average score for the SLQ category, Aversive Leadership, was 1.88, with one question related to reprimand scoring a notably higher average of 3.50. For this reprimand question, responses included one "strongly agree," two "agree," and one "strongly disagree." For the remaining three questions, responses were predominantly negative, with nine "strongly disagree," two "disagree," and one "neutral."

Table 36 - Case Study 2-1 SLQ Aversive Leadership

Category	Average	STDEV
Aversive Leadership	**1.88**	**1.36**
Intimidation	1.75	0.96
Intimidation	1.00	0.00
Intimidation	1.25	0.50
Reprimand	3.50	1.73

4.4.3 Case Study 2-1 Conclusion/Case Study Overview

This case study explored how governance in IPD projects influences the formation of SL within virtual teams utilizing BIM technologies. The focus was on a VDC coordination team in a design-build project. The findings fall into the themes of SL and IG, summarized below by IG categories.

1. Team Organization: How People Meet Up and Work Together
    - The team clearly understands their roles, although support and recognition of how they contribute to other team members was not evident.
    - A VDC facilitator consistently guided the team through BIM coordination.

2. Decision Making
    - Opportunities existed to participate in BIM execution planning.
    - Participation in pull planning was evident through interviews and multiple coordination meeting observations.
    - Direct involvement in goal-setting exercises was absent, but team members provided input to help establish schedules and deliverable dates.
    - Access to decision making was widespread, though authority seemed largely organization-driven. Coordination meetings included several instances of decision-making participation.
    - The team demonstrated empowerment to change project goals when justified.
    - Collaborative group decision making was evident.

- While participation may have been limited, a decision-making process was developed early by key individuals and was observed being implemented in meetings.

3. Team Building: Activities that Build Team Rapport
    - The VDC coordination team participated in training focused on project digital tools.
    - Early project team-building exercises were conducted, though some later additions to the team may not have participated.
    - Participation in non-work activities depended on individual circumstances.
    - There was a strong desire among team members to work together on future projects.

4. Communication System: How You Document Decisions and Goals
    - Prior working experience and candid approaches fostered open, honest, and hard conversations, which were also observed during coordination meetings.
    - Team performance measurements varied by role and appeared organization-driven. Meeting observations noted communication of scheduled completion dates to the entire team.
    - Coordination meetings leveraged shared programs to communicate tasks and track issues.

5. Workspaces: Where You Work
    - BIM technologies were well aligned, with minimal struggles reported.
    - The VDC team primarily worked remotely, demonstrating proficiency in navigating breakout rooms and digital collaboration spaces according to task requirements.

The SLQ score based on four responses from this VDC coordination team was 3.39 overall, improving to 3.67 when the lowest scoring category, Aversive Leadership, was removed. All scores were above the neutral threshold of 3.00, suggesting evidence of SL development within the team.

4.5 Case Study 3-1

4.5.1 Case Study 3-1 Background

Three individuals were interviewed for this case study: a trade field supervisor for a trade contractor and two VDC coordinators who work for the GC. For clarity in presenting the interview findings, the more senior VDC coordinator will be referred to as the "VDC manager," and the other as the "VDC coordinator." Additionally, four coordination meetings were observed—held both in-person and online—and are referenced as CS3VM# (Case Study 3, Virtual Meeting number).

4.5.2 Case Study 3-1 Findings

The findings of this case study are presented according to the IG definitions and their operationalizations. Data collection for this case study employed three methods: interviews, ethnographic observations, and the SLQ. Three individuals participated in interviews, and one responded to the SLQ.

4.5.2.1 Case Study 3-1 Informal Governance

The findings of this case study are presented according to their IG definitions and indicators, along with the SLQ results based on the overall score, the overall score excluding the Aversive Leadership category, and the scores for each SLQ category and its individual items.

1. Team Organization: How people meet up and work together

1.1: Team Roles are Clearly Understood

Interview Findings

Everyone clearly understands their roles within this project and their organization, and knows how they support the team. The trade field supervisor demonstrated a clear understanding of their role, including how it applies to design coordination and implementation in the field. The VDC manager described their role as understanding the issues at hand and connecting them to workflows, ensuring everyone is heard and valued during coordination meetings. They explained how they prioritize issues within the coordination schedule and drive them to resolution, which is then documented and communicated to the broader team for alignment. The VDC coordinator's understanding of their role involved addressing project risks within the IPD approach. These responses provide evidence that the team has a strong understanding of their roles and how to support both the team and the project objectives.

1.2: Assigned Team Facilitators

Interview Findings

The responses clearly reveal the use of facilitators for the VDC team and their impact of guiding the team. The trade field supervisor described having multiple facilitators for phases of the project but did find some disjointedness when lead by a new facilitator. With the VDC manager and VDC coordinator both working for the GC, their responses flipped the perspectives of the relationship between the facilitator and the team. They both saw themselves in a leadership role and connecting with the individuals they are working with. VDC manager recognized how their role existed both in and out of the meetings and to create an atmosphere of SL with an inclusionary approach. The VDC coordinator understands their role as a VDC coordinator as a leadership role in driving the team towards a solution. Also see their role as working with all the people on the project and being flexible in their role. Also needing people skills and developing

trust so others will be comfortable with you in bringing up problems. Drives the idea of doing what's best for the project.

Observation Findings

CS3VM#1 – The assigned facilitator guided the team on ten occasions, including navigating the model, leading resolution of coordination issues, communicating decisions from absent members, tracking resolved clashes, and reminding the team of outstanding issues while organizing breakout meetings.

CS3VM#2 – Eleven instances were observed where the facilitator led the team by navigating the model, facilitating clash coordination reviews and discussions, offering suggestions for absent members, and proposing solutions based on past experience.

CS3VM#3 – The facilitator guided the team five times, including model navigation, clarifying collaboration responsibilities for clash resolution, tracking meeting comments in coordination tools to assign tasks, and highlighting potential clashes for group resolution.

CS3VM#4 – Thirteen instances were noted where the facilitator guided the team by navigating the model, leading clash resolution efforts, collaborating with individuals to develop solutions, communicating critical deliverable dates, assigning tasks, and keeping the meeting on track by tabling issues requiring smaller groups.

2. Decision Making: How decisions are made

2.1: Participation in BIM Execution Planning

Interview Findings

Everyone interviewed had participated in the BIM execution plan and explained how it was used on the project. The trade field supervisor described leveraging experience from previous project phases to better inform goal setting, particularly focusing on task durations within the schedule. The VDC manager emphasized making the BIM execution plan practical for all project stakeholders by gathering feedback from trade contractors to ensure the plan facilitates effective execution of their scopes. This perspective was echoed by the VDC coordinator, who described the process as inclusive, collaborative, and amendable, with team buy-in viewed as essential. These responses indicate that participation and leadership in developing the BIM execution plan were deliberate and regarded as a shared team effort.

2.2: Participation in Pull Planning Exercises

Interview Findings

Participation in planning involved a broad spectrum of the MEP coordination team, as all interviewees reported involvement in these exercises throughout the project. The trade field supervisor actively participated in pull planning sessions across project groups, using these opportunities to provide feedback based on experiences from earlier construction phases. Both the VDC manager and VDC coordinator were engaged throughout the pull planning process and helped lead an inclusive practice. The VDC coordinator described developing a milestone and coordination scale as "a whole collaborative process for this particular project," noting it differed from other projects within their organization. These responses provide evidence that the team

was given leadership opportunities and access to planning activities through pull planning exercises, emphasizing an inclusive and collaborative approach.

2.3: Participation in Goal Setting Exercises

Interview Findings

Not everyone interviewed participated in the goal-setting exercises, and the two individuals involved had different experiences. The trade supervisor was not involved and believed that these responsibilities fell to a "core team" composed of the owner, GC, design team, and MEP trade contractors. The VDC manager, however, was part of the goal-setting process and helped establish the Conditions of Satisfaction (CoS), which align design and installation efforts with those goals. These goals were documented to ensure communication with new team members, aiming to "…make an effort to re-communicate and re-engage with the teams on those specific goals." While some goals may have been set before the VDC coordinator joined the project, they creatively developed processes to achieve targets such as "no RFIs," crediting the project's lean practices as a motivator for continuous improvement. These responses suggest that although goal setting may be limited to a core group, the goals themselves guide the broader team's processes and focus on project delivery.

2.4: Allowed in Decision Making

Interview Findings

Everyone interviewed was empowered to make decisions on the project, though their role and the stakeholders they represented influenced their decision-making approach. The trade field supervisor explained that their organization's hierarchy grants them significant decision-making

responsibilities, but on this project, they worked more collaboratively with the core team in a co-location setting. The VDC manager emphasized their intentional effort to foster SL, noting that the decision-making process varies depending on the situation and who holds final authority, especially when cost implications arise. The VDC coordinator described supporting decisions that prioritize the project's best interests and being open to suggestions that promote continuous improvement and lessons learned. Together, these responses indicate that the project employs a decision-making approach that empowers stakeholders and designates leaders to guide and support decision-makers. This provides strong evidence that team members have opportunities to make decisions and that the project intentionally cultivates collaborative decision-making throughout its lifecycle.

Observation Findings

CS3VM#1 – There were nine instances where individuals participated in decision-making, mostly involving resolving coordination issues, communicating their solutions and impacts, raising new coordination concerns, and challenging solutions they believed were not buildable.

CS3VM#2 – Seven instances were observed where individuals were involved in decision-making, including providing honest updates on outstanding issues, communicating solutions and their impacts, collaborating with other trades to find solutions, and raising new coordination issues.

CS3VM#3 – Two instances were witnessed where decision-making included ensuring that an individual absent from the meeting was consulted through comments from others, and cooperative efforts were made to adjust clashing systems.

CS3VM#4 – Six instances of decision-making participation were noted, including collaboratively presenting solutions, sharing screens to work through proposed fixes, and the facilitator encouraging attendees to reach solutions appreciated by the team.

2.5: Allowed to Change Goals as the Project Moves Forward

Interview Findings

The individuals shared their experiences regarding how project goals can be changed and how they adapt to more rigid requirements. CS3-1 discussed the ability to change goals within the context of amending decision-making processes, describing it as having "some fluidity" and being a "good collaborative environment." CS3-2 provided an example of competing project goals, such as the percentage of the project prefabricated and how its associated schedule impacts affected the finish date, which led to a change in that goal. CS3-3 described adjusting a workflow for a popular tool and overcoming implementation challenges through training to improve a prefabrication objective. These responses provide evidence that this team has the flexibility to change goals and a clear understanding of when and how to make those adjustments.

Observation Findings

CS3VM#2 – During this meeting, goals were changed twice as the project progressed. Both changes involved deliverable dates: one due to additional scope needing to be incorporated into the design, and the other because a trade required an extra day to complete their task.

2.6: Decisions are Made with Plurality of Team Members Present

Interview Findings

The responses clearly indicate that team member involvement in decision-making on this project is deliberate and situational. The trade field supervisor explained that the size and complexity of a problem determine who handles it—issues that can be resolved in the field are addressed there, while larger problems require input from others. The VDC manager described how they facilitate efficient meetings by focusing on who needs to be involved in decisions and organizing breakout sessions to give everyone a better opportunity to voice their concerns. The VDC coordinator mentioned using a decision-making tool called Choosing by Advantages (CBA), which collects data and desired outcomes to provide decision options based on priorities. These responses suggest that decision-making occurs with a plurality of team members present and with careful consideration of how, who, what, where, and when decisions are made.

Observation Findings

CS3VM#1 – Five instances were observed where decisions were made with a plurality of team members, all involving coordination of clashes with multiple participants.

CS3VM#2 – The team collaboratively worked through coordination issues related to lighting, piping, and ductwork systems on two occasions.

CS3VM#3 – A cooperative effort was noted to ensure that items were moved appropriately to their required locations.

CS3VM#4 – Twice, the group made collaborative, solution-oriented efforts to address proposed solutions, although no final resolution was reached during those meetings.

2.7: A Decision-Making Process that has been Developed or Agreed Upon by the Team

Interview Findings

The interviewees discussed their ability to modify decision-making processes, emphasizing empowerment and continuous improvement. The VDC manager noted that while changes to the decision-making process ultimately require owner approval, the owner often refrains from intervening if approval would delay the project. The VDC coordinator explained that the team collectively agreed to use Choosing by Advantages (CBA) as their decision-making tool, noting that it aligns with systems they had informally used before. These responses suggest that the team actively participates in shaping decision-making processes, even though controls exist that may limit empowerment or obscure visible changes to all members.

Observation Findings

CS3VM#1 – Two instances were observed where a decision-making process was utilized: one involved explaining how tolerances and clearances should be observed, and another where the facilitator emphasized collaborating effectively on proposed solutions.

CS3VM#2 – One instance occurred when the location of a system was debated, and the team was reminded of the standards established in an earlier project phase.

CS3VM#3 – During this meeting, the team shifted their clash review approach from sorting by trade to a room-by-room method.

CS3VM#4 – Two instances were noted where an upcoming coordination milestone was reviewed and instructions on how to review a design document were explained to the group.

3. Team Building: Activities that build team rapport

3.1: Team Participation in Training Exercises

Interview Findings

The interviews reveal a variety of team training exercises offered, ranging from digital tool applications to project onboarding. The trade field supervisor described attending multiple trainings focused on digital tools that support design coordination, installation progress, and productivity tracking. The VDC manager emphasized onboarding training designed to familiarize new project members with the project culture. The VDC coordinator participated in various training activities, including both digital tools and cultural onboarding. These responses provide evidence that the team had access to project-specific training aimed at enabling them to perform their tasks effectively while preparing them to work collaboratively.

3.2: Team Building "Boot-Camp"

Interview Findings

The responses regarding project team building and exercises revealed a synergy between skill development and building team rapport. The trade field supervisor described milestone celebrations, such as "signing off a level," and noted that training was "advantageous to the

entire team" and "an area of opportunity." The VDC manager also mentioned celebrating milestones by recognizing individuals responsible for outcomes, often taking them out to lunch. The VDC coordinator emphasized that "team building exercises… have been super critical to making this project where it is right now," and praised team retreats and quarterly team health surveys. These responses indicate that the project values team building and training, providing evidence of a deliberate effort to foster team cohesion.

3.3: Team members participate with each other for "non-work" activities.

Interview Findings

Participation in non-work activities is an integral part of this project team, although personal responsibilities sometimes limit attendance. The trade field supervisor has taken part in events such as golf outings with the project's field supervisors but noted that family obligations restrict their participation. The VDC manager described several non-work activities available on the project, including a book club and an onsite gym aimed at promoting work/life/health balance. The VDC coordinator acknowledged a variety of non-work events, such as diverse festival celebrations, and appreciated "craft lunches" that allowed them to connect with trade workers and better understand how to support fieldwork. These responses suggest that the project values fostering team rapport beyond the office and that team members enjoy spending time together outside of work hours.

3.4: Desire to Work on Future Projects with Team Members

Interview Findings

Everyone expressed that they have enjoyed working with many of their team members and look forward to collaborating on future projects. The trade field supervisor responded in a business-like manner, conveying optimism about continuing to work with the team and demonstrating a serious approach to managing relationships with individuals from other organizations. The VDC manager was very positive about continuing with the current team but acknowledged the presence of difficult personalities. They also expressed enthusiasm for working with new team members who bring fresh ideas and challenge existing approaches. The VDC coordinator gave a brief yet enthusiastic endorsement of the team, simply stating, "Oh, hell yeah." These responses collectively indicate a strong desire to continue working together, an awareness that challenges remain, and an optimistic outlook toward integrating new members.

4. Communication Systems: How you document decisions and goals

4.1: Open, Honest and Hard Conversations Take Place

Interview Findings

The responses regarding open, honest, and difficult conversations varied depending on the individual's role and whom they were speaking with. The trade field supervisor focused on conversations within their own organization and noted that there are certain people with whom they can and cannot have open discussions. The VDC manager described handling uncomfortable conversations in meetings by taking them outside the room, viewing these moments as opportunities to build trust. They see their role in the "coordination process more as a people's process," emphasizing respect for others' feelings and egos, and always approaching situations with empathy. The VDC coordinator shared that "the project encourages you to raise your hand and speak up a lot," recounting a time when the VDC team needed more time to

complete a deliverable and felt comfortable being upfront and honest about it. These responses suggest that the project team is generally willing to engage in open, honest, and hard conversations, though some reservations may exist. Notably, the two individuals who work directly for the GC appeared more enthusiastic about approaching team members, whereas the trade contractor representative spoke more about internal organizational conversations.

Observation Findings

CS3VM#1 – Two instances of open, honest, and hard conversations were observed. One involved a detailer communicating the installation sequence to avoid rework, and another noted the team members being very candid with each other during discussions of open issues.

CS3VM#2 – Three occurrences of open, honest, and hard conversations were noted. These included a trade falling behind on their deliverable leading to a difficult discussion about added scope and coordination efforts, as well as debates around the definition of 100% completion.

4.2: Team Performance is Measured

Interview Findings

The question regarding how team performance was measured revealed that both project and organizational goals guide the evaluation, focusing on traditional metrics like production as well as softer indicators such as team health. The trade field supervisor described the production rate metrics used by their organization and how this data helps coordinate with the GC. They also explained that the GC employs a scanner referencing the BIM model to track installation progress and monitors worker activity against crew projections submitted by the contractor. The

VDC manager emphasized that team performance is driven by meeting scheduled milestones, resolving issues, and maintaining process discipline. They highlighted the importance of the team health survey, which gauges whether team members feel supported, their workload balance, how effectively they are leveraging VDC practices, and captures concerns or suggestions ("what keeps you up at night"). These insights are communicated in Big Room meetings to give the team a voice and boost morale. Similarly, the VDC coordinator referenced the team health survey and noted that contingency budgets serve as a key performance indicator, with performance tracking regularly shared among the team.

4.3: Access to Decision Making Platforms

Observation Findings

CS3VM#1 – During this meeting, six instances were noted where participants accessed decision-making platforms, focusing on organizing and assigning clashes and using the model to communicate which systems required correction.

CS3VM#2 – Six occurrences during the meeting involved accessing decision-making platforms, primarily centered on using the model to highlight necessary system corrections and enabling the entire team to use and share the model throughout the session.

CS3VM#3 – Six times during this meeting, the group was observed sharing and navigating the model to identify systems needing correction.

CS3VM#4 – Eight instances were witnessed during this meeting where the team shared and utilized the model to communicate and resolve coordination issues

5. Workspaces: Where you work

5.1: Common/Integrated BIM Technologies

Interview Findings

The responses regarding common and integrated BIM technologies varied among interviewees. Two expressed frustration with the project management platform in use, while the others viewed the BIM technologies as well integrated. The field trade supervisor noted challenges arising from different organizations using their own platforms (e.g., Zoom versus Teams) and disliked the project management system due to unfamiliarity and difficulty "searching forever" for data. The VDC manager acknowledged the overwhelming number of digital tools required to perform a single task but reframed this challenge by focusing on desired outcomes and making the best use of available tools. They gave positive feedback on a digital tool that uses QR codes placed in the field, allowing users to scan and instantly access design information about installed components. The VDC coordinator also praised the effectiveness of these QR codes despite challenges related to their placement and software. Overall, these responses reflect differing opinions on the integration of BIM technologies but show that the team has successfully navigated challenges with a project-first mindset.

5.2: Defined Workspaces Specifically for Project Teams/Work Groups

Interview Findings

The team worked in a mix of virtual and in-person spaces, but the preferred approach for this project was in-person collaboration, as expressed by the interviewees. The field trade supervisor acknowledged the necessity of working in both virtual and physical environments but favored face-to-face coordination meetings for better understanding of scope conflicts and

priorities. They felt more comfortable working virtually only with people they had previously collaborated with. The VDC manager intentionally prioritized in-person interactions, believing they foster mutual respect and help build relationships that extend beyond meetings. They also emphasized the importance of seeing fieldwork firsthand while recognizing the value of virtual spaces to engage team members who cannot attend in person. The manager noted that platforms like Microsoft Teams are mainly used for screen sharing during meetings, which are predominantly attended in person. Similarly, the VDC coordinator preferred in-person meetings but appreciated virtual options due to logistical challenges and personal circumstances, such as caring for a sick child. Collectively, these responses highlight the team's preference for in-person collaboration while acknowledging the practicality and communication benefits of virtual meetings.

Observation Findings

CS3VM#1 – On three occasions, I observed the use of defined workspaces, primarily involving breakout rooms to address tasks that could not be resolved during the main meeting.

CS3VM#2 – During one instance, a question that interrupted a design update was deferred to an offline conversation.

CS3VM#3 – I noticed that most participants had their cameras off, which was later explained by the fact that many attendees were physically together in person. The online meeting platform was primarily used for screen sharing during these in-person meetings, with remote participation occurring only occasionally under extenuating circumstances.

4.5.2.2 Case Study 3-1 Shared Leadership

To examine the SL within this VDC team, the SLQ was distributed, yielding a single response. The survey was distributed both through representatives at the GC familiar with the VDC team and directly emailed by this researcher to the VDC team. The sole respondent was a VDC coordinator employed by the GC who was not interviewed. The results are presented in tables showing the overall SLQ score for all 24 questions, the six SL categories (Transformational Leadership, Transactional Leadership, Directive Leadership, Empowerment—Individual, Empowerment—Team, and Aversive Leadership), and average scores with standard deviations for each category and individual question. Due to the outlier nature of the low Aversive Leadership scores relative to the other categories, an overall SL Score excluding Aversive Leadership is also provided. Respondents rated each item on a scale from 1 ("strongly disagree") to 5 ("strongly agree") as it related to their project's VDC coordination team.

CS3-1 SLQ – Overall & Shared Leadership Categories

The tables below present the overall SL scores both including and excluding the Aversive Leadership category, as well as the scores for each individual category. The overall SL rating was 4.27, which increased to 4.64 when Aversive Leadership was excluded. Among the six categories, five scored above "neutral," with both Directive Leadership and Empowerment (Team) achieving perfect scores of 5.0 across all questions. Although based on a single response, these SLQ results provide evidence suggesting the formation of SL within this project team.

Table 37 - Case Study 3-1 SLQ Overall

Category	Average	STDEV
Shared Leadership Overall	4.27	1.22
Shared Leadership w/out Aversive	4.64	0.73

Table 38 - Case Study 3-1 SLQ Detailed Categories

Category	Average	STDEV
Transformational Leadership	4.50	0.55
Transactional Leadership	4.00	1.41
Directive Leadership	5.00	0.00
Empowerment (individual)	4.75	0.50
Empowerment (team)	5.00	0.00
Aversive Leadership	2.25	1.50

CS3-1 SLQ – Transformational Leadership

The average score for the SLQ category, Transformational Leadership, was 4.50, with three of the six questions rated as "strongly agree" and the remaining three rated as "agree."

Table 39 - Case Study 3-1 SLQ Transformational Leadership

Category	Average	STDEV
Transformational Leadership	**4.50**	**0.55**
Vision	5.00	0.00
Idealism	4.00	0.00
Inspirational Communication	4.00	0.00
Intellectual Stimulation	5.00	0.00
Intellectual Stimulation	5.00	0.00
Performance Expectations	4.00	0.00

CS3-1 SLQ – Transactional Leadership

The average score for the SLQ category, Transactional Leadership, was 4.00, with two questions rated as "strongly agree," while the question related to material rewards was rated as "disagree."

Table 40 - Case Study 3-1 SLQ Transactional Leadership

Category	Average	STDEV
Transactional Leadership	**4.00**	**1.41**
TRK1 - Transactional	5.00	0.00
Material Rewards	2.00	0.00
Personal Rewards	5.00	0.00
Personal Rewards	4.00	0.00

CS3-1 SLQ – Directive Leadership

The average score for the SLQ category, directive leadership, was 5.00, with all questions being rated "strongly agree."

Table 41 - Case Study 3-1 SLQ Directive Leadership

Category	Average	STDEV
Directive Leadership	**5.00**	**0.00**
Participative Goal Setting	5.00	0.00
Participative Goal Setting	5.00	0.00
Participative Goal Setting	5.00	0.00
Participative Goal Setting	5.00	0.00

CS3-1 SLQ – Empowerment (individual)

The average score for the SLQ category Empowerment (Individual) was 4.75, with all items rated "strongly agree," except for the item on "independent action," which was rated "agree."

Table 42 - Case Study 3-1 SLQ Empowerment (individual)

Category	Average	STDEV
Empowerment (individual)	**4.75**	**0.50**
Independent Action	4.00	0.00
Independent Action	5.00	0.00
Self-Development	5.00	0.00
Self-Reward	5.00	0.00

CS3-1 SLQ – Empowerment (team)

The average score for the SLQ category Empowerment (Team) was 5.00, with all items rated "strongly agree."

Table 43 - Case Study 3-1 SLQ Empowerment (team)

Category	Average	STDEV
Empowerment (team)	**5.00**	**0.00**
Teamwork	5.00	0.00
Teamwork	5.00	0.00
Teamwork	5.00	0.00
Teamwork	5.00	0.00

CS3-1 SLQ – Aversive Leadership

The average score for the SLQ category Aversive Leadership was 2.25, with two items rated "strongly disagree" and the item related to "reprimand" rated "agree."

Table 44 - Case Study 3-1 SLQ Aversive Leadership

Category	Average	STDEV
Aversive Leadership	**2.25**	**1.50**
Intimidation	1.00	0.00
Intimidation	1.00	0.00
Intimidation	3.00	0.00
Reprimand	4.00	0.00

4.5.3 Case Study 3-1 Conclusion/Case Study Overview

This case study set out to explore how the governance of IPD projects impacts the formation of SL within virtual teams utilizing (BIM technologies. The investigation was situated within a VDC coordination team on a design-build project. The findings of this case study relate to the subjects of SL and IG. A summary of the key categories is presented in Table [insert table number here]. Below is a recap of the findings, organized by IG categories:

1. Team Organization: How People Meet and Work Together
    - The team demonstrated a clear understanding of their roles and how they support one another.
    - Interviews and multiple observations highlighted the importance of facilitators in VDC coordination and team leadership.

2. Decision Making
    - Participation in developing the BIM Execution Plan was widespread across the team.
    - Leadership opportunities and involvement in planning activities, such as pull planning, reflected an inclusive and collaborative approach.

- Goal setting appeared to be limited to a core group, while the broader team contributed to developing the approaches and processes supporting those goals.
- The team was empowered to make decisions, as confirmed by several observations during virtual meetings.
- Goals were adjusted as project conditions changed, with priority given to the most critical objectives.
- Decision making by a plurality of the team was common, guided by a shared understanding of how, who, what, where, and when decisions could be made. This was supported by multiple observations of intentionally cooperative interactions.
- The team collaboratively developed and followed a decision-making process during meetings, whether formally recognized or tacitly applied.

3. Team Building: Activities That Build Team Rapport
    - Team members were provided with project-specific training intended not only to support task execution but also to prepare them to work collaboratively.
    - The project emphasized the importance of team-building and training exercises to foster cohesion.
    - Team members valued rapport-building beyond the work setting and expressed enjoyment in each other's company, even outside of work hours.
    - There was a strong desire to continue working with current teammates and optimism about collaborating with new members who could contribute fresh ideas.
4. Communication System: How You Document Decisions and Goals

- Open, honest, and sometimes difficult conversations occurred and were observed, although occasionally constrained by organizational boundaries.
- Team performance was measured through work-in-place assessments, project-based benchmarks, key performance indicators (KPIs), and team health surveys.
- Access to decision-making platforms was observed during coordination meetings, including tools for tracking clashes and communicating resolutions within the BIM model.

5. Workspaces: Where You Work
    - Although the team faced challenges aligning BIM technologies, efforts to resolve these issues were guided by a shared "project-first" mindset.
    - While the team preferred in-person collaboration, virtual platforms were used to enhance communication during meetings and provide access for those unable to attend in person. Breakout meetings were intentionally used to resolve smaller conflicts efficiently without slowing down full-team coordination sessions.

The SLQ score, based on one response within this VDC coordination team, was 4.27. When the lowest-scoring category—aversive leadership—was removed, the score increased to 4.64. Both values exceed the neutral rating of 3.00 and provide evidence supporting the development of SL within this team.

Chapter 5: Discussions, Implications, Recommendations

The case study findings presented in Chapter 4 illustrate the IG systems employed by each project and provide a corresponding score to interpret the extent of SL formation within the team. These findings, drawn from interviews and observations, were developed to address the following:

This research will examine the informal governance of collaborative project delivery methods to explore how it impacts the formation of shared leadership within virtual teams utilizing BIM technologies.

Each case study contributed uniquely to addressing the research question. In this chapter, I discuss the contributions of these findings to the existing body of knowledge and examine their broader implications. I will identify which elements of IG were most apparent and influential in the formation of SL and explore additional governance themes that emerged from the data.

5.1 Informal Governance – Team Organization: Facilitation

The IG element *Team Organization* was examined to better understand how team members meet and collaborate. What became apparent is how much influence the facilitator had on spreading the culture of SL and guiding the team in behaviors that lead to a more inclusive and collaborative process of coordination.

In exploring this element within the case studies, I focused on the clarity of team roles and the presence of an assigned team facilitator. Generally, participants demonstrated a clear

understanding of their roles and how their responsibilities aligned with those of their teammates. Additionally, each project included an assigned facilitator. While there remains a need to further investigate how role clarity contributes to the development of SL, the findings in this area did not offer substantial new insight toward answering the research question. What did emerge, however, was the notable influence and consistently positive response to the presence of a facilitator.

Previous studies have identified facilitation as a form of IG in collaborative projects (Chen and Manley, Validation of an Instrument to Measure Governance and Performance on Collaborative Infrastructure Projects 2014). The presence of facilitators within the MEPFSA coordination teams in this study consistently emerged as a driving force behind collaborative efforts. In Case Study 1-1, the facilitator was praised by the field supervisor for leveraging their knowledge of BIM systems to foster a collaborative project environment (Findings, 4.1.2.1, Part 1, 1.2). Similarly, in Case Study 1-2, a designer credited the project's collaborative success to the efforts of the VDC facilitators (Findings, 4.2.2.1, Part 1, 1.2). In Case Study 1-3, the facilitator—who also held that role in Case Studies 1-1 and 1-2—described their position as an opportunity to cultivate long-term relationships with team members they were likely to work with again (Findings, 4.3.2.1, Part 1, 1.2).

In Case Study 2-1, the facilitator was valued for leading coordination efforts (Findings, 4.4.2.1, Part 1, 1.2). In Case Study 3-1, the facilitator played an integral role in guiding coordination and fostering a culture of SL. Their inclusive approach and ability to connect with individuals (Findings, 4.5.2.1, Part 1.2) align with previous research emphasizing the importance

of relationship management in collaborative project teams (Chen, Manley, et al., Procurement and Governance Choices for Collaborative Infrastructure Projects 2018). These findings also support the argument by Fischer et al. (2017) that access to a skilled facilitator enhances team capacity by strengthening the relationships necessary for effective collaboration.

Three of the individuals interviewed in this study served as facilitators for the MEPFSA coordination process on behalf of the GC. While the facilitator in Case Study 2-1 was not interviewed, I was able to observe three meetings that they led. Across all cases, facilitators described their role as one of unifying the team and ensuring the right individuals were engaged in the process at the appropriate time. These findings reinforce the benefits of assigning a facilitator to the MEPFSA coordination process and suggest that their leadership can significantly influence the development of SL within the team.

Based on the findings of this research, the IG element of team organization appears to influence the formation of SL, with facilitation serving as a potential spearhead for fostering a culture of collaboration and SL outcomes. However, several factors warrant further exploration, including which organization should take responsibility for facilitating coordination efforts and how the facilitator's organizational systems may influence the overall project approach.

5.2 Informal Governance – Decision Making

At its core, a culture of SL requires granting decision-making authority through contractual mechanisms and empowering the appropriate individuals and organizations, those with experience and capacity to build and lead collaborative teams. This was apparent in my

findings that included empowerment of decision-making thru leadership of the GC organization, and a premeditated systematic approach driven by the ownerships' progressive design-build project delivery approach.

The IG element of decision making was developed to understand how decisions were made within project teams. This included examining access to leadership opportunities, how the team collaborated during decision-making processes, and whether systems had been developed to guide those decisions. Findings related to this IG element were collected through interviews and field observations.

Overall, participants were widely engaged in decision making, although the degree and manner of access varied. In Case Study 1-1, team participation was encouraged by the field supervisor, who empowered team members to make decisions. The VDC coordinator similarly noted that his role was "to get everyone but [himself] to make decisions" (Findings, 4.1.2.1, Part 2, 2.1). It was evident that the GC brought its own organizational practices related to decision making into the project environment. In Case Studies 1-2 and 2-1, both of which had the same project owner with a history of implementing progressive design-build approaches, structured systems were in place to guide decisions. These systems were particularly impactful in encouraging participation and providing access to leadership opportunities within the MEPFSA coordination teams (Findings, 4.2.2.1, Part 2, 2.1–2.6; Findings, 4.3.2.1, Part 2, 2.1–2.3, 2.6–2.7). This broad distribution of decision-making roles aligns with a defining characteristic of SL: the distribution of influence across multiple individuals (Northouse 2018).

Decision making was also shaped by project-specific documents, such as the BIM Execution Plan, which was developed to guide decisions throughout the project (Findings, 4.1.2.1, Part 2, 2.1, 2.6). However, decision-making authority was sometimes limited by contractual relationships—particularly when decisions required owner involvement or when subcontracts explicitly defined the GC's coordination responsibilities (Findings, 4.1.2.1, Part 2, 2.4–2.5; Part 4, 4.1). Despite these constraints, the GC remained the lead in coordination efforts, and the overall decision-making culture appeared to be driven by the GC's organizational approach (Findings, 4.1.2.1, Part 2, 2.6).

5.3 Informal Governance – Team Building

There was a strong team building approach across all the case studies and there was an emphasis on team training and activities to help build the capacity and camaraderie that were driven by both the project and the GC. While some of the case studies examined didn't require a project specific program to drive team building, other case studies successfully implemented activities that drove a culture of collaboration and SL.

This IG element was developed to investigate how the case study teams were formed through project-specific training and team-building exercises. Prior research has shown that teams engaging in continuous training are better equipped for self-evaluation and process improvement, while team-building activities contribute to the development of trust (Fischer, et al. 2017). As observed in the case studies, training and team-building efforts may be intentionally planned for individual projects or provided by the project organization in response to emerging needs, as was the case in Case Study 1-1.

In Case Study 1-1, team-building efforts were particularly evident and appeared to be driven largely by the GC and the remote nature of the project. Regarding training exercises, interview responses indicated that these were initiated by the GC, consistent with the organization's standard practice at the start of each project (Findings, 4.1.2.1, Part 3, 3.1). Team-building activities emerged organically among onsite personnel who did not live locally; they began meeting outside of work to participate in recreational sports leagues and community events (Findings, 4.1.2.1, Part 3, 3.2–3.3). Given that many team members had limited prior experience working together, these informal opportunities to connect were valuable for building trust (Findings, 4.1.2.1, Part 3, 3.4). This case study offers evidence supporting the value of team building as an IG mechanism in the development of SL.

The development of group cohesiveness benefits the team, as prior research has shown it can lead to increased efficiency (Molenaar, et al. 2014). However, this example also illustrates a reliance on the governance practices of an external organization. While such reliance does not necessarily hinder project success, it implies that the culture of SL may be shaped more by the external organization's governance than by the project team itself.

In Case Studies 1-2 and 2-1, I was fortunate to examine two projects led by the same project owner, who had implemented a progressive design-build strategy. This coincidence offered valuable insight into a consistent team training approach that familiarized participants with the owner-driven systems and digital platforms used to deliver the coordinated MEPFSA model (Findings, 4.2.2.1, Part 3, 3.1). Case Study 1-2 also incorporated team-building activities

at the project's outset to help participants become better acquainted (Findings, 4.2.2.1, Part 3, 3.2). Similarly, Case Study 2-1 hosted events such as a kickoff barbecue and holiday potlucks, where team members were encouraged to share childhood photos as a way to foster cohesion (Findings, 4.4.2.1, Part 3, 3.2).

Additional activities such as golf outings and fun runs further contributed to team bonding (Findings, 4.2.2.1, Part 3, 3.3). Despite the remote nature of many roles, the team in Case Study 2-1 found opportunities to meet in person, such as attending lunches to celebrate project milestones (Findings, 4.4.2.1, Part 3, 3.3). These findings offer evidence for how group cohesiveness can be cultivated through project-specific systems (Molenaar, et al. 2014) and they suggest that a culture of SL can be intentionally fostered through IG practices that prioritize team building.

Case Study 3-1 demonstrated many similarities to the other projects in terms of fostering group cohesiveness through project-specific systems; however, it also stood out for its ability to leverage the collective experience of the owner, design team, and construction trades to build upon prior successes rooted in a culture of SL. In construction settings, the importance of prior working relationships should not be underestimated. Shared experience can significantly accelerate the development of trust and mutual respect. Across all case studies, there were examples of individuals drawing on previous collaborations to support their teammates and promote a collaborative environment (Findings, 4.1.2.1, Part 3, 3.4; 4.2.2.1, Part 3, 3.4; 4.3.2.1, Part 3, 1.2; 4.4.2.1, Part 2, 2.5).

What was unique about Case Study 3-1 was its deliberate effort to build on these established relationships. Many team members had previously worked together (Findings, 4.5.2.1, Part 2, 2.2; Part 3, 3.4), and the project implemented onboarding programs to familiarize new members with the project's IPD approach. Training sessions were used to introduce new participants to the project culture (Findings, 4.5.2.1, Part 3, 3.1), while team-building activities celebrated milestone achievements and included retreats (Findings, 4.5.2.1, Part 3, 3.2). Additionally, several non-work-related events encouraged not only team cohesion but also a healthy work–life balance (Findings, 4.5.2.1, Part 3, 3.3).

The team-building efforts in Case Study 3-1 were unmatched by the other case studies, which align with the project's high level of commitment to collaboration through IPD practices. Importantly, this case highlights the powerful synergy between systematic IG strategies and the experiential knowledge gained from previous team collaborations. Together, these factors can lead to improved processes (Fischer, et al. 2017), as well as enhanced trust and cohesion—qualities commonly found in teams that successfully share leadership (Molenaar, et al. 2014).

5.4 Informal Governance – Communication Systems

The findings suggested that empathetic communication strategies can be instrumental in cultivating the collaborative climate necessary to support a culture of SL (Northouse 2018). They also indicate that such approaches may help project teams navigate difficult conversations more effectively, even when constrained by contractual limitations

The IG element of communication systems focused on the team's ability to document decisions and goals by examining how teams navigated difficult conversations, measured performance, and provided access to decision-making platforms. Across all case studies, individuals demonstrated the ability to engage in open, honest, and sometimes difficult conversations, albeit to varying degrees. In the absence of clearly defined, project-specific goals, team performance often defaulted to the expectations and aspirations of individual organizations. Access to decision-making platforms was consistently observed in coordination meetings and appeared to be a standard practice across the projects.

What stood out in this IG element was the relationship-based approach adopted by the VDC coordinators in Case Study 3-1. These coordinators intentionally fostered a supportive environment in which team members felt more comfortable engaging in difficult yet necessary conversations. This approach appeared to strengthen the culture of SL, aligning with prior research that emphasizes the role of open communication, trust, and relational leadership in collaborative teams (Northouse 2018) (Molenaar, et al. 2014) (Fischer, et al. 2017).

A common finding across the case studies was that individuals felt comfortable engaging in open, honest, and difficult conversations. Although contractual relationships occasionally influenced how these discussions were navigated, some individuals demonstrated the skills and approaches necessary to encourage continued dialogue and idea-sharing. For instance, in Case Study 1-1, the field supervisor valued having contract documents available when discussing scope-related issues (Findings, 4.1.2.1, Part 4, 4.1). Similarly, the VDC coordinator in Case Study 1-2 and the trade field supervisor in Case Study 3-1 acknowledged the limitations imposed

by contractual structures when engaging in such conversations (Findings, 4.2.2.1, Part 4, 4.1; 4.5.2.1, Part 4, 4.1). Despite these constraints, the VDC coordinators in Case Study 3-1 did not view contractual boundaries as a barrier. Instead, they adopted empathetic approaches that respected the perspectives and emotions of their teammates, thereby fostering a psychologically safe environment where individuals felt encouraged to continue speaking up (Findings, 4.5.2.1, Part 4, 4.1).

5.5 Informal Governance – Workspaces

The examination into workspaces revealed how teams leveraged their digital tools to create more efficient meetings, through systematic communication, and allow for greater team participation when remote work was necessary. Whether this be by creating breakout rooms, coordinating individually through the BIM model while still working in the same physical space, or creating flexibility for those who cannot meet in-person, the case studies showed creative approaches to maximize the value of their workspaces.

The development of the IG element Workspaces focused on the use of BIM technologies to facilitate seamless sharing of essential project information, as well as on the definition and use of project-specific workspaces—both physical and virtual—to better understand how colocation and digital collaboration supported the coordination process (Molenaar, et al. 2014). While all case studies reported challenges with BIM integration, the findings were difficult to synthesize into a singular strategy directly tied to the IG element. In contrast, the strategies employed to utilize workspaces—both in-person and virtual—proved more readily observable and impactful. These approaches were used to overcome several challenges, including a global pandemic,

geographically dispersed team members, and the need for efficient meeting structures and problem-solving processes.

Given that I began this dissertation in the wake of the global COVID-19 pandemic, it is unsurprising that participants in this study were well-versed in the use of virtual and digital collaboration spaces. However, Case Study 3-1 stood out in its approach to balancing onsite work with virtual communication tools. The MEPFSA team in this case worked primarily onsite but effectively leveraged virtual platforms to enhance communication and provide flexibility for team members who needed to work remotely.

Across all case studies, remote work was supported, and virtual spaces were widely utilized to increase efficiency, especially for individuals working from their organization's home offices (Findings, 4.1.2.1, Part 5, 5.2; 4.2.2.1, Part 5, 5.2; 4.3.2.1, Part 5, 5.2; 4.4.2.1, Part 5, 5.2; 4.5.2.1, Part 5, 5.2). These projects were not purely virtual, however. Most maintained onsite colocation spaces for remote workers to use when visiting the project site (Findings, 4.2.2.1, Part 5, 5.2; 4.4.2.1, Part 5, 5.2). Despite this, colocation was not the primary mode of collaboration for most MEPFSA teams.

Case Study 3-1 presented a different model. In this project, colocation was intentionally prioritized to improve coordination and communication among MEPFSA team members and to provide opportunities for the team to observe the work being put in place. This emphasis on physical proximity did not preclude the use of virtual platforms; in fact, all coordination meetings were conducted online. This enabled participants to navigate the BIM model from their

own computers during meetings—offering greater engagement and flexibility than relying on a single shared screen. It also accommodated those who could not attend in person due to geographic distance or personal obligations, such as caring for a sick family member (Findings, 4.5.2.1, Part 5, 5.2).

Furthermore, the ability to use virtual breakout sessions during in-person meetings increased efficiency by allowing those not directly involved in specific issues to step away, thereby minimizing wasted time (Findings, 4.5.2.1, Part 5, 5.2). These approaches not only provided the team with the resources necessary to complete their tasks effectively (Northouse 2018), but also demonstrated how virtual spaces can be used strategically to maximize their value in a hybrid work environment.

5.6 Shared Leadership Questionnaire

Although the results of the SLQ were limited by a small sample size, there was consistent evidence across the case studies indicating that SL was present. Notably, Case Studies 1-2 and 2-1—both of which shared the same project owner and had similar project-wide systems in place—produced comparable SLQ scores. This correlation warrants attention, as it may indicate the influence of the project owner's governance approach on team dynamics. Perhaps more notably, when I examined the combined results from all case studies, empowerment at the team level was consistently rated highly, while aversive leadership appeared to be largely absent—except for the question related to teammates pointing out when someone's work was not up to standard.

Table 44 provides a comparison of the SLQ scores across all case studies, supported by a heat map legend in Table 55 to help visualize the survey results. Case Study 3-1 stands out with the highest overall SLQ score among the cases; however, this finding is limited by the fact that it is based on a single response. In contrast, the responses to the empowerment (team) category averaged above "mostly agree" across all case studies. Given the larger number of responses contributing to this particular metric, the consistency observed reduces the likelihood that these results are coincidental.

Table 45 - Case Study Recap of SLQ Scores with Detailed Categories

Case Study	CS 1-1	CS 1-2	CS 1-3	CS 2-1	CS 3-1	Overall
SL Overall	3.69	3.27	3.57	3.39	4.27	3.55
SL Overall w/out Aversive	4.00	3.64	3.90	3.67	4.64	3.87
Transformational Leadership	4.00	3.83	3.92	3.75	4.50	3.91
Transactional Leadership	3.25	3.25	3.88	3.25	4.00	3.55
Directive Leadership	4.00	3.00	3.56	3.19	5.00	3.55
Empowerment (individual)	4.25	3.00	3.88	3.88	4.75	3.91
Empowerment (team)	4.50	5.00	4.25	4.25	5.00	4.41
Aversive Leadership	2.00	1.25	1.75	1.88	2.25	1.82

Table 46 - SLQ Heat Map Legend

SLQ Rating	Strongly Agree (4.00 +)	Agree (3.01 - 3.99)	Neutral (3.00)	Disagree (2.00 - 2.99)	Strongly Disagree (1.99 -)
Heat Map					

Across all case studies, the questions associated with the *empowerment (team)* category received the highest average scores of all SLQ categories, and the low standard deviation suggests strong reliability in the responses (see Table 46). This trend may reflect team members encouraging one another to collaborate across roles, an approach supported by previous research on SL in teams (Hoch, Dulebohn and Pearce 2010) This finding also aligns with the collaborative practices led by facilitators in several case studies (Findings, 4.1.2.1, Part 1, 1.2; 4.5.1.2, Part 1, 1.2), as well as with projects that developed inclusive decision-making processes empowering a diverse group of individuals to participate (Findings, 4.2.2.1, Part 2, 2.1–2.4, 2.6; 4.4.2.1, Part 2, 2.1, 2.2, 2.6, 2.7; 4.5.2.1, Part 2, 2.1–2.7).

The systems implemented in these projects resemble collaborative governance models that promote participation in activities such as pull planning, joint goal-setting, and stakeholder inclusion (Molenaar, et al. 2014, Fischer, et al. 2017). While some variation in responses could be attributed to external factors or the limited sample size, the consistency of high scores in this category provides reasonable support for the idea that collaborative, inclusionary practices contribute to teams that feel empowered to support one another and work cohesively.

Table 47 - All Case Study Responses SLQ Empowerment (team) Questions

Empowerment (Team) Questions	Average	STD
My team members encourage me to work together with other individuals who are part of the team	4.36	0.48
My team members advise me to coordinate my efforts with other individuals who are part of the team	4.36	0.77
My team members urge me to work as a team with other individuals who are part of the team	4.45	0.78
My team members expect that the collaboration with the other members in the team works well	4.45	0.50

Another notable statistical outlier in the SLQ results was the consistently low score in the Aversive Leadership category. Of the four questions in this category, three were associated with "intimidation" and one with "reprimand" (Hoch, Pearce and Welzel 2010, 116). Across all case studies, the average scores for the "intimidation" items were 1.64 or lower, with the question regarding whether team members felt intimidated by others' behavior averaging just 1.09. The low standard deviation of 0.30 further supports the reliability of that response.

The only question in this category that scored above 3.00 was the item associated with "reprimand," which asked whether team members believed their colleagues would point out when their work was not up to par. The stark contrast between the low scores for intimidation and the relatively neutral score for reprimand presents an interesting juxtaposition, especially when considered alongside the interview findings that emphasized open, honest, and difficult conversations. This suggests that while teams generally rejected coercive or fear-based communication, they still valued constructive feedback as part of maintaining accountability within the team.

Table 48 - All Case Studies SLQ Aversive Leadership Questions

Aversive Leadership Question	Average	STD
My team members try to influence me through threat and intimidation	1.36	0.66
I feel intimidated by my team members' behavior	1.09	0.30
My team members can be quite intimidating	1.64	0.50
When my work is not up to par, my team members point it out to me	3.18	1.45

The connection between this question and SL is supported by previous research, which suggests that team leaders must be willing to confront and resolve issues related to inadequate team member performance (Northouse 2018). Several case study findings reflected this behavior, with participants demonstrating the ability to engage in open, honest, and difficult conversations (Findings, 4.1.2.1, Part 4, 4.1; 4.2.2.1, Part 4, 4.1; 4.4.2.1, Part 4, 4.1; 4.5.2.1, Part 4, 4.1). This suggests that teams capable of having such conversations may improve their communication effectiveness and create opportunities for identifying best practices and areas for development.

While the Aversive Leadership category in the SLQ appears to contrast sharply with the collaborative behaviors observed in these AEC project teams, the higher score for the "reprimand" item complicates this interpretation. It implies that direct, constructive feedback may not be perceived as aversive behavior, but rather as a necessary aspect of accountability in a SL context. The polarized responses to this particular question indicate a need for further exploration into how teams distinguish between confrontational versus constructive communication in performance-related feedback.

5.7 Related Governance Topic – Contract Boundaries

Across all case studies, MEPFSA facilitation was led by the GC. While this could be attributed to various factors, one key consideration is that hiring decisions inherently introduce the systems and practices of the selected organization into the project's governance structure. For example, in Case Studies 1-1, 1-2, and 1-3, the VDC coordinator indicated that training efforts were based largely on their home organization's established practices (Findings, 4.1.2.1, Part 3, 3.1). Similarly, team-building initiatives in Case Study 1-1 were led by the GC (Findings,

4.1.2.1, Part 3, 3.2–3.3). These contributions were viewed positively within the context of the case studies and were further affirmed by the designer in Case Study 1-2, who expressed high praise for the GC's involvement (Findings, 4.2.2.1, Part 3, 3.4).

The influence of contract language was also evident in the IG elements related to decision making and communication systems. During discussions about open, honest, and difficult conversations, the constraints imposed by contractual boundaries emerged as a recurring theme. The field superintendent and VDC coordinator in Case Study 1-1, as well as the trade VDC coordinator in Case Study 2-1, all noted the value of having contract documents on hand when navigating challenging discussions (Findings, 4.1.2.1, Part 3, 4.1; 4.4.2.1, Part 3, 4.1). Not surprisingly, contract terms also placed limits on the scope of decisions that could be made by certain individuals or teams.

Chapter 6: Conclusions

In this final chapter, I present a summary of the research findings, their contributions to the body of knowledge, potential impacts on the AEC industry, study limitations, and directions for future research. First, I revisit the research question, the methodological approach used to examine the topic, and the key findings that emerged from the five case studies. This is followed by a discussion of the study's contributions to both academic scholarship and industry practice, along with an acknowledgment of its limitations. The chapter concludes with recommendations for future studies that build on the findings of this research.

6.1 Research Summary

This research aimed to expand the understanding of project governance and SL by addressing the following core objectives:

This research will examine the informal governance of collaborative project delivery methods to explore how it impacts the formation of shared leadership within virtual teams utilizing BIM technologies.

Through interviews, observations, and surveys conducted across five case studies, this research collected data that helped illustrate each team's approach to SL. A mixed methods case study design was employed, combining qualitative interviews and observations to examine IG, along with a quantitative assessment using the SLQ to evaluate the presence of SL. IG was analyzed through five elements—team organization, decision making, team building,

communication systems, and workspaces—each of which was guided by operationalized definitions that informed both the interview questions and field observation protocols.

The SLQ measured leadership characteristics across 26 questions grouped into six categories: transformational leadership, transactional leadership, directive leadership, empowerment (individual), empowerment (team), and aversive leadership. Data from the interviews and observations were reviewed for thematic patterns and were organized according to the IG elements' operational definitions for each case study. Survey responses from the SLQ were averaged by category and by individual question to provide insight into the perceived presence of SL across the project teams.

The findings related to the IG elements from the individual case studies revealed how MEPFSA coordination teams approached team organization, decision making and inclusion, team building and training, communication, and workspace management—each contributing to the development of a SL culture. For the IG element of team organization, every case study emphasized the importance of assigned facilitators in leading MEPFSA coordination efforts and in cultivating an atmosphere conducive to SL.

Decision making access varied depending on an individual's role and how empowerment was granted by leadership or organizational practices. However, there was strong evidence to suggest that structured programs designed to place decision-making authority in the hands of the team—particularly within progressive design-build and IPD contexts—were effective. Team building efforts were sometimes driven by the GC facilitating the MEPFSA coordination, but

CPD strategies that emphasized training and group cohesion-building activities also proved successful in fostering camaraderie and collaboration.

For the IG element of communication systems, both prior experience and contractual relationships influenced the team's ability to engage in open, honest, and difficult conversations. Nonetheless, VDC facilitators who adopted empathetic communication strategies—those that acknowledged and respected team members' opinions and emotions—were successful in fostering the collaborative climate essential for SL (Northouse 2018).

Regarding workspaces, teams demonstrated the flexibility to work remotely and effectively leveraged virtual platforms to facilitate breakout sessions, improve meeting efficiency, and resolve coordination issues even during in-person interactions. Overall, the presence of IG elements that support SL was evident across all case studies. Notably, project-specific approaches stood out as more effective in fostering SL compared to teams that relied solely on their home organizations' governance practices.

The results of the SLQ provided evidence that SL was present among members of the MEPFSA coordination teams, with notable patterns observed across the SLQ categories. Each case study produced an overall SL score above 3.00—the neutral midpoint between "strongly disagree" (1.00) and "strongly agree" (5.00)—indicating a general agreement that SL behaviors were occurring. Across all case studies, empowerment (team) consistently received the highest average score, while aversive leadership received the lowest. While the low number of SLQ survey responses in each case study presents a limitation, the consistency of the responses

indicating the formation of SL within MEPFSA coordination teams provides internal validation to support the impacts of the IG elements examined.

The questions within the empowerment (team) category focused on team members encouraging one another to collaborate with different individuals on the team, which aligned with the inclusive and facilitative leadership practices described by the project facilitators. Conversely, the aversive leadership questions, particularly those related to intimidation, were consistently rated below 3.00, with the lowest average scores observed across all case studies. These findings may be connected to themes within the IG element communication systems, where participants described their ability to engage in open, honest, and difficult conversations. In this context, the relatively higher score for the question regarding whether team members would offer feedback when others' work was subpar suggests that constructive confrontation may be viewed as a supportive—rather than aversive—behavior within teams practicing SL

6.2 Contributions to Knowledge

This research, which examined the impact of CPD IG on the formation of SL within MEPFSA coordination teams, makes several contributions to the academic community.

Foremost among these is the identification of the facilitator’s critical role in supporting the development of SL in AEC project teams. Facilitators were not only instrumental in guiding teams through the technical coordination of MEPFSA systems but also played a central role in cultivating an environment conducive to SL.

The influence of facilitators on project outcomes is consistent with prior research in the AEC industry, which has highlighted the importance of facilitation in enabling effective project delivery (Chen and Manley, Validation of an Instrument to Measure Governance and Performance on Collaborative Infrastructure Projects 2014), providing leadership clarity (Fischer, et al. 2017), and acting as relationship managers (Chen, Manley, et al., Procurement and Governance Choices for Collaborative Infrastructure Projects 2018). However, the novel contribution of this study lies in its extension of SL theory (Bergman, et al. 2011) (Hoch and Kozlowski 2014) into the AEC context. By demonstrating how facilitators actively foster SL behaviors, this research bridges a gap between leadership theory and construction management practice, offering new insight into how facilitation contributes to collaborative project success in complex, multidisciplinary environments.

Another key contribution from this research is the reinforcing of the influence that CPD governance can have on MEPFSA coordination and other AEC project teams. When CPD methods were first introduced, they were positioned as a remedy to the punitive nature of traditional contracting, aiming instead to influence team behavior toward more collaborative practices (The American Institute of Architects 2007). The desired behaviors included fostering a culture of collaboration and shared responsibility—core principles of IPD. Evidence from this research suggests that the collaborative governance structures embedded in the case studies played a significant role in supporting the emergence of SL within these teams (The American Institute of Architects 2007). As detailed in the findings, all five IG elements—team organization, decision making, team building, communication systems, and workspaces—appeared to influence the development of SL within the MEPFSA coordination teams. This

expands the current understanding of how CPD governance can be leveraged not only to manage workflows but also to cultivate the collaborative and participatory behaviors essential for effective SL in complex construction environments.

Finally, this research expands the understanding of SL as it applies to MEPFSA coordination teams and its manifestation within the broader AEC industry. The case study approach employed in this study led to the development of IG categories grounded in operationalized definitions. These categories were specifically designed to reflect SL dynamics as they emerged under the unique antecedent conditions of each project team (Carson, Tesluk and Marrone 2007).

While the limitations and opportunities for refinement of the IG elements are addressed in the following section, their ability to capture context-specific expressions of SL in MEPFSA coordination teams should not be overlooked. These elements represent meaningful contributions to how IG can be studied in relation to team leadership within AEC environments.

Moreover, the way SL emerged in these teams—particularly under CPD-driven governance structures—offers insight into how collaborative behaviors are supported in practice. Although the SLQ survey data may not be fully representative of all individual case studies, the consistent scoring patterns—particularly the high averages and low standard deviations in the empowerment (team) category and the low scores in aversive leadership—provide valuable indications of how SL behaviors are expressed in AEC coordination teams.

6.3 Potential Impact on Industry

The application of VDC coordination teams is expected to grow as digital tools continue to evolve and the AEC industry increasingly embraces collaborative approaches to project delivery. This research demonstrates that a project's governance structure can be intentionally leveraged to shape its desired culture. In the context of this study, the desired culture was SL, and it was supported through IG systems—including how teams are organized, how individuals are empowered to make decisions, how team-building and training activities are implemented, how communication systems are structured to promote accountability, and how workspaces are managed to support collaboration.

Among these elements, the role of facilitation emerged as particularly critical. Facilitators not only contribute to organizing the team but also play a key role in immersing participants in the culture of CPD. As evidenced in Case Studies 1-2, 2-1, and 3-1, having a defined decision-making framework helps clarify roles and can empower subject-matter experts to drive collaborative problem-solving. Having a facilitator that can guide individuals through the decision-making framework will help clarify roles develop the habits needed to empower SL throughout the team.

Early project training that introduces and reinforces the CPD approach is instrumental in setting the tone for SL. However, it is equally important to consider how new team members are onboarded so that they, too, are integrated into the collaborative culture. Communication systems should be designed not only to document decisions but also to support transparency and shared accountability. Efficient workspaces—both physical and virtual—can further enhance team

effectiveness. For example, breakout rooms improve focus during meetings, and digital tools enhance communication and allow for flexible participation, accommodating individuals' varying needs and constraints when working remotely.

6.4 Limitations

In this section I will acknowledge the following limitations in this research.

Data limitations – Qualitative methods: This study's qualitative data were limited in both the number of interviews conducted and the availability of field observations for certain case studies. A total of nine interviews were conducted across the five case studies. Of these, a single interview was used to inform Case Studies 1-1, 1-2, and 1-3. Specifically, two interviews were applicable to Case Studies 1-1 and 1-2, and one interview to Case Study 1-3. These three case studies also lacked field observations, unlike Case Studies 2-1 and 3-1.

For Case Study 2-1, field observations included one "big room" coordination meeting involving the MEPFSA team and two additional site-based observations. Although I was unable to attend scheduled coordination meetings in late September due to a calendar conflict, the data already collected were deemed sufficient for analysis. Case Studies 2-1 and 3-1 each had three interview participants, providing a stronger basis for developing findings. Additionally, three field observations were completed for Case Study 3-1, and these were determined to have reached a point of data saturation.

Among the five case studies, Case Studies 1-1, 1-2, and 1-3 were the most limited in both qualitative and quantitative data. In contrast, Case Study 3-1 was the most complete, with robust data collected through multiple interviews and field observations. Case Study 2-1 was slightly less complete due to the fewer field observations, though it still offered sufficient data for analysis. These limitations affect the overall depth and breadth of perspectives represented in the findings—particularly for the less complete case studies. As a result, the data from those cases may reflect individual biases or offer a limited view of team dynamics, especially in instances where only one or two participants provided insights without the benefit of corroborating field observation data.

Data limitations – Quantitative methods: The primary limitation in the quantitative component of this study was the low response rate to the SLQ. Across all five case studies, only 11 responses were received. Case Studies 1-3 and 2-1 had the largest response counts, with four participants each. The remaining case studies—1-1, 1-2, and 3-1—each received only a single response. While the anticipated size of the MEPFSA coordination teams was initially estimated at approximately 10 individuals, subsequent field observations revealed that actual team sizes ranged from 17 to 30 participants. Given this scale, quantitative studies of this nature ideally require near-complete participation to ensure validity and representation. Unfortunately, none of the case studies in this research achieved that threshold.

There are several possible explanations for the limited response rate. One contributing factor was my restricted ability to communicate directly with team members. Although I composed the invitation message for the survey, it was distributed by a management representative who had

contact with the MEPFSA coordination team. In the case of CS 3-1, I was able to contact the team directly via email; however, the only response I received was a reply asking whether the individual was considered part of the MEPFSA coordination team. After confirming that they were, no further communication or survey submission followed.

In past research, I had the benefit of meeting with survey participants in person, which yielded nearly full participation (Hochstatter, Borhani, et al. 2022). In contrast, the majority of the teams in this study were either geographically remote from my location in Seattle or rarely gathered in the same physical space, which likely contributed to the low response rate.

6.5 Future Studies

There his research opens the door for several future studies that could expand and deepen the understanding of IG and SL in the AEC industry. The following recommendations outline areas for continued exploration:

1. Examine IG and SL Across Diverse AEC Project Teams

One of the primary motivations for examining IG and SL in MEPFSA coordination teams was the recognition that CPD systems emphasize governance structures that focus on team behaviors. This foundation enabled the development of IG elements that were tested in the field. Now that these elements have been established, future research could apply them to a wider variety of AEC project teams—such as design teams, field crews, or general project management groups—to explore how SL manifests in other organizational and delivery contexts.

2. Explore the Impact of External Organizational IG on SL Formation

While this study focused primarily on the internal IG systems of individual project teams, interview data frequently referenced the influence of external organizational culture and governance. Several participants described how their home organizations' leadership models, values, or prior experiences shaped their behavior on the project. For example, in Case Studies 1-1, 1-2, and 1-3, participants noted that the GC brought an existing SL culture into the project environment, which supported the project's SL objectives. Similarly, the GC in Case Study 3-1 appeared to intentionally foster SL practices within the MEPFSA coordination team. Future studies could examine how these external governance systems influence or shape SL dynamics within CPD projects.

3. Investigate the Relationship Between Formal Governance Structures and SL Practices

This research focused on IG systems under the assumption that they would have the greatest influence on collaborative behaviors such as SL. However, several interviewees noted that formal contractual boundaries—particularly those related to risk, responsibility, and authority—constrained certain types of communication and decision making. Future studies could explore how formal governance structures, such as multi-party contracts and risk-sharing arrangements typical of IPD and CPD models, affect the development of SL culture. Additionally, since the SLQ instrument includes a transactional leadership category, it would be valuable to examine whether formal governance mechanisms that rely on incentives or penalties

align with responses in this category, and how they interact with or counterbalance collaborative leadership behaviors.

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Appendix A – Interview Protocols

Case Study Informal Governance – Interview Protocol

Target: Individuals who work on the MEPFSA coordination team and that include tasks that support coordinating the BIM model and/or coordination with MEPFSA field installation.

- Designers/architects
- Trade detailers
- VDC coordinators
- Assigned facilitators
- Field support/coordinators
- Project engineers/managers

Topics Covered:

- Team organization
- Decision making
- Team building
- Communication systems
- Workspaces

Protocol:

Hello, my name is Kirk. Thank you very much for taking the time out of your busy schedule to participate in my research. Are you still available for this interview?

Elevator pitch: What I am researching are the impacts of informal governance and the formation of shared leadership within your MEPFSA coordination team. I have developed 17 questions today that I am going to ask that's going to serve as our framework for a conversation about these IG elements and we have about an hour to complete this. When responding to the questions, please take them from the perspective of your MEPFSA coordination team, and not of the overall project team, or your organization. Do you have any questions before we proceed?

Team Organization

1. What are the roles of you and your MEPFSA/BIM coordination team members?
2. If you have a facilitator for your team, describe their relationship with the team.

Decision Making

1. How did you contribute with BIM execution planning?
2. How were you included in pull planning exercises?
3. How would you describe your participation in any project and/or team goal setting exercises?
4. Describe your role in decision making.
5. Describe a time when you were allowed to change or update the goals of the team.
6. In a group environment, how are the decisions made?
7. How was the team involved in creating the decision-making process?

Team Building

1. What training exercises did you participate in with your project team?
2. What team building exercises did you participate in?
3. What "non-work" activities do you and your project team members participate in?
4. How would you describe your enthusiasm to work on future projects with this project's team members?

Communication Systems

1. How comfortable do you feel with having open, honest, and hard conversations with your team?
2. How is your project team performance measured?

Workspaces

1. How integrated are the technologies used across the team? Is there any challenges with compatibility?
2. Describe the in-person and virtual spaces you work in?

IG Element Defined	IG Element Operationalized	Interview Question
Team Organization: How people meet up and work together	Team Roles are Clearly Understood	What are the roles of you and your MEPFSA coordination members?
	Assigned Team Facilitator	Do you have a MEPFSA facilitator for your team and describe their relationship with the team?
Decision Making: How Decisions are Made	Participation in BIM Execution Planning	How did you contribute in BIM execution planning?
	Participation in Pull Planning Exercises	How were you included in pull planning exercises?
	Participation in Goal Setting Exercises	How would you describe your participation in any project and/or team goal setting exercises?
	Allowed in Decision Making	Describe your role in decision making?
	Allowed to Change Goals as the Project Moves Forward	Describe a time when you were allowed to change or update the goals of the team.
	Decisions Are Made with Plurality of Team Members Present	In a group environment, how are the decisions made?
	A Decision Making Process that Has Been Developed or Agreed Upon By the Team	How was the team involved in creating the decision making process?
Team Building: Activities that Build Team Rapport	Team Participation in Training Exercises	What training exercises did you participate in with your project team?
	Team Building "Boot Camp"	What team building exercises did you participate in?
	Team Members Participate with Each Other for "Non-Work" Activities	What "non-work" activities do you and your project team members participate in?
	Desire to Work on Future Projects with Team Members	How would you describe your enthusiasm to work on future projects with this project's team members?
Communication Systems: How You Document Decision and Goals	Open, Honest, and Hard Conversations Take Place	How comfortable do you feel with having open, honest, and hard conversations with your team?
	Team Performance is Measured	How is your project team performance measured?
	Access to Decision Making Platforms	Site Observation Only
Work Spaces: Where You Work	Common/Integrated BIM Technologies	How integrated are the technologies used across the team? Is there any challenges with compatibility?
	Defined Work Spaces Specifically for Project Teams/Work Groups	Describe the in-person and virtual spaces you work in?

Interview/Field Observation Worksheet Used During Coding Field Observations

IG Element	IG Element Operationalized	Observable?	What is the goal of the question/observation
Team Organization: How people meet up and work together	Team roles are clearly understood	Interview/Site Visit	Understand if the person clearly understands their role and the roles of the person they are working with. If they understand their roles, they will better understand how to support and recognize the efforts of their other team members.
	An assigned team facilitator	Site Visit/Interview	Understand if the team had an assigned facilitator and if the impact they had guiding the team.
Decision Making: How decisions are made	Participation in BIM execution planning	Interview/Site Visit	Understand the access to leadership opportunities by having access to planning activities.
	Participation in pull planning exercises	Interview/Site Visit	Understand the access to leadership opportunities by having access to planning activities.
	Participation in goal setting exercises	Interview/Site Visit	Understand the access to leadership opportunities by having access to goal setting exercises
	Allowed in decision making	Interview/Site Visit	Being given the opportunity to make decisions within the team.
	Allowed to change goals as the project moves forward	Interview/Site Visit	Understand the freedom that team members have to change goals.
	Decisions are made with plurality of team members present	Interview/Site Visit	Understand the how much the team is allowed to make decisions.
	A decision making process that has been developed or agreed upon by the team	Interview/Site Visit	Understand the team participation process in decsion making processs.
	Access to decision making platforms	Site Visit	Is the decision making more public or private within the team spaces?
Team Building: Activities that build team raport	Team participation in training exercises	Interview	Understand how the team was prepared for working together.
	Team building "boot-camp"	Interview	Understand the effort made to create team cohesion.
	Team members participate with each other for "non-work" activities	Interview	Understand if the team members enjoy being around each other even if it's not working time.
	Desire to work on future projects with team members	Interview	Understand their desire to continue working with each other.
Communication Systems: How you document decisions and goals	Open, honest and hard conversations take place	Interview/Site Visit	Understand how willing the team is to share, even if it's not good news.
	Team performance is measured	Interview/Site Visit	Understand how the team performance is measured.
	Access to decision making platforms	Interviews/Site Visit	Being given the opportunity to make decisions within the team.
Work Spaces: Where you work	Common/integrated BIM technologies	Interview/Site Visit	Looking for any challenges that may be created due to a lack of alignment with technology platforms.
	Defined work spaces specifically for project teams/work groups	Interview/Site Visit	Understand the make-up of in-person and virtual work spaces.

