Progress Loops in Interorganizational Project Teams: An IPD Case

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ABSTRACT

The Architectural, Engineering and Construction (AEC) industry currently lacks streamlined corrective measures to improve communication within cross-functional teams and optimize project outcomes. Previous research in this area offers lean construction methodologies, building information modeling techniques, and Integrated Project Delivery (IPD) principles. However, communication aspects within project teams and their impact on project outcomes are to be further examined. Using a well accepted taxonomy of team processes, this paper explores the communication aspects among AEC team members in an IPD case. Process maps developed based on project team meeting minutes guided this study in identifying the episodes in study case leading to positive or negative cost outcomes. Due to the intrinsic characteristics of IPD projects, the authors were able to rule out some key concepts of team integration such as collaborative decision-making, respect, trust, early involvement of participants and open communication, and focus on information exchange dynamics among participants in the case study. Results suggest that influence in decision-making, integrated communication, and timing for key decisions are among the major factors that lead progress during project delivery to optimize project cost.

INTRODUCTION

Project team members involved in Architectural, Engineering and Construction (AEC) projects continuously work under the pressure of making progress during project delivery while improving project outcomes. They are expected to periodically increase project completion percentage and, simultaneously, reduce cost and time, and enhance safety, quality and sustainability. Therefore, it is very important that project managers make the right decisions to keep projects on the right track and indicate what is to be done, how, when and by who to clearly establish a framework that can be continuously updated during project delivery.

Traditionally, planning of AEC projects has been carried out mostly neglecting the methods that new trends in the AEC industry propose. The IPD method emphasizes collaborative decision-making, respect, trust, early involvement of participants, and open communication (AIA, 2007), and Lean Construction highlights the importance of managing the production process so as to detect practices that add value and eliminate those that do not (Howell, 1999), rather than base planning on minimizing costs and controlling deviations from plans (Koskela and Ballard, 2006). Past research utilizing lean philosophy (e.g., Last Planner, Ballard, 2000;
e.g., DePlan tool, Choo et al., 2004; Lapinski et al., 2006) and IPD principles (e.g., building information modeling techniques, Eastman et al., 2011; Korkmaz et al., 2010; Li et al., 2013; Molenaar et al., 2009) confirmed that these methodologies optimized project outcomes such as cost, time, safety, quality and sustainability. Nevertheless, other methodologies have been developed to support project management to make planning decisions in such manner that project outcomes are optimized. This is the case of Continuous Value Enhancement Process (CVEP) (Pulaski & Horman, 2005) that quantitatively analyzes contribution of project alternatives to different project outcomes and the Monetary Quantification Points of Difference (Wouters et al., 2008) that uses a monetary unit of measure to quantify differences on project outcomes of alternative materials in the design. Regarding communication aspects, Dossick and Neff (2011) suggest that unplanned conversations improve project outcomes by fostering communication of tacit knowledge which complements software technologies. Oke and Oke (2010) indicate that high richness communication channels (e.g. face-to-face meetings and videoconference) significantly affect time of project development.

The aim of this paper is to determine the key communicational factors within project teams that lead progress to optimize project cost. To achieve this aim the authors, first, performed a literature review, defined progress loops around Marks, Mathieu, and Zaccaro’s (2001) team process taxonomy, and identified constructs related to cross-functional team cooperation and lean principles as potential factors influencing progress loops. Second, these constructs are further explored through a detailed analysis of an IPD case study via process maps and qualitative analysis of project team meeting minutes. Due to the intrinsic characteristics of IPD projects, the authors were able to rule out some key concepts of team integration including (AIA, 2007): collaborative decision-making, respect, trust, early involvement of participants, and open communication, and focus on information exchange dynamics (Dossick & Neff, 2011) among participants in the case study. Findings suggest influence in decision-making, integrated communication, and timing for influencing decision-making are the key factors leading project progress towards minimizing cost.

LITERATURE REVIEW

Project teams engaged in new product development projects go through episodes (Marks et al., 2001) which are temporal cycles comprised by sets of organized activities that contribute, directly or indirectly, to the progress of the overall project toward its final goals (Weingart, 1997; Zaheer et al., 1999). Episodes can be defined as well as identifiable lapses of time where progress accumulates and, at the end, assessed when feedback is obtained (Mathieu & Button, 1992). Project team members, after evaluating project outcomes update, are able to find the point where the project stands at and start a new cycle, yielding a sequence of episodes properly connected (Marks et al., 2001). For instance, an AEC project team that advances in the mechanical design during an episode could obtain, at the end, feedback on outcomes estimates indicating that the project is overbudget and its completion would occur beyond the deadline. Then, project team members would have an accurate snapshot of the actual and current state of the project and would apply actions accordingly during the next episode. Marks et al. (2001) defined two types of episodes: action phases where project team members perform tasks directly focused on directly increasing project progress; and transition phases devoted to assess past performance and make planning decisions. Projects go through a succession of transition-action phases where the outcome of each phase becomes the input of the following one (Marks et al., 2001).
While team members work on AEC projects, progress loops are generated between the point when a decision is made and the point when feedback on project outcomes is obtained so quality of both past decisions and progress made can be evaluated. Progress loops refer to a cycle of transition-action-transition phases (Figure 1) where, first, planning decisions are made; second, project team members perform tasks according to the decisions made in the first stage and, consequently, project progress increases; and third, feedback, or, in other words, project outcomes estimates updates are obtained allowing the evaluation of both progress and adequacy of decisions made at in the first stage. Thereafter, AEC project teams engage in a new progress loop. In this paper, progress refers to the increase in project completion percentage. Progress loops do not refer to quantitative progress (it is assumed that progress increases but it is not known how much) but qualitative, that is, the positive or negative impact of progress on project outcomes improvement. Positive progress loops improve project outcomes with respect to the last point where they were estimated, and negative progress loops worsen them. If project outcomes remain constant, then neutral progress loops are obtained. Certainly, progress loops can improve some outcomes and worsen others. In this case, to decide whether a progress loop is positive or negative, priorities can be established between outcomes or a system that allocates weights to each outcome can be developed; however, this paper does not go further in this issue. Also, progress loops can have different time durations since the length between the point when planning decisions are made and the point when feedback is obtained can vary.

**Study Constructs**

In AEC projects implementