

Working Paper Proceedings

15th Engineering Project Organization Conference
with
5th International Megaprojects Workshop
Stanford Sierra Camp, California
June 5-7, 2017

Exploring The Impact of Feedback Systems in Collaborative Project Delivery Approaches: A Transactive Memory System Perspective

Anthony Elijah Sparkling, Michigan State University, USA

Sinem Mollaoglu, Michigan State University, USA

Shivam Sohani, Michigan State University, USA

Proceedings Editors

Ashwin Mahalingam, IIT Madras, Tripp Shealy, Virginia Tech, and Nuno Gil, University of Manchester



© Copyright belongs to the authors. All rights reserved. Please contact authors for citation details.

IDENTIFYING A BEHAVIORAL FEEDBACK SYSTEM IN ARCHITECTURE, ENGINEERING, AND CONSTRUCTION PROJECT PARTNERING

Anthony E. Sparkling¹, Sinem Mollaoglu², and Shivam Sohani³

ABSTRACT

The Architecture, Engineering, and Construction (AEC) industry is increasingly challenged with improving the efficacy of project team performance through collaborative working arrangements. Collaborative working arrangements such as integrated project delivery, design-build, and project partnering are all comprised of interorganizational project teams. Recent research shows cohesive teams are perpetuated by strategies to facilitate team integration. Efficient knowledge sharing and processing systems, also called transactive memory systems (TMS), are integral to cohesive project teams and their tasks coordination. Although the AEC literature is widespread on the importance of team cohesion, little emphasis is placed on the effects of goal alignment and its relationship to performance outcomes. This research aims to explore the relationship among partnering characteristics to performance outcomes within interorganizational AEC project teams.

Partnering characteristics provide feedback cues to individuals and are integral to partnered-projects during project delivery, although can vary depending on project size and duration. This organic feedback system is present within the phenomenon to investigate its implications for interorganizational project teams. The characteristics of partnered-projects are generally in the form of partnering workshops, charters, and teams' self-evaluated surveys and scorecards. These are some of the top reported practices that occur during project delivery which help increase goal alignment within project teams. The link between partnering practices and project success dominates AEC literature, yet the elements of partnering practice should be examined separately. To support this idea, data was collected via an in-depth case study examining team dynamics during partnered-project delivery. Preliminary findings offer support for the partnered-project delivery framework connecting partnering practices to changes in team interactions and performance outcomes. Furthermore, this research points out how behavioral attributes (e.g., transactive memory systems) of partnered-project teams are important to successful project delivery on AEC projects. The overarching aim is to move the discussion from important, but, superfluous attributes towards more substantive metrics. This will allow both researchers and industry practitioners to adequately advance team integration efforts.

¹ Doctoral Candidate, School of Planning, Design and Construction, Michigan State University, East Lansing, MI 48824 USA, sparkli1@msu.edu

² Associate Professor, School of Planning, Design and Construction, Michigan State University, East Lansing, MI 48824 USA, sinemm@msu.edu

³ Former Masters Student, School of Planning, Design and Construction, Michigan State University, East Lansing, MI 48824 USA, sohanish@msu.edu

KEY WORDS: Project partnering, Teams, Partnering characteristics, Performance outcomes, Transactive memory systems

INTRODUCTION

PROJECT PARTNERING “WHY DOES IT WORK?”

Despite its prevalence in architecture, engineering, and construction (AEC) literature, project partnering is not only an effective tool, but requires a new perspective to understand “why” and “how” it works. Project partnering is predominately investigated with an emphasis on hard metrics (e.g., cost, schedule, litigation, and safety improvements) while intangible results (e.g., better optimized projects, owner/client satisfaction, and better overall team satisfaction) are slowly emerging as other consequences of partnering implementation (Anderson & Polkinghorn, 2011; Yeung, Chan, Chan, & Li, 2007). This paper suggests an alternative lens in which we should view project partnering which focuses on *transactive memory systems* (TMS) of partnered-project teams.

Lewis (2003) describes TMS as “the active use of a transactive memory by two or more people to cooperatively store, retrieve, and communicate information”. The notion of this shared memory systems was spawned by Wegner (1987), who first observed how groups in close relationships have implicit knowledge of one another’s memory. This memory system is structured such that it is easily retrieved from others when needed hence; a *transactive memory system* (TMS) is greater than the sum of its parts or individual memories (Wegner, Erber, & Raymond, 1991).

Theory and research suggest TMS facilitates quick and coordinated access to specialized expertise, thereby improving group performance. The performance attributed to TMS is explained by the unique knowledge structure that develops. More importantly, this depository of knowledge is coded and stored in a systematic process that allows for easy retrieval or elicitation from group members. An effective TMS is further enhanced by the dynamic interplay as teams communicate, interact, and execute tasks in groups (Lewis & Herndon, 2011).

BACKGROUND

Traditional construction project delivery methods such as design-bid-build (DBB), construction management (CM), and design-build (DB) have dominated construction contracts in the U.S. for well over 30 years. During this period, alternative project delivery approaches have also begun to emerge as viable options to increase collaboration and integration among project teams (Gransberg & Scheepbouwer, 2015). The traditional methods, though effective, do not encourage collaboration and communication across organizations during the early planning stages of the construction process. In fact, many of these approaches put contractors in a position where behaviors are focused on transaction costs and posturing against uncertainty involved in project delivery (Li, Arditi, & Wang, 2013). Newer relational project delivery methodologies (e.g., Project Partnering, Strategic or Project Alliancing, and Integrated Project Delivery [IPD]) surfaced in the late 1980s continuing to expand over a fifteen year period bent on increasing levels of collaboration across organizations and to help mitigate risks (Lahdenperä, 2012).

Project partnering, as the focus of this paper, continues to receive attention in the literature. Even recently, partnering is reportedly defined based on the context and region (i.e., United States (U.S.) or internationally in the United Kingdom (U.K.), etc.) in which it is used (Gransberg & Scheepbouwer, 2015). Much of the confusion with the term “partnering” can be attributed to the

misunderstanding of the contractual arrangements when it is referred to in Architecture, Engineering, and Construction (AEC) literature. According to Gransberg and Scheepbouwer (2015), the primary difference between project partnering as implemented in the U.S., project partnering contracts (PPC 2000) and partnering alliances as in the U.K. are whether good faith agreements are binding on the parties through contractual agreements. In the U.S., project partnering is typically a voluntary arrangement among parties and is non-binding whereas partnering alliances and project partnering contracts are binding.

Project partnering aims to address the interests of all parties involved in project delivery such as the owner, designer, contractors, other project stakeholders (Anderson & Polkinghorn, 2011). Several steps are undertaken to encourage collaboration such as early involvement of key participants during planning and design phases, gaining top management support, affording equality to all team members, joint decision-making and problem solving strategies, joint partner selection, workshops, and open communications focused on mutual goals and objectives (Jacobsson & Wilson, 2014; Lahdenperä, 2012). These benefits and barriers to project partnering are commonly posited yet its implementation on projects in the U.S. remains elusive (Mollaoglu, Sparkling, & Thomas, 2015). A recent study ranked project partnering last in terms of being able to achieve successful team integration and high levels of collaboration (Gransberg & Scheepbouwer, 2015).

Based on a meta-analytic synthesis of AEC partnering literature and conceptual framework, this paper uses evidence-based information to guide the discussion on partnering in practice (Sparkling, Mollaoglu, & Kirca, 2016; Mollaoglu & Sparkling, 2015). An in-depth partnering case study which involved a complex airport construction project in San Francisco is analyzed to validate the conceptual framework (Sohani, 2016). From this, social network analysis techniques are used to analyze project meeting minutes and other project documents to understand characteristics of project partnering, referred to herein as partnering, on team performance. Results of this paper demonstrate the influence of partnering characteristics on team interactions and performance outcomes. Meanwhile, an emerging structure and metrics are presented to understand the perceptions of individuals working under collaborative project delivery arrangements.

PARTNERED-PROJECT DELIVERY FRAMEWORK

Recent research points out the broad characteristics of AEC partnering literature and potential links among these characteristics (Mollaoglu & Sparkling, 2015; Sparkling, Mollaoglu, & Kirca, 2016). In their syntheses, 73 partnering studies are classified into several prominent categories using a meta-analytic review process. The work posits a clear taxonomy regarding partnering characteristics, specifically categorizing them *as partnering drivers, project team characteristics, and performance outcomes* among others. In their analysis, underlying groups are reported in each category. The following is a list of the groups associated with their partnering taxonomy:

1. *Drivers during partnered-project delivery*: Contractual (e.g., contracting language and incentives); Procurement (e.g., early involvement of project stakeholders, designers, contractors, subcontractors); Practices (e.g., partnering workshops and benchmarking)
2. *Project team characteristics*: Project team level (e.g., relational attributes and skills important for team cohesion); Individual team level (e.g., internal beliefs, attitudes, and behaviors)
3. *Project performance outcomes*: Cost (e.g., cost growth, meeting budgeted cost goals, etc.); Schedule (e.g., meeting scheduling targets); Quality and safety (e.g., maintaining quality)

of the project and minimizing accident rates); Conflict resolution (e.g., reduced claims and disputes)

As a point of departure, a path to improved performance outcomes is proposed which is moderated by transactive memory systems (TMS). So far, researchers have emphasized hard metrics to understand partnering performance (Yeung et al., 2007) while not teasing out the underlying behavioral attributes (Jacobsson & Wilson, 2014). Therefore, a path focused on three categories defined as 1) Partnering drivers (i.e., collaborative project delivery practices) – best practices followed during contractual, procurement, and partnering practice related activities; 2) Team performance– is concerned with developing team cohesion and trust; and, 3) Project performance– is concerned with improved outcomes in the areas of cost, schedule, quality/safety, and conflict resolution. This research intends to demonstrate the validity of the partnered project delivery framework while focusing on individuals and project teams.

METHODS

This paper is developed via a partnered aviation case study project. The scope of the case study project was to provide a special safety zone at the end of the two runways of one of the busiest airports in San Francisco, CA. The project included the installation of Engineered Material Arresting Systems (EMAS) to capture an aircraft's landing gear in the event an aircraft overshoots the runway. The project scope also included the installation of navigation systems, relocation of landing lights, and other related equipment.

Partnering was established early on as a requirement for the project due to complexity, compressed schedule, the scope of stakeholder involvement, and cost control objectives. The original budget was between \$ 50-100 million and the original project schedule is about eight months. The project was competitively bid (i.e., design-bid-build delivery, low-bid selection, and lump-sum contract) and awarded to a joint venture contractor while owner consultants and construction management teams were evaluated using request for qualifications and proposal (RFQ/P) processes. The construction work for the project was completed on a unit price basis. Notice to proceed was given on February 12th, 2014. The executive and core teams held monthly partnering meetings during the project. In total, nine partnering sessions were held. The runway stayed closed between May 17th and August 10th with construction running between early June and August. The last partnering session was devoted to close-out and took place on September 23rd, 2014. The case study project was substantially completed in early November of 2014.

STUDY APPROACH

This study evaluates the following project documents from the case study: 1) Partnering specifications; 2) Partnering session documents / partnering charter; 3) Partnering score cards; and, 4) Weekly project meeting minutes. These documents were analyzed in light of the partnered-project delivery framework. Time interval for analysis is determined as one month, marked by the occurrence of partnering sessions each month. Data was analyzed using qualitative analysis and social network analysis (SNA) techniques. Team interactions in the form of sociograms were analyzed to understand how team characteristics change during partnered-project delivery. The project documents and SNA analysis results were used to explore links among partnering drivers, team characteristics, and performance outcomes.

DATA COLLECTION

Data was collected using a web-based information sharing platform to access partnering session documents, partnering scorecards, and meeting minutes. Meanwhile, semi-structured interviews with key partnering stakeholders (i.e., partnering facilitator, owner, and contractors over the telephone) were used to help triangulate qualitative interpretations.

Partnering session documents and the partnering charter included project goals, a dispute resolution ladder and partnering maintenance intended to encourage continuous improvements among the partnering team. Partnering sessions held monthly, provided a forum in which team participants could discuss their concerns with the project team. These sessions primarily included members of the executive team representing both the owner and general contractor. Similar, but separate, partnering sessions were also held expanding to included consultants and subcontractors, along with the executive team. All partnering sessions were facilitated by a third-party facilitator to ensure neutrality and keep meetings focused on project goals and objectives.

The purpose of these sessions were to discuss key issues affecting the project performance. Participants also discussed team performance and how it aligns with project goals such as safety and security (i.e., zero incidents related to construction, airport operations, field work, electrical installations and environment conditions), schedule control (i.e., the contract included penalties for late delivery or missed milestones). Contracts also included incentives for early runway opening and cost control (i.e., complete the project under budget and the contractor will earn their full incentives and help airport save money), quality control (i.e., eliminate rework and meet all the specification requirements) good public perception (i.e., eliminate chance for negative press about the project and complaints from neighbors), minimizing operational disruption, and ultimately having fun. These sessions also helped in getting feedback from the facilitators and other team participants as well.

Partnering scorecards were used to evaluate team performance surrounding key issues and project goals. The scorecards permitted participants to score key issues and goals on a scale ranging from 1 to 5, with 5 being excellent and 1 being poor. These scorecards were administered via a web-based survey instrument managed by the partnering facilitator monthly following partnering sessions. Information gathered from the surveys serve as feedback to the project team during next month's partnering session.

Weekly project meetings took place over the entire project duration. As a result, weekly project meeting minutes provided a great opportunity to explore team member interactions during project delivery. Each organization identified in the project meeting minutes was assigned a node and becomes a unit of analysis. These data are used to understand team communications and is vital to advancing AEC project delivery processes, in terms of quality, productivity, and team performance (Gultekin, Mollaoglu-Korkmaz, Riley, & Leicht, 2013). These information exchanges are filled with important data specifically pointing to TMS and can be identified using social network analysis (SNA) techniques.

SOCIAL NETWORK ANALYSIS TECHNIQUES

This paper analyzes partnering session documents, the partnering charter, partnering scorecards and weekly project meeting minutes using SNA methods (Sohani, 2016). Based on SNA, this paper directs attention to developing team interaction during partnered-project delivery and explores the correlations between these changes and partnering practices. SNA provides a formal

representation of the team interactions through the use of sociograms (Chinowsky, Diekmann, & Galotti, 2008). Furthermore, it is a process that helps us understand both formal and informal communication along with the exchange of technical project information (Chinowsky et al., 2008). SNA can also be used to investigate the extents of ties (i.e., type of communication) occurring between the nodes (i.e., people) and how information flows among team members within a project network.

Inter-organizational AEC project teams constitute complex contractual, organizational, and hierarchical boundaries which influence how project teams interact, function, and perform. Mollaoglu-Korkmaz et al., (2014) classified such tiers of operation as (Figure 1):

- Tier 1: Tier 1 includes participants (i.e., typically project managers) from partnered-project team (e.g., owner’s senior management, construction and program management executives, contractor’s executive management, and partnering facilitator) representing their home organizations within an inter-organizational AEC project team;
- Tier 2: Team members (e.g., construction management field team, superintendents, and subcontractors) whom act as a bridge and support the associated inter-organizational AEC project from the home organizations of Tier 1 representatives; and
- Tier 3: Organizations working on the associated inter-organizational AEC project subcontracted to Tier 2 organizations on the project team (e.g., subcontractors, trades, consultants, stakeholders).

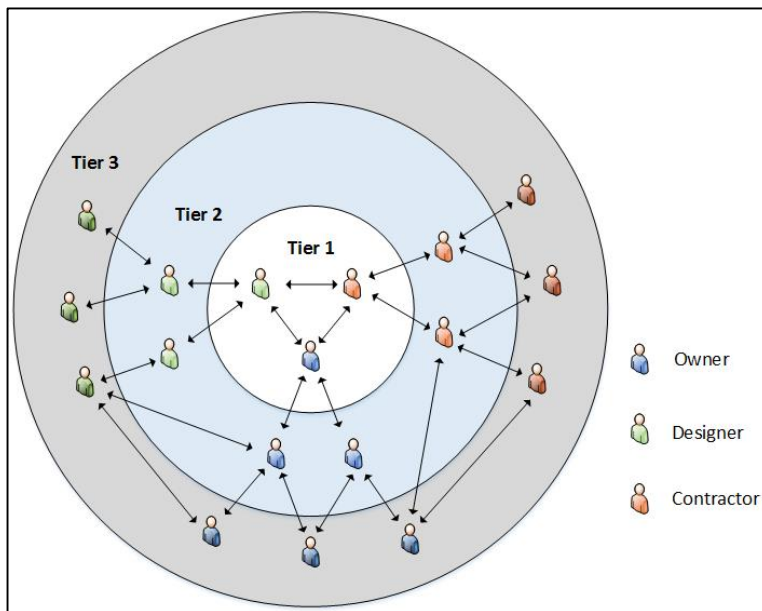


Figure 1: Tiers of operation in inter-organizational architectural, engineering, and construction (AEC) project teams (Mollaoglu- Korkmaz et al. 2014)

These tiers help illustrate the size and complexity of AEC project teams and will vary based on the project. A matrix was developed using the project documents and data. The matrices included information related to participants’ tier level, number and direct of communication exchanges and relationships among organizations within the AEC project team. The matrix data is then analyzed using UCINET software.

DATA CODING

Case study participants were coded according to the tiers presented above and the teams they represented (Table 1). Some examples for data coding at this stage are as follows:

- Tier 1 members for the case study project included owner's senior management (O_SM), construction and program management team's executives (C_PM1, C_CM1, S_SC1), contractor team's executives (T_GC1), and partnering facilitator (F).

Table 1: Sample data coding procedure to categorize project participants and their roles in the team.

Team	Sub Team	Designation	Code	Symbol of the tier	Tier	Symbol of Team	
General Contractors' Team (T)	General Contractor (TGC)	General Contractor					
		President	T_GC1		1		
		Vice President #1	T_GC1	◆			
		Vice President #2	T_GC1				
		Manager #1	T_GC2		2		
		Manager #2	T_GC2				
		Construction Manager	T_GC2				
		Safety Manager	T_GC2				
		QC Manager	T_GC2				
		Project Manager #1	T_GC2	◆			
		Project Manager #2	T_GC2				
		Project Engineer #1	T_GC2				
		Project Engineer #2	T_GC2				
		Superintendent #1	T_GC2				
		Superintendent #2	T_GC2				
		General Superintendent	T_GC2				
		Electrical Coordinator	T_GC2				
					◆		
	Electrical (TEC)	Sucontractor			◆	3	
		Vice President	T_EC				
Supplier (TSP)	Supplier			◆	3		
	EMAS Consultant	T_SP					

- Tier 2 members for the case study are individuals from home organizations of Tier 1 members such as design and construction (O_DC), facilities (O_FC), finance and accounting (O_FA) and airport operation (O_OP). Their counterparts in the construction and program management team (C_PM2, C_CM2 and S_SC2) and construction managers and superintendents (T_GC2) from the contractor’s home organization were coded as Tier 2 members.
- Tier 3 included all the remaining stakeholders (P_FA, P_TS, P_FI, P_PO and P_AI) from the owner’s team, engineers and inspectors that consult for the construction and program management organizations (S_DE3 and S_MT1), and subcontractors (T_EC and T_SP).

Once the above process was completed, individuals’ interactions were then coded. Individuals were coded only when they were clearly identified in the project documents. Otherwise, participating tier members listed in the minutes-documents for the related meetings were used, when an organization was called out for a task/action item.

MEASURES AND ANALYSIS

Three SNA metrics are used to analyze the UCINET data being network density, degree centrality, and geodesic distance. Network density helps to determine the most efficient network and is calculated by dividing the number of interactions by the total possible interactions available in the network (Hanneman & Riddle, 2005). The network density ranges between 0 and 1 where 0 describes no interactions and 1 asserts the most efficient network structure in terms of interactions. Degree centrality is determined by the number of both incoming and outgoing ties as it relates to nodes (e.g., individuals, teams, and organizations). A higher centrality refers to the importance of a node within a network structure, thus yielding significant influence within the project team. Finally, geodesic distance is concerned with the flow of information between nodes. Essentially, information communicated directly from one node “A” to the next node “B” is 1 geodesic distance apart. Whereas, the geodesic distance is 2 when information passes from node “A” by way of node “B” to node “C”(Hanneman & Riddle, 2005). Results obtained from SNA were analyzed and demonstrate links among partnering drivers, team performance, and project performance outcomes.

RESULTS

The participants in this case study followed key partnering practices and established succinct goals for the project, in part, because the team lacked previous working relationships. Some of the practices were to establish weekly project team meetings, partnering charter, and monthly partnering sessions always including the partnering facilitator and stakeholders (e.g., airport operations, Transportation Security Administration (TSA), etc.). Other partnering practices such as forming an issue resolution ladder, creating common project goals, and cohabitation is used to encourage a collaborative environment focused on the goals of the team rather than that of individual organizations. Meanwhile, focused action strategic teams (FAST) are empowered to facilitate quick and timely exchanges of ideas and information to resolve issues. Many of these partnering practices implemented as part of the project allowed the researchers to examine team interactions using SNA as the project moved through its various stages of delivery.

SNA results related to degree centrality demonstrate the early involvement of executive team members (i.e., Tier 1) was vital to project goals and objective at the onset of the project. In fact, the degree centrality for this group was the highest during this timeframe or in the first month of the project (Figure 2).

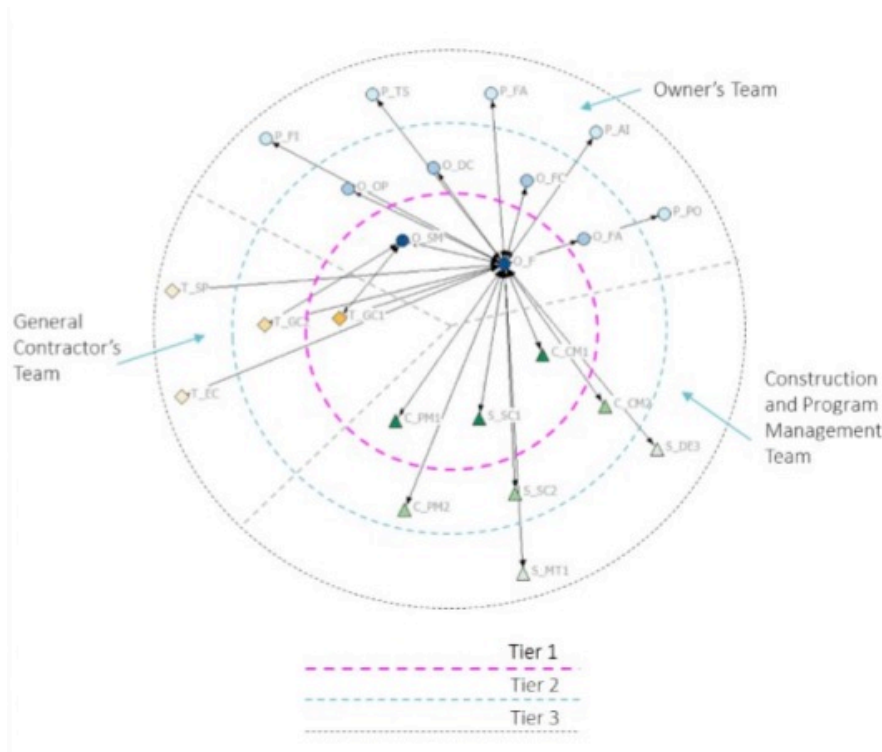


Figure 2: Sociogram showing team interactions in the first month of partnered-project planning and procurement.

Formal tools implemented during this initial period (e.g., partnering workshops and sessions, early contractor involvement) serve an important role in relationship development and help ensure benefits of partnering are achieved (Bayliss, Cheung, Suen, & Wong, 2004; Sparkling et al., 2016). Based on Figure 3, communication and trust are slowly emerging within the executive project team with the owner team leading the effort. This is preliminary evidence that a transactive memory system (TMS) has not developed among team members.

Tier 2 partnering team members achieved significant degree centrality as the project moved into the construction phase and the runway was fully closed (Figure 3). Collaboration amongst the teams is highest at this point, thus network density reaches its apex during the first month of construction. The construction management teams' position within the network (i.e., degree centrality) becomes, particularly, integral in maintaining project schedules and coordinating subcontractors work. Figure 4 illustrates the strong presence of a TMS with many team members coordinating, communicating, and tapping into the specialized expertise held by individuals despite their position in the network. Geodesic distances were minimized as the necessity to access information in a timely manner became more important. This held true for approximately four months during the project. Interestingly, communication patterns demonstrate that these boundary spanners (i.e., individuals who serve as a broker between project teams) become less important as the level of collaboration increases.

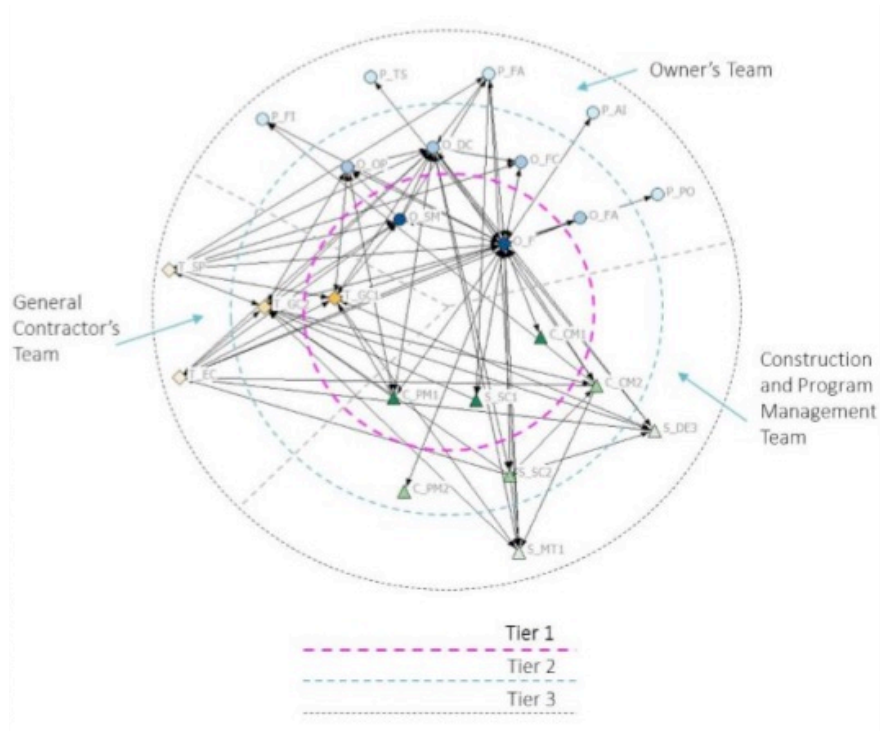


Figure 3: Sociogram showing team interactions during the first month of construction.

Network density, also, markedly increased as the project neared completion (Figure 4). This is attributable to high levels of collaboration within the owner and stakeholders' organizations as the construction teams make their final push to deliver the project to the end users. It is clear individuals positioned within the project network recognize and are willing to rely on the shared expertise of all the members of the partnering team.

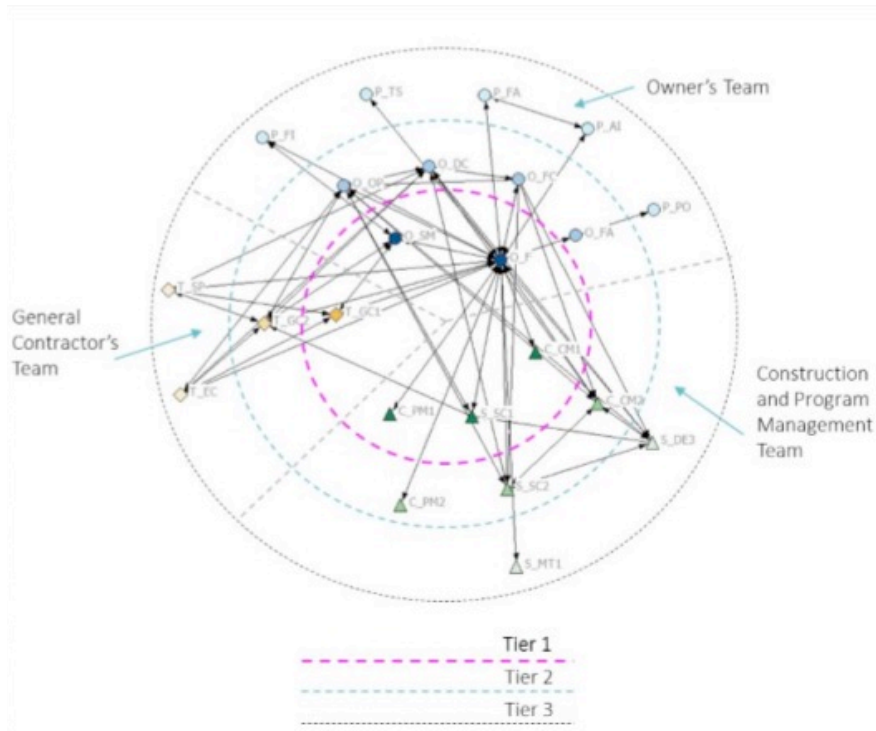


Figure 4: Sociogram showing team interactions one month before project completion.

This study not only illustrates how project team interactions change over time, but also suggest a way to better understand individual attributes of team members. For example, the formation of a strong TMS is impacted by facilitators engaged in process related task of the project (Comu, Iorio, Taylor, & Dossick, 2013). Therefore, the researchers believe partnering drivers entail goal aligning practices that changes behaviors and provide feedback into AEC project teams. In addition, TMS may be moderating the relationship between collaborative project delivery practices (i.e., partnering drivers) and performance outcomes.

DISCUSSION

The case study investigated in this paper provides evidence that team interactions increase when partnering practices are followed during partnered-project delivery. The success of the project was attributed to partnering, specifically the high levels of team interactions across tiers within the project network. Despite lines of contractual privity, organizations working under partnering contracts can successfully work towards common goals and objectives. This shared vision and purpose is an inherent aspect of partnering which not easily understood. The emergence of a strong TMS may explain the high performance these teams can achieve. Consequently, the following theoretical model is postulated as missing links and levels of analysis between goal alignment, TMS, and performance outcomes on partnered-projects (Figure 5).

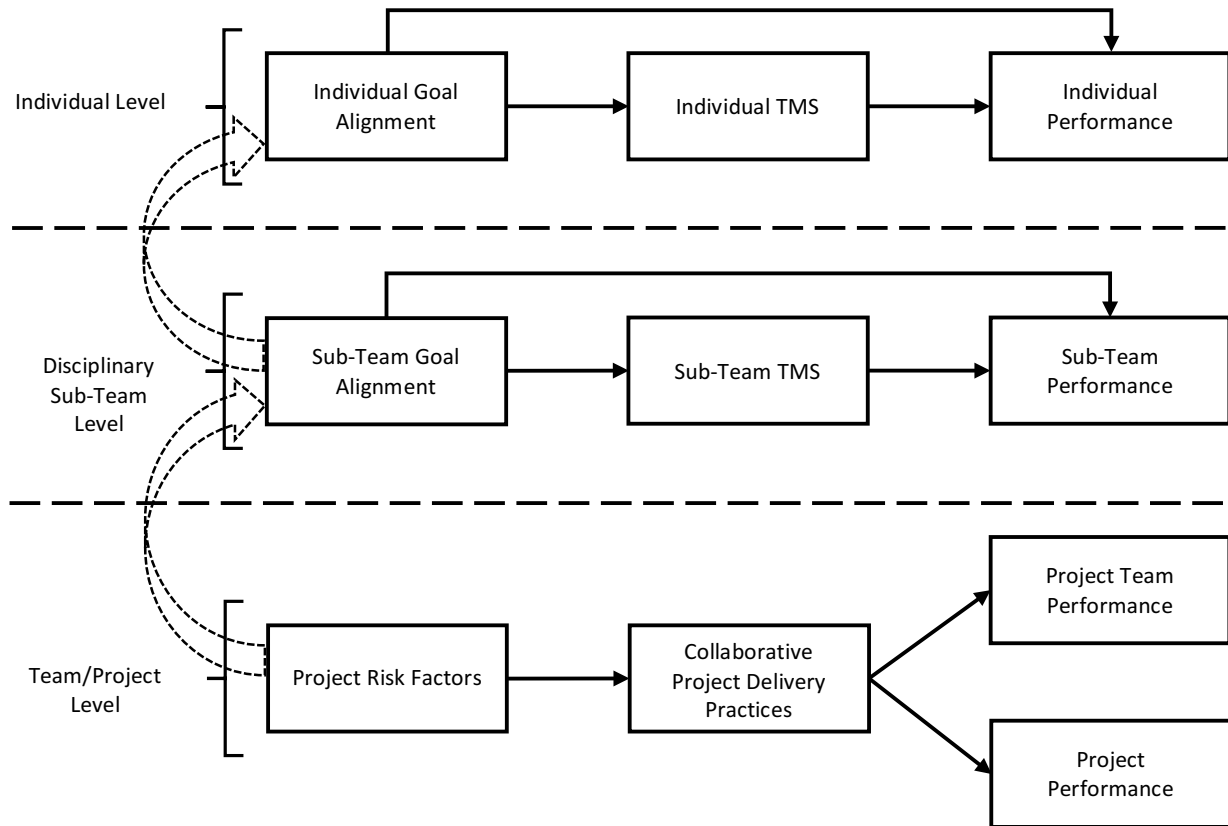


Figure 5: Framework illustrating the operational levels of analysis for goal alignment, TMS, project risk factors, collaborative project delivery practices, and performance outcomes.

Based on the model, partnering drivers should be separated into collaborative project delivery practices and goal alignment items. The model also postulates project risk factors such as project size and complexity will influence team behaviors. These risk factors are also critical when building collaborative project teams during the procurement process. Risk factors will also interact with collaborative practices which positively impacts relational behaviors of the project team (Suprpto et al., 2015). Thus, it is important to adequately assess this risk and ensure the level of partnering practices are fitting for the project (Eriksson, 2010).

Ongoing case studies not only explore project documents, but directly measure individuals' perceptions and the development of a TMS using the model asserted in this paper. In particular, TMS measurements help interpret the extent of convergence or similarity among team members' knowledge (Mohammed, Klimoski, & Rentsch, 2000). The dimensions are specialization, credibility, and coordination with five items for each dimension (Lewis, 2003). It is anticipated partnered-project teams experience a convergence towards a shared memory system during practices.

The critical component in SNA and TMS as it relates construction project performance is the free flow of information between project teams. This militates against distorted communication messages when sending or receiving information from other individuals performing a related task or function to complete the project. It is this fluid information exchange and interplay among team members that can enhance performance outcomes. According to AEC industry practitioners, a new era is being ushered which is distinctly focused on collaborative project delivery approaches. Some

even maintain, their organizations are placing a strong emphasis on collaboration encouraging methodologies such as design-assist (DA), integrated project delivery (IPD), and partnering with the expectation to share proven rewards with all parties involved the project.

Collaboration between different organizations is critical to accomplishing common goals and factors heavily into performance outcomes (Dietrich, Eskerod, Dalcher, & Sandhawalia, 2010). According to Dietrich et al. (2010), there are five high-quality characteristics demonstrated in collaborative projects being: communication, coordination, mutual support, aligned efforts, and cohesion. These characteristics are generally present among project teams when agreed-upon goals are established, clear and open conflict resolution strategies are used, effective communication systems are employed. They assert, other characteristics of are joint problem solving, trust, and goal congruence are all present within collaborative project teams. Thus, these teams may adjust their behavior in the relational exchanges with other organizations based on the feedback received. Under close monitoring intended to provide feedback, party's may resist and begin concealing underlying motives focused on their organizations' goals as opposed to those of the team (Stephen & Coote, 2007). This occurs when formal and explicit language is not included contracts. In fact, Stephen and Coote (2007) argue that relational behaviors are best aligned with goals when supportive leadership is involved.

With this in mind, construction project team integration and cohesion are clearly influenced by these characteristics (Franz, Leicht, Molenaar, & Messner, 2010). For example, early involvement of contractors in the schematic design phase, a goal alignment strategy, helps integrate their knowledge and experiences into decisions that ultimately affect the teams' performance on a project. This suggests that increased team integration and cohesion is not confined to specific project delivery methods, rather results from manipulated team behaviors effectuated by owner decisions. Another alternative explanation is whether collaborative practices adopted for projects are the right fit, especially considering how levels feedback is contingent on ones' experience as these practices are followed.

To respond to the gap in the literature, a future research questions in the context of partnered-projects is proposed: *"how do collaborative project delivery practices affect goal alignment and performance in AEC project teams."* This research questions aims to delve into underlying behavioral attributes and dynamics of AEC project teams working in collaborative project delivery arrangements.

CONCLUSION

This paper used SNA as a guide to understand changes in team interactions over time. Others have continually pointed out benefits of partnering and critical success factors while leaving out specifics relating to "how" and "why" it works (Anderson & Polkinghorn, 2011; Black, Akintoye, & Fitzgerald, 2000; Chan et al., 2004). Though important, a paradigm shift is occurring within the construction industry focusing on collaborative project delivery approaches. Jacobsson and Roth (2014) recently attempted to move partnering conversations forward by thoroughly examining the interpersonal fluidity required to develop collaborative working environments. They contend collaboration is normalized as individuals working in a collaborative spirit continue working together across new projects. Therefore, time appears to influence team dynamics as new project teams are formed or reconstituted.

In response to a changing paradigm in the AEC industry, this paper illustrates behavioral underpinnings as critical attributes affecting performance outcomes of both individuals and project teams. Although limited to a single case study project, it is believed future research will show similar results. Longitudinal research may show dissimilar results, yet offer stronger insights as to changes in team interactions and the role of TMS. Despite this possibility, future studies can explore partnering from a new perspective using SNA and TMS guidance illuminating from this paper.

ACKNOWLEDGMENTS

This material is based on work supported by the National Science Foundation Graduate Research Fellowship Program under Grant No. DGE1424871. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

This study also greatly benefited from International Partnering Institute (IPI) Board of Advisors' input, guidance, and support.

REFERENCES

- Anderson, L. L., & Polkinghorn, B. D. (2011). Efficacy of Partnering on the Woodrow Wilson Bridge Project: Empirical Evidence of Collaborative Problem-Solving Benefits. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, 3, 17–27.
- Bayliss, R., Cheung, S.-O., Suen, H. C. ., & Wong, S.-P. (2004). Effective partnering tools in construction: a case study on MTRC TKE contract 604 in Hong Kong. *International Journal of Project Management*, 22, 253–263.
- Black, C., Akintoye, A., & Fitzgerald, E. (2000). Analysis of success factors and benefits of partnering in construction. *International Journal of Project Management*, 18, 423–434.
- Chan, A. P. C., Chan, D. W. M., Chiang, Y. H., Tang, B. S., Chan, E. H. W., & Ho, K. S. K. (2004). Exploring Critical Success Factors for Partnering in Construction Projects. *Journal of Construction Engineering and Management*, 130, 188–198.
- Chan, A. P. C., Chan, D. W. M., Fan, L. C. N., Lam, P. T. I., & Yeung, J. F. Y. (2006). Partnering for construction excellence—A reality or myth? *Building and Environment*, 41, 1924–1933.
- Chinowsky, P., Diekmann, J., & Galotti, V. (2008). Social Network Model of Construction. *Journal of Construction Engineering and Management*, 134, 804–812.

- Comu, S., Iorio, J., Taylor, J. E., & Dossick, C. S. (2013). Quantifying the Impact of Facilitation on Transactive Memory System Formation in Global Virtual Project Networks. *Journal of Construction Engineering and Management*, 139, 294–303.
- Dietrich, P., Eskerod, P., Dalcher, D., & Sandhwalia, B. (2010). The Dynamics of Collaboration in Multipartner Projects. *Project Management Journal*, 41, 59–78.
- Eriksson, P. E. (2010). Partnering: what is it, when should it be used, and how should it be implemented? *Construction Management and Economics*, 28, 905–917.
- Eriksson, P. E., Atkin, B., & Nilsson, T. (2009). Overcoming barriers to partnering through cooperative procurement procedures. *Engineering, Construction and Architectural Management*, 16, 598–611.
- Franz, B., Leicht, R., Molenaar, K., & Messner, J. (2016). Impact of Team Integration and Group Cohesion on Project Delivery Performance. *Journal of Construction Engineering and Management*, 4016088–6, 1–12.
- Franz, B. W., & Leicht, R. M. (2016). An alternative classification of project delivery methods used in the United States building construction industry. *Construction Management and Economics*, 34, 160–173.
- Grajek, K. M., Gibson Jr., G. E., & Tucker, R. L. (2000). PARTNERED PROJECT PERFORMANCE IN TEXAS DEPARTMENT OF TRANSPORTATION. *Journal of Infrastructure Systems*, 6, 73–79.
- Gransberg, D. D., Dillon, W. D., Reynolds, L., & Boyd, J. (1999). Quantitative analysis of partnered project performance. *Journal of Construction Engineering and Management*, 125, 161–167.
- Gransberg, D. D., Reynolds, H., Boyd, J., & Gokdogan, G. (1998). Evaluation of the TxDOT Partnering Plus Program Final Report and Implementation Plan By : Douglas D . Gransberg , Ph . D . , P . E . , C . C . E . Research Supervisor Howard L . Reynolds Researcher Jack Boyd Research Assistant Gokcer Gokdogan Research Assis, 7.
- Gransberg, D. D., & Scheepbouwer, E. (2015). US Partnering Programs and International Partnering Contracts and Alliances: Comparative Analysis. *Transportation Research Record: Journal of the Transportation Research Board*, 73–77.
- Gultekin, P., Mollaoglu-Korkmaz, S., Riley, D. R., & Leicht, R. M. (2013). Process Indicators to Track Effectiveness of High-Performance Green Building Projects. *Journal of Construction Engineering & Management*, 139. doi:10.1061/(ASCE)CO.1943-7862.0000771
- Hanneman, R., & Riddle, M. (2005). *Introduction to Social Network Methods*. Riverside, CA. Retrieved from <http://faculty.ucr.edu/~hanneman/>
- Hughes, D., Williams, T., & Ren, Z. (2012). Differing perspectives on collaboration in construction. *Construction Innovation*, 12, 355–368.
- Hughes, D., Williams, T., & Ren, Z. (2012). Is incentivisation significant in ensuring successful partnered projects? *Engineering, Construction and Architectural Management*, 19, 306–319.
- Jacobsson, M., & Roth, P. (2014). Towards a shift in mindset: partnering projects as engagement platforms. *Construction Management and Economics*, 32, 419–432.

- Jacobsson, M., & Wilson, T. L. (2014). Partnering hierarchy of needs. *Management Decision*, 52, 1907–1927.
- Lahdenperä, P. (2012). Making sense of the multi-party contractual arrangements of project partnering, project alliancing and integrated project delivery. *Construction Management and Economics*, 30, 57–79.
- Le-Hoai, L., Lee, Y. D., & Son, J. J. (2010). Partnering in Construction - Investigation of Problematic Issues for Implementation in Vietnam. *KSCE Journal of Civil Engineering*, 14, 731–741.
- Lewis, K. (2003). Measuring transactive memory systems in the field: Scale development and validation. *Journal of Applied Psychology*, 88, 587–604.
- Li, H., Arditi, D., & Wang, Z. (2013). Factors That Affect Transaction Costs in Construction Projects. *Journal of Construction Engineering & Management*, 139, 60–68.
- Mohammed, S., Klimoski, R., & Rentsch, J. R. (2000). The Measurement of Team Mental Models: We Have No Shared Schema. *Organizational Research Methods*, 3, 123–165.
- Mollaoglu-Korkmaz, S., Miller, V. D., & Sun, W. (2014). Assessing key dimensions to effective innovation implementation in interorganizational project teams: an Integrated Project Delivery case. *Engineering Project Organization Journal*, 4, 17–30.
- Mollaoglu-Korkmaz, S., Swarup, L., & Riley, D. (2011). Delivering Sustainable, High Performance Buildings: Influence of Project Delivery Methods on Integration and Project Outcomes. *Journal of Management in Engineering*, 29, 76.
- Mollaoglu, S., & Sparkling, A. (2015). A Meta-Analytic Synthesis of Partnering Literature in the Architecture, Engineering, and Construction Industry. Livermore, CA.
- Mollaoglu, S., Sparkling, A., & Thomas, S. (2015). An Inquiry to Move an Underutilized Best Practice Forward: Barriers to Partnering in the Architecture, Engineering, and Construction Industry. *Project Management Journal*, 46, 69–83.
- Sohani, S. (2016). In-Depth Case Study of a Partnered Project Delivery. Michigan State University.
- Sparkling, A. E., Mollaoglu, S., & Kirca, A. (2016). Research Synthesis Connecting Trends in Architecture , Engineering, and Construction Project Partnering. *Journal of Management in Engineering*, 4016033-1, 1–12.
- Suprpto, M., Bakker, H. L. M., & Mooi, H. G. (2015). Relational factors in owner–contractor collaboration: The mediating role of teamworking. *International Journal of Project Management*, 33, 1347–1363.
- Stephen, A. T., & Coote, L. V. (2007). Interfirm behavior and goal alignment in relational exchanges. *Journal of Business Research*, 60, 285–295.
- Wegner, D. M. (1987). Transactive Memory: A Contemporary Analysis of the Group Mind. In *Theories of Group Behavior* (pp. 185–208). New York: Springer.
- Wood, G., McDermott, P., & Swan, W. (2002). The ethical benefits of trust-based partnering: the example of the construction industry. *Business Ethics: A European Review*, 11, 4–13.

Yeung, J. F. Y., Chan, A. P. C., Chan, D. W. M., & Li, L. K. (2007). Development of a Partnering Performance Index (PPI) for Construction Projects in Hong Kong : a Delphi Study. *Construction Management and Economics*, 25, 1219–1237.

Zhang, L., Cheng, J., & Fan, W. (2015). Party Selection for Integrated Project Delivery Based on Interorganizational Transactive Memory System. *Journal of Construction Engineering and Management*, 4015089.

Zhang, Z.-X., Hempel, P. S., Han, Y.-L., & Tjosvold, D. (2007). Transactive memory system links work team characteristics and performance. *The Journal of Applied Psychology*, 92, 1722–30.