Appendix B: Example of Coding Procedure and Case Study Coding Takeaways

Case Study 1-1, 1-2, and 1-3 Interviews Takeaways Recap

Interview Question	**Operationalized**/Goal of the Question	**CS1-1 Takeaway**	**CS1-2 Takeaway**	**CS1-3 Takeaway**
1. What is your role in the MEP coordination team?	**Team roles are clearly understood** *Understand if the person clearly understands their role and the roles of the person they are working with. If they understand their roles, they will better understand how to support and recognize the efforts of their other team members.*	Very clear understanding of the role that they play on their project. Uses BIM and the VDC coordinatin to help them complete their superintendent tasks. Uses the tool to plan the physical work of construction, but only after the model has been fully coordinated. Discusses how the federated model helps create an effecient meeting where schedule buy-in from the other trades is expeditiously accomplished (in an hour).	The individual clearly understands their role for the project and how they support the project and other team members.	This individual leads the VDC efforts for their company and also fills in the role of facilitation when its needed. They see their role as not the expert but getting the experts to speak up and work together. As they said in their own words, "a ringleader."
2. Describe the in-person and virtual spaces you work in.	**Defined work spaces specifically for project teams/work groups** *Understand the make-up of in-person and virtual work spaces.*	They understand the value of virtual and in-person work spaces as well as the challenges that come with working remotely from people, even in online meetings. Communication is challenging across trades and even more difficult when hosting meetings remotely. There is a clear understanding and perference to the work spaces they want to work in with the tasks that they have in front of them.	The individual worked virtually and locally. They spoke to "big room" meetings held montly that could be virtual or onsite. They are actually based on the east coast so they would travel to the project monthly where they would share an office space next to the project where they could meet in person with the other team members. BIM clash meetings were held virtually that started with the design team and eventually incorporated the trade fabricators and installers. Eventually these meetings shifted to onsite as materials started showing up onsite for installation. MEP trades did share an office	While this individual would prefer to work on the jobsite, their role and the people they work with demands flexibility to work remotely as well. After COVID, working remotely and providing a virtual space was more common and easier to adapt to after the fact. Virtual spaces have just become easier to work in given the time they spend in front of screens in the first place.

3. If you have a facilitator for your team, describe their relationship with the team?	**An assigned team facilitator** *Understand if the team had an assigned facilitator and if the impact they had guiding the team.*	The team has a facilitator and based on the relationship they have with the facilitator, the individual is able to get a lot of work out of the facilitator to help them with their tasks. However, this is based on their past relationship and the employees who don't know the facilitator that well struggle with asking for help or understanding the skillset the facilitator brings. There does seem to be an expectation that the "younger individuals" need to reach out to the facilitator to trigger the help they can receive.	The faciilitation was lead by the GC who had a dedicated VDC engineers to drive the clash detection. These facilitators were responsible for collecting the "issues" and then decide to resolve those issues in a coordination or not. They described the collaboration effort as "really pretty good" and "everybody was really...invested in this and understood the scope of the project."	This individual's work usually involves being the facilitator for VDC coordination and values his role of building relationships with his teams, especially the long term projects, where you "learn how to leverage other people's knowledge." To build "that strong team to go successfully coordinate a project." Also recognizes how the work they do in facilitating BIM coordination trickles down to the field and executing the installation.
4. How did you contribute to BIM execution planning?	**Participation in BIM execution planning** Understand the access to leadership opportunities by having access to planning activities.	Has not been involved in BIM execution planning on this project. In the past, when they were another role (project engineer), they had facilitation and coordination responsibilities on other design-build projects. They seemed to be a conduit between the design and the build aspects.	Their organization maintains a BIM execution plan but that was not specifically used to for the project. The GC had their own BIM plan and they worked with them to modify their plan "as something like an amendment or addendum to theirs." Their company also has a BIM specialist who participaed in the BIM execution planning, that supported this "abridged version of our own as an amendment to the BIM ex plan." Their company specific BIM exececution plan works as a template that expresses contractually agreed upon standards and how to create an effecient process. These standards help the other users work in their shared model space and create something they can all view. The template seems to be a starting point for projects to use to make sure the teams are able to ammend it to work for their project parameters. So this is organizationally driven, it is a template that is designed to support project requirements and actors.	They are very much a part of the BIM execution planning and facilitate the development of the plan utilizing the parts of the project team, designer, MEPs, owner, and GC. Their response indicates that they really see developing this plan as a team effort that happens at the very first meeting.

5. How were you included in pull planning exercises?	**Participation in pull planning exercises** Understand the access to leadership opportunities by having access to planning activities.	They lead pull planning exercises for the field and have even trained other superintendents on how to facilitate these meetings. They lead the conversations with the trade partners and steer "the conversations in the right direction." Sees their role as extracting the information from the trades to develop the schedule. Seems like the knowledge of how to pull plan a project is left up people with previous experience to train others on the go.	This individual was not part of the initial j"bigger" pull planning but believes that senior individuals at their organization did. They were allowed to adjust the activities within the larger milestones that were planned, indicating they had the ability to adjust activities at a certain level of planning.	They support the pull planning process, even if they don't directly facilitate the pull planning meetings. A lot of the value they get from those meetings help them develop their own schedules that they use for planning. They do seem to have access and are empowered in the planning of project activities but also see how their role more supports those actually doing the pull planning.
6. How would you describe your participation in any project and/or team goal setting exercises?	**Participation in goal setting exercises** Understand the access to leadership opportunities by having access to goal setting exercises	The participation of goal setting in their role is to develop the plan between the contractural start and finish dates. Using pull planning, they are given the freedom to create and adjust the tasks to get to those goals. These tasks and durations are developed with the input of the trade contractors	This project had a clear stakeholder engagement and goal setting process that had "a lot of owner involvement…." with a lot of "…exercises and workshops with the owner about setting goals fro the project, but it included members of the GC." This organization helped facilitate projet goals with the MEP teams to "bring everybody on along." Very much appears to be a project wide approach to setting goals and driven by the ownership.	They participate in developing plans to hit more traditional project goals, like schedule and budget. How they support achieving those goals. But they don't really create project "goals."
7. Describe your role in decision making.	**Allowed in decision making** Being given the opportunity to make decisions within the team.	This individual has an assigned leadership authority on the project. They appear to have the power to empower others on the project to make decsions, however they only speak to people in their company making those decisions, and these decisions seem to be fairly inconsequential as sort of a practice to make bigger decsions in the future. Regardless, it appears that this ability to make decisions is an implied process within their organization and is not something specific to this particular project. External organizational governance and not project specific.	Decision making was a collaborative effort, so yes, this individual had a role in decision making but it truly was a team process. The individual expressed that this may have been a first where the GC was involved this early in the design reviews and that was appreciated with them being so remote from the project. They beleived this was pretty successful.	They don't see themselves as the person that should be making the decisions but their responsibility to make sure the right people who knows more than them to make those decisions. They do acknowledge that they need to use judgement when they see thousands of clashes on kind of clashes need to be deligated to the experts, but they are just facilitating and their role is to make the right people make the right decisions.

8. Describe a time when you were allowed to change or update the goals of the team.	**Allowed to change goals as the project moves forward** Understand the freedom that team members have to change goals.	Missed this question in the interview.	Since the goal setting process was a collaborative effort that took a lot of work to finalize, they didn't change throughout the project. The individual did say that if they did change, it would require that the stakeholders who came up with the goals would need to be consulted as they were in the begining of the project to be changed. None of the goals would've been changed that were self-motivated or in isolation.	Considering that they see the goals of the team being schedule and budget, they do have the autonomy to adjust the schedule as better information becomes available. But if there is a conflict with the overall schedule or budget, they know that they need to talk with the owner and designer to "try and go figure this out." So they can adjust goals but with boundaries of big goals of the project.
9. In a group environment, how are the decisions made?	**Decisions are made with plurality of team members present** Understand the how much the team is allowed to make decisions.	There is not a specific process for decision making as a group, but up to the leadership of the project team to empower the team to make decisions. The example used to show how this individual empowers someone to make a decision comes across as partially empowering and somewhat gate keeping. What I mean by that is the person who was empowered to make the decision had done the work to know what to do, but the individual leading still had to authorize them to move foward. In other words, the individual leading understands that the people who are responsible for the work need to implement their plans, but there is still a tacit recognition of authority that needs to addressed before those decisions are implemented.	Group decisions were made with the consideration of who was being impacted and who needs to be a part of the process. Very much a team process that appears to be driven by the owner and supported by the design-build team.	While his role as a facilitator is to empower the team to make decisions in a group environment, he brings up how the BIM Execution Plan comes in handy when people try to change things after they all signed off on it. How this becomes a tool when things go from push to shove and explain to people "we've all signed off on it" and "you gotta go do it this way..." "...we try to get all that suff out on the table ahead of time....So that there is no confusion about that kind of stuff." Also acknowledges "how it's contracted ."(CM, risk). "where all that risk falls." Ultimately they try to work on the relationship with the partners to get them to do the work they owe, including being practical with the work they are assigning them so they don't bog them down. They just know they have a lot of tools at their disposal to get the team and trades to complete the work that they are responsible for.

10. How was the team involved in creating the decision making process?	**A decision making process that has been developed or agreed upon by the team** Understand the team participation process in decsion making processs.	No, the team was not involved in any specific decision making process and this is typical of tall the projects they've worked on in their organization. The process "falls into that heirarchy…." There does appear to be an opportunity given to subordinates to make decisions that may or may not be coached by supervisors in order for those individuals to learn from, but there was no team participation on making a decisions making process for this specific project. The culture of decisions making comes from their organization and not project specific. There is some speculation as the project moves along that others may be included in developing the decision making process, but at this point in time, this is driven by the orgainzation.	There was a process. With this being a design build project, they used a lot of tenants of IPD and assembled project working teams (PWT) throughout the design process that into construction. The owner did have organizational architectural advisors that sometimes needed to chime in on bigger decisions that affected their campus standards, and large cost decisions sometimes involved higher-ups to authorize, but the project team worked together in developing the information needed to help facilitate those decisions. Very much sounds like the decision making process was project specific driven by owner organization processes.	Discussed in previous sections.
11. What training exercises did you participate in with your project team?	**Team participation in training exercises** Understand how the team was prepared for working together.	No real team training exercises for this project and typically the requests for training exercises are driven by their organization.	Team training exercises were used to get the teams up to speed on how the owner runs their projects, like the PWT's, and translating their acronyms. Another example of the owner establishing their building protocals to the design-build team.	Trainings do take place if the project needs it. They assess this need at the begining of the project and then get the training tools to the team to get up to speed. It can be a simple as a Youtube video or in-person. Example they used was about a project where they used a non-Navisworks software for the clash coordination that was required by the owner, so they host a training and make themselves avaialbe for follow up questions after training.

12. What team building exercises did you participate in?	**Team building "boot-camp"** Understand the effort made to create team cohesion.	The team has taken it upon themselves to create activities for others to hang out and get to know other team members. Fantasy football, bar trivia, local festivals. This is a remote project so they have a lot of individuals who have travelled from all over the west coast to work. This seems to be driven by the individual leadership and typical of their past projects similar to this. It is done in the effort to build camaraderie and get individuals to get to know each other.	The project team had gatherings at the beginning of the project get to know each other. These were fully remote due to the pandemic, but their still was an effort to get to know each other with activities like happy hour, and guessing contests. The individual did say that during construction there were events that the GC hosted celebrating safety week and maintaining a safe site.	Team building for the VDC team can be challenging since so many people are remote so it doesn't happen. They do feel that teams are forged during "crunch time" but in the end of the day, the people working hard just want to turn off their computers and go home. They have looked into some online team building, like virtual escape rooms, but nothing implemented so far.
13. What "non-work" activities do you and your project team members participate in?	**Team members participate with each other for "non-work" activities** Understand if the team members enjoy being around each other even if it's not working time.	Similar to the last response. Individuals from the team have come together to play soccer at a very early hour because this is the only time they have to do this on a very demanding project. And the participants seem to really enjoy it.	While this individual works on the east coast and visits the project monthly, they are limited on what they can do with the team for non-work activities. With that said, they did say that when in town they will participate in activities like going out to dinner, golfing, and "fun runs." While they may not actually do activies like golf or running, they did show up and support. They did say that these non-work activities were driven by the GC and "they've been really good about taking charge of that."	Depends on the project. The projects in areas where individuals are working aways from their homes, the teams will find ways to do non-work activities. Other teams will sometimes be invited to a sporting event and this builds relationships with companies they do a lot of work with. It's intersting though, because this person has a family so they don't do a lot of non-work activities and I've heard that from other respondents too.

14. How would you describe your enthusiasm to work on future projects with this project's team members?	**Desire to work on future projects with team members** Understand their desire to continue working with each other.	They are only a couple months into this project so the individual doesn't and does know if they want to continue working with each other. The individuals they do want to work with they've worked with on past projects, but there is obvious skepticism towards new individuals on if they can keep up with how their organizations expect them to work. Their statement also reinforces that their is an expectation to do things the way their organization expects them to, rather than a project specific expectation, indicating that internal project governance to forming shared leadership is non-existant but would be fostered through their organzational	They had a "great relationship" and expressed how much they trusted the GC. They want to work with them again.	While the person being interviewed isn't referencing a specific project, they seem to like working with a lot of the people they come across. "for every 20 people I get to work with, there's like maybe one person I would be fine if I never had to work with again." They have repeatedly reinforced the relationship aspect of the job and "..building those relationships...."
15. How comfortable do you feel with having open, honest, and hard conversations with your team?	**Open, honest and hard conversations take place** Understand how willing the team is to share, even if it's not good news.	This individual is not afraid to have difficult conversations but I think that is due to their experience and knowledge of how projects are managed. One of the examples he uses discusses how a contractural mechanism empowered them to push back on a surveying request and this is an excellent example of how contractural governance helped back up their position in a disagreement and resolved the issue. Their response also included an example of how they were able to use existing office desk layouts to direct a new employee on how to set up their office. A potentially akward situation that was averted due to existing informal company standards.	While tough conversations may not have taken place, this individual said they would "feel pretty comfortable about it" if they did need to have one. Key note in this was that they stated that they're "just trying to observe contractural relationships" that may limit them from approaching a subcontractor to the GC in adressing an issue, but they would still go through the GC to have them address.	They believe that open and honest conversations are easy and hard conversations are a little more hard. It depends on the team you're addressing and the contractural relationships. If the design team works for the owner, you approach it different if its a design build scenario.

16. How is your project team performance measured?	**Team performance is measured** Understand how the team performance is measured.	Team performance is an internal practice and they have a formal process. The KPI's seem to be set up that would drive project performance but not something that is specifically created for this individual project. It is standard across the company. They also employ a 3rd party to perform safety audits, but this is still an organizational decision and not a project specific driven decsion.	Revisions to RFI's and submittals was really important to them. Having a great relationship with the GC allowed for them to streamline the issues that could cause revisions. They saw how getting ahead of these revisions keeps the project on-track and this could be influenced by the design-build relationship and shared responsibility.	Time and money. "We're hitting the deadlines….finishing stuff in time." "That's construction, schedule delays. That's money."
17. How integrated are the technologies used across the team? Are there any challenges with compatibility?	**Common/integrated BIM technologies** Looking for any challenges that may be created due to a lack of alignment with technology platforms.	There are some struggles with the technologies being used not being compatible but there is an effort by the organization to make sure they "talk to each other." The effort is in place to reduce the amount of documentation they are having to do. Seems to be organization driven, but with the respect to make the work on the project better for those executing the work.	No issues. The team was all able to upload to the 3D model, which was managed by the GC. Scopes that utilized 2D design was not impacted and they were able to incorporate their designs into the model for visualization purposes. Execution of those scopes knew they should not be using the 3D model so there was clear lines of demarcation on what the model was used for and when scopes needed to rely on the 2D documents.	They work towards makning sure everything is integrated and if it isn't, "at least making sure the right data is translating back and forth…."

Case Study 2-1 Interview Takeaways Recap

Interview Question	**Operationalized**/Goal of the Question	**CS2-1 Takeaway**	**CS2-2 Takeaway**	**CS2-3 Takeaway**
1. What is your role in the MEP coordination team?	**Team roles are clearly understood** *Understand if the person clearly understands their role and the roles of the person they are working with. If they understand their roles, they will better understand how to support and recognize the efforts of their other team members.*	They very clearly and simply see their role as the plumbing detailer on the project..	The individual is the VDC manager for the electrical contractor and makes sure that the people in their company have all the information they need to model it.	They work with the architecture team and knows very specifically what they do in their role, even as their role has expanded since the beginning of the project (discusses his project role further in other responses).
2. Describe the in-person and virtual spaces you work in.	**Defined work spaces specifically for project teams/work groups** *Understand the make-up of in-person and virtual work spaces.*	This individual works remotely and will periodically go on a job walk to review the work. They have in the past met with the MEP lead for the GC on this project, but they have not met in person with the MEP coordination team for this project.	They work primarily in virtual spaces. Their response explains the work they do in the Autodesk Construction Cloud and the improvements to the system that continue to allow for them to work virtually. How the functions of the program and their "hubs" are working better with how they transfer work between the GC's program and theirs.	They are mostly virtual, which is a trend post-pandemic for their work.
3. If you have a facilitator for your team, describe their relationship with the team?	**An assigned team facilitator** *Understand if the team had an assigned facilitator and if the impact they had guiding the team.*	The team has a facilitator who is also considered their MEP lead coordinator for the GC. Describe the facilitator as someone "who's running the show…." and "we give our input but the end of the day he gets to help call the shots…."	Yes, thei project has a facilitator, who works for the GC. The interviewee's interactions with the facilitator are in meetings and working with them to "bridge funtionalities" to get the technolgoy to work correctly.	They don't know if there is a specific facilitator assigned but that the role can sometimes fall to a "younger team member" or to a project manager. Also the interviewee notes the difficulties of working with ACC.
4. How did you contribute to BIM execution planning?	**Participation in BIM execution planning** Understand the access to leadership opportunities by having access to planning activities.	The individual explained their experience in developing a schedule with the GCs. Input and compromise were themes. This project was approached the same way and the schedule was determined through compromise and at the time of this interview, they said "it is pretty much...exactly where I thought we're going to be."	They are not typically involved in the BIM execution plan. If they do get involved, it is usually with precon, estimators and PMs.	This individual sat in the BIM "kickoff meeting" where they reviewed items like level of design and aligning expectations. Understanding deliverables and phases of design.
5. How were you included in pull planning exercises?	**Participation in pull planning exercises** Understand the access to leadership opportunities by having access to planning activities.	They didn't feel there was time to do any pull planning exercises and they started their work immediately. The schedule was developed through input and compromise with the GC. Iterations of back and forth proposals before it was finalized.	Missed interview question	They did not participate in the pull planning for this project because they were only part time on the project early on. They did use a "mural board" that they would continually update and review in the "Big Room" meetings and they would be part of updating. Said "that maybe worked reasonably well."

6. How would you describe your participation in any project and/or team goal setting exercises?	**Participation in goal setting exercises** Understand the access to leadership opportunities by having access to goal setting exercises	The individual very much sees the schedule as the primary goal for the work they're doing. They described how they'll help the trades that will impact the overall schedule and how they appreciate when other trades will help them throughout the project. When asked about the coordination process, they described how code requirements will usually trump other trades trying to get their work in first and further into how trades will help each other out when their systems conflict in spaces dedicated to a certain trade. But overall, it is a first come, first serve. This approach can lead to some contentious situations but the facilitator needs to be able to drive the tough decisions.	Does not participate.	They don't remember being a part of this or if any specific project goals being published. They mentioned examples of issuing permits and drawing sets as examples of goals, which could serve as what they are driving towards when doing their work.
7. Describe your role in decision making.	**Allowed in decision making** Being given the opportunity to make decisions within the team.	The individual describes how they are empowered by their company to make decisions if it saves money and time and they'll review these decsions with their foremen and PM when they can. They are ultimately held accountable with their projections vs. actual. As it relates to the project, it appears that they will suggest changes that saves the project time and money and share this in meetings where decisions are made and recorded.	They are allowed the automony from their orgainzation and installers to make a decision based on "what works best, what's best for the field." They say this trust to make these decisions is based on their experience.	They were allowed to make decisions as it related to their scope of work and work with the other designs to coordinate.
8. Describe a time when you were allowed to change or update the goals of the team.	**Allowed to change goals as the project moves forward** Understand the freedom that team members have to change goals.	They describe when changes in the design come up, they are allowed to adjust the schedule due to the scope revisions. This individual very clearly sees the project goal as the schedule and describes as being empowered to change this schedule goal. My thought with this is that every project allows for this through legal precidence that changes in scope have impact and those impacted are entitled to compensation, such as time lost.	They don't know of any goals they'd be able to change.	Missed interview question
9. In a group environment, how are the decisions made?	**Decisions are made with plurality of team members present** Understand the how much the team is allowed to make decisions.	They repeatedly described the decision making in a group environement as "chaos." That right now on the project so much is changing and its chaos every week. While that is happening, the BIM tool has been helpful for showing conflicts and what is possible in solving the problems. That folks will share their screens with the group to make decisions and it's "powerful."	"…my first job…for decision making is of what we can and cannot do." Seeing a "give and take" process, the interviewee emphasised a "good working relationship with the other trades" in order to get it done.	The approach is to have the impacted disciplines to work together for a solution, the GC would direct cost impacts and hopefully have it decided in that meeting. Some difficulty using this method when people who are impacted are not at the meeting.
10. How was the team involved in creating the decision making process?	**A decision making process that has been developed or agreed upon by the team** Understand the team participation process in decsion making processs.	They explained that while this project did not have a decision making process, due to the rapid pace of the project, they have participated in these decision making process in the past. They did mention that one of the other reasons they may have bipassed this is due to the familiarity of the team with each other. "...we've all worked together before....you know the deal...."	While the interviewee eludes to a potential decision making flow model in a BIM execution plan, it seems like this whole process is tacit to them. That when they get to a situation, they know what works and what doesn't.	Yes, the team was brought on early to meet quarterly with the UW to get into the design-build mindset for the project. Working with the owner, they would discuss their direction and make sure they were meeting the clients needs. Each discipline got to present things they needed feedback on and having the GC leading where the work needed to be spent or a different path was needed.

11. What training exercises did you participate in with your project team?	**Team participation in training exercises** Understand how the team was prepared for working together.	Yes, they did do training on this project. It was in regard to updating from CAD to Revit and syncing their models and a plugin tool on Navisworks.	They had team training on Autodesk Construction Cloud setups.	They don't know if they had any training exercises except for the brief rundown of the model in ACC. They need more training for this as it is a constant learning process.
12. What team building exercises did you participate in?	**Team building "boot-camp"** Understand the effort made to create team cohesion.	This individual has not participated in any team building exercises but knows that others in their company have on this project. They do anticipate future team meetups for traditional celebrations like topping out.	No team building exercises.	For this individual, they've attended several team building exercises. A kickoff BBQ on the project site, where they did a trivia quiz competition. They also had to share a picture from an earlier age with the team and had a holiday potluck in the Big Room.
13. What "non-work" activities do you and your project team members participate in?	**Team members participate with each other for "non-work" activities** Understand if the team members enjoy	No non-work activities with this project, which is not suprising since they work remotely.	"As we're virtual, there's really none. At this point." "At this point" could be eluding that some may occur in the future.	They have had opportunities to meet up for lunch with the team after a big deadline but they have been too busy to join.
14. How would you describe your enthusiasm to work on future projects with this project's team members?	**Desire to work on future projects with team members** Understand their desire to continue working with each other.	This individual loves working with these team members and working with the GC and owner.	They enjoy working with this group and praised their positivity.	Yes, they "would be happy to work with all these folks again." They appreciate the collaborative approach by the team and collegial atmosphere.
15. How comfortable do you feel with having open, honest, and hard conversations with your team?	**Open, honest and hard conversations take place** Understand how willing the team is to share, even if it's not good news.	They have no issues with being open and honest with this team because they know them. If it wasn't the same team, they've experienced that their input wasn't as appreciated.	"Internally…I think it's great." They have an approach where they come in with a good attitude and try to maintain professionalism even if it gets combative. Sounds they are using their typical approach to this project as well.	They haven't had to have a difficult conversation and been accustom to just calling it as they see it and have a discussion about it. Nobody is trying to hide things or lie about something.
16. How is your project team performance measured?	**Team performance is measured** Understand how the team performance is measured.	Their team performance is based on him keeping up with the schedule, making sure they are keeping up with the current design, is your content accurate, are you being proactive with the coordination efforts. and make it installable. His organization measures his performance through his forecasted hours and if he's keeping up with that. If he isn't he keeps a daily journal to track impacts.	Their team performance is measured in their job of resolving clashes and maintaining design, construction with their sign off dates.	Nothing that is generated for this specific project. Just that the measurement is if the client is happy, how fast conflicts are resolved and their cost impacts, and the schedule is being maintained. Commonly used AEC performance benchmarks.
17. How integrated are the technologies used across the team? Are there any challenges with compatibility?	**Common/integrated BIM technologies** Looking for any challenges that may be created due to a lack of alignment with technology platforms.	Just a few hiccups with Revit and the cloud based systems, but described as "not a huge deal."	The modelling itself in Revit is "fantastic" and compatibility is "real smooth" but the coordination in the ACC program is challenging. Worries about protecting internal information makes it difficult to do their job efficeintly.	For the most part, its "better than other projects" but there are struggles with navigation and having multiple models altogether. Some challenges with working with Autodesk, and the ownership of the product. Sounds like no big complaints but there are issues.

Case Study 3-1 Interview Takeaways Recap

Interview Question	**Operationalized**/Goal of the Question	CS3-1 Takeaway	CS3-2 Takeaway	CS3-3 Takeaway
1. What is your role in the MEP coordination team?	**Team roles are clearly understood** *Understand if the person clearly understands their role and the roles of the person they are working with. If they understand their roles, they will better understand how to support and recognize the efforts of their other team members.*	Very clear understanding of the task at hand and their role. Very specific to the design coordination progress to the implementation in the field.	This individual works as a VDC facilitator , that includes understanding the issues at hand and connecting it to the workflows, and making sure everyone is being heard and being valued as a part of the coordination meetings. To connect those voices with "the process of how to prioritize where that issue falls within our coordination schedule" and drives that through to resolution and "memorialized and broadcasted to the broader team for alignment."	There is a clear understanding of their role and how it works with the IPD approach taken by the project. Understands how the risk pool with the prime contract members motivates and understand the collaborative approach required of the team members.
2. Describe the in-person and virtual spaces you work in.	**Defined work spaces specifically for project teams/work groups** *Understand the make-up of in-person and virtual work spaces.*	They work in both the virtual and in person spaces but very much prefers working face-to-face with people. They note the importance of working together with people from previous projects, and with this specific cleint, they people they've worked with on earlier phases have been easier to work with virtually because that in-person experience helped build that trust. Also expressed the value of having a person who can run the VDC meetings that can meet with individuals face to face to understand scope conflicts and priorities.	They work in-person and this is very much intentional as they believe that they create mutual respect when working face-to-face and establish the "relationship beyond the meeting." Also helps with going out and seeing the work that is happening in the field when they are working together onsite. They do use virtual spaces for meeting and discussing the model and coordinatin, but that is done so that they all can see the same screen at the same time when navigating the model. It helps make the tings youre trying to talk about easier.	The vast majority of the project works onsite and the limited virtual team members are only working virtuality due the practicalities of their location (Atlanta office) or life situations (staying home to take care of a chile).
3. If you have a facilitator for your team, describe their relationship with the team?	**An assigned team facilitator** *Understand if the team had an assigned facilitator and if the impact they had guiding the team.*	Yes, they have multiple facilitators for certain phases of the project. They suggested that the lessons learned from the first phase needs to be shared with the second phase. A "rules of the road." Even suggesting some time to reflect on what worked well and what didn't to improve effeciency.	They are one of the faciliators for this project and they very much are intentionally trying to elevate all the voices that are in these meetings. They use their role to work in and outside the meetings with those who need to resolve the clashes in the model and see the problems from multiple viewpoints. They very specifically see their role as a way to create an atmosphere of shared leadership. They believe this inclusionary approach leads tocertainty in the project schedule and efficiency in the installation.	Understands their role as a VDC coordinator as a leadership role in driving the team towards a solutin. Also sees their role as working with all the people on the project and being flexible in their role. Also needing people skills and developing trust so others will be comfortable with you in brining up problems. Drives the idea of doing what's best for the project.
4. How did you contribute to BIM execution planning?	**Participation in BIM execution planning** Understand the access to leadership opportunities by having access to planning activities.	Yes, they have been involved in the BIM execution plan and have leveraged their experience on pervious phases to help better inform the project goals. They speak very specifically to durations in planning, as would be expected with someone who works in the trades, but seems to be a common association when the question of planning and goals are brought up.	This individual not only works on the BIM execution plan, they are very much invested in making the document work for all the parties on the project. They do this by empathizing with the trade contrators to create a plan that works for them. They also want the feedback from their trade partners to make sure that they see that their voice has been included in its development. They very much want this document to help people execute their work and not to become a "cover your ass" (CYA) document that typically covers your risks. That it is a document that speaks to the detailers and that they actually want to use it.	They've participated in building the BIM execution plan from a template based on the needs of the project. The development is an inclusive process that focuses on being collaborative and allowing itselve to be ammendable. When they are working through the part of the plan that is inclusive to the GC, everone that is part of that team buys into the plan.
5. How were you included in pull planning exercises?	**Participation in pull planning exercises** Understand the access to leadership opportunities by having access to planning activities.	Yes, as explained in an earlier question, they were a part of the pull planning exercises and used the opportunities to give feedback on what they need to plan for based on earlier phases of construction.	VDC coordinators (what this person does) is 100% a part of the pull planning process as it helps them develop the coordination schedule and milestones, which they pull from. They also include the designers, detailers, and field in this pull planning development as well. It sounds like a very inclusionary practice.	Yes, they were involved in the pull planning process and how they worked from the completion date back to design development. They also described it as "a whole collaborative process for this particular project" that includes the design and trades participating in the pull plan.Also described how this experience is different vs. their previous projects with the same company that uses a CPM approach to driving a schedule.

6. How would you describe your participation in any project and/or team goal setting exercises?	**Participation in goal setting exercises** Understand the access to leadership opportunities by having access to goal setting exercises	The interviewee was not involved in the goal setting exercises and explained how these responsibilities would fall under the "core team." The core team was described as representatives from the owner, GC, architect, structrual, and MEP contractors. These are the decisions makers as well when it comes to money and the logic is this is due to them being part of the master contract and profit/risk sharing. Very much an IPD project.	Yes, they are very much a part of goal setting and brought up establishing Conditions of Satisfaction. These CoS are used to align design and installation with these goals in mind and drives decisions and their proposed solutions. These goals are also memorialized in order to communicate to new team members what they are doing and not to allow for traditional construction approaches to take over. To "...make it an effort to re-communicate and re-engage with the teams on those specific goals."	They explain how the the goal of "Nn RFI's" was decided before they were part of the project but they were given the task of making sure this goal is achieved. They were allowed to be creative in meeting this goal and given the responsibility to create a process to meet that goal. Credited the project being lean as a motivator and the desire for continous improvement.
7. Describe your role in decision making.	**Allowed in decision making** Being given the opportunity to make decisions within the team.	This individual has a lot of authority to make decisions on the project. Part of it is heirarchy in his organization and the chain-of-command that gives him that responsibility, and the other is this specific project,and working out thing collaboratively with the core team in a co-location space.	The decision making approach is very intentional for creating shared leadership. Decisions are prioritized to be made for the good of the project and there is a hierarchy on where decisions take place (in the field, in a meeting, or in the BIG room). There is some resistance to the systems being applied, but the approach is to listen to their objections and show them respect. They want to establish trust.	Discussed their role about supporting decisions that focus on the best thing for the project. To elevate ideas for continuous improvement and taking in ideas for lessons learned. Developing workflows and improving them. Many processes have been changed over the past 2 months and some that are working great. Sounds very dynamic.
8. Describe a time when you were allowed to change or update the goals of the team.	**Allowed to change goals as the project moves forward** Understand the freedom that team members have to change goals.	Said "there's some fluidity to it" and then discussed the "good collaborative environment" that the GC has created for this project. They discussed that the field respects the project by showing "them that they care, and give them a little bit more of that human respect." This leads to better performance and "it doesn't seem like there's a lot of problems that the group hasn't been able to work through."	Yes, they can change project goals if they impact a goal with higher priority.	They described their experience and approach changing a workflow that involved a popular ditigal tool and implemented another digital solution. It was not popular and they reacted to this by providing training to help communicate the way the tool worked. As they move into prefabrication, there is a confidence that this tool has delivered their desired objective?
9. In a group environment, how are the decisions made?	**Decisions are made with plurality of team members present** Understand the how much the team is allowed to make decisions.	For the project, decision making determines on the size of the problem and who it can be handled by. Small problems that can be figured out in the field, can be decided on in the field. Larger problems may command other peoples attention to make a decision. Also could depend on the trades or disciplines and, of course, the cost. The bigger point is they have a clear understanding of how decisions are made and who can decide and this applies to the entire project.	There is an emphasis on making meetings efficeint and do this by breaking the meeting into two focuses; trade and design coordination. They also will have to make decisions where a limited amount of meeting participants are impacted by the discussion, and they will continue with a breakout meeting afterwards. The intent is to not waste the time of others not needed in the decision, and give "a better voice for everyone to talk about their concerns."	They bring up Choosing by Advantages (CBA) as a method they have used for adjudicating the choice of which digital tool was better for the project. After all the data was gathered, the decioins was made that focused on what was best for the installer workflow.
10. How was the team involved in creating the decision making process?	**A decision making process that has been developed or agreed upon by the team** Understand the team participation process in decsion making processs.		They are allowed to modify the decision making process if it is allowed by the owner. Their baseline expectation is does the team feel like they are "empowered to making their own decisions." Ultimately the owners desire to control the process is always in their favor, but if they want to expedite the process and not be someone slowing up the project, they can abstain.	The decision to use CBA sounds like it came from a pllurality of the decision makers and they even believed it had been being used without it even being known that they were using a similar system.
11. What training exercises did you participate in with your project team?	**Team participation in training exercises** Understand how the team was prepared for working together.	They discuss the internal training that they do at Sprg to support the work they do in the field, including digital tools so they can support the BIM coordinatin efforts.	The project has an onboarding process for each employee and they recall how just the day before a member of their team spoke up on how the onboarding may not address the culture of the project and what shared leadership as a concept looks like. That their responsibility to the project is more than resolving "...clashes and move elements and pieces in Revit."	There is a wide variety of trainings they participate in, ranging from team retreats and digital tools project wide training. Priority on individuals being VDC ready.

12. What team building exercises did you participate in?	**Team building "boot-camp"** Understand the effort made to create team cohesion.	Team building activites would be celebrating the sign off of a level. As for team trainings, they discussed the "Sitelink" QR code system they had in the building where you can scan QR codes throughout the building so you can reference the model at the exact spot. This training was described as "advantageous to the entire team." They also think the more team trainings are "an area of opportunity."	They have several team training exercises that also serve as team building. They also celebrate milestones that focuses on the individuals who were directly responsible for the outcomes (lunch with the detailers).	Emphasized their previous experience from the Rosebud retreat and the quarterly team health surveys. They believe the "team building exercises…have been super critical to making this project where it is right now."
13. What "non-work" activities do you and your project team members participate in?	**Team members participate with each other for "non-work" activities** Understand if the team members enjoy being around each other even if it's not working time.	While the personal and work responsibilities can limit the opportunities for participating in "non-work" activities, they know that there are people on the project who do this. They did just recently particiapte in a Top Golf event with the GC superintendents.	A lot of non-work activies for the project that include community events, and even book clubs. The project also has an onsite gym and there was an emphais on work/life/mental balance.	A wide range of non-work activies including a diversity of festival celebrations and having craft lunches where they are able to learn more from the field how they can better support their work.
14. How would you describe your enthusiasm to work on future projects with this project's team members?	**Desire to work on future projects with team members** Understand their desire to continue working with each other.	The response to the question was very business like. They talked about being optimistic, as if the question was more of a prediction vs. an opinion of your team members personalities. I would say this means the desire is there and they are taking that very seriously to make sure it happens.	"all in for all of the team members and project members" they are working with but also aknowledged they do encounter difficult personalities. And while they are enthusiastic for working with their current team members, they welcome working with new team members who bring new ideas and challenge the current approaches.	They are very enthusiastic to continue working with this group. "oh, hell yeah."
15. How comfortable do you feel with having open, honest, and hard conversations with your team?	**Open, honest and hard conversations take place** Understand how willing the team is to share, even if it's not good news.	As it relates to their company, they know the people they can and cannot have an open honest conversation with.	In meetings, uncomfortable conversations are handled outside the meeting. Sees touch conversatins as an opportunity to build more trust and see the "coordination process more as a people's process." They approach the situation with a respect for the other person's feelings and egos and be empathetic.	Describes how the "…the project encourages you to raise your hand and speak up a lot." Shared a story of when the VDC team needed more time to get a deliverable completed and feeling comfortable being upfront and honest about this.
16. How is your project team performance measured?	**Team performance is measured** Understand how the team performance is measured.	They use their organization's metric of production rates of install to help coordinate with the GC. The GC then uses a scanner that can refernce the model to track their installation as well track the workers in areas with the crew projections they provided the GC.	Their team performance is driven by the milestones, schedule, issue resolution, and process discipline. The interviewee is then described they have a "team health survey" that survey's for data including feeling supported, workload, leveraging VDC, what keeps you up at night, and project improvementand how that survey could be shared in the Big Room to make their voices heard and improve morale.	Team health surveys are mentioned again and contingency being a KPI. The data that the project is tracking for performance is shared with the team on a regular basis.
17. How integrated are the technologies used across the team? Are there any challenges with compatibility?	**Common/integrated BIM technologies** Looking for any challenges that may be created due to a lack of alignment with technology platforms.	There seems to be struggles with all the different organizations having their own software and programs (Zoom vs. Teams was mentioned) and this person does not like using ACC and would prefer Procore. They seem to be struggling with familiarity with the program and seeming to be "searching forever" for data.	The project has experienced frustration with the plethora of digital tools/platforms to do a single task. ACC was mentioned again. So rather than start the conversations about how the tools were failing them, the approach was to discuss the desired outcome and work from there to use the tools at their disposal. The QR tool was lauded for its effeciency in getting the user what they needed instead and leaving the worrying of the platform to the VDC folks.	They believe that the BM technologies are very integrated and discussed the challenges of pasting all the QR codes in the field for the Site Link program being more of a challenge.

Appendix C – Shared Leadership Questionnaire – Items used to measure shared leadership (Hoch, Pearce and Welzel 2010)

Label	Transformational leadership
	Vision
TRF1	My team members provide a clear vision of whom and what our team is.
	Idealism
TRF2	My team members are driven by higher purposes or ideals.
	Inspirational communication
TRF3	My team members show enthusiasm for my efforts.
	Intellectual stimulation
TRF4	My team members encourage me to rethink ideas which had never been questioned before.
TRF5	My team members seek a broad range of perspectives when solving problems.
	Performance expectations
TRF6	My team members encourage me to go above and beyond what is normally expected of one (e.g., extra effort).
	Transactional leadership
TRK1	My team members and me have clear agreements and stick to those when we work together.
	Material rewards
TRK2	If I perform well, my team members will recommend more compensation.
	Personal rewards
TRK3	My team members give me positive feedback when I perform well.
TRK4	My team members give me special recognition when my work performance is especially good.
	Directive leadership
	Participative goal setting
PART1	My team members decide on my performance goals together with me.
PART2	My team members and I work together to decide what my performance goals should be.
PART3	My team members and I sit down together and reach agreement on my performance goals.
PART4	My team members work with me to develop my performance goals.
	Empowerment (individual)
	Independent action
EMP-IND-1	My team members encourage me to search for solutions to my problems without supervision.
EMP-IND-2	My team members urge me to assume responsibilities on my own.
	Self-development
EMP-IND-3	My team members encourage me to learn new things.
	Self-reward
EMP-IND-4	My team members encourage me to give myself a pat on the back when I meet a new challenge.
	Empowerment (team)
	Teamwork
EMP-TEA-1	My team members encourage me to work together with other individuals who are part of the team.
EMP-TEA-2	My team members advise me to coordinate my efforts with other individuals who are part of the team.
EMP-TEA-3	My team members urge me to work as a team with other individuals who are part of the team.
EMP-TEA-4	My team members expect that the collaboration with the other members in the team works well.
	Aversive leadership
	Intimidation
AVERS-1	My team members try to influence me through threat and intimidation.
AVERS-2	I feel intimidated by my team members' behavior.
AVERS-4	My team members can be quite intimidating.
	Reprimand
AVERS-3	When my work is not up to par, my team members point it out to me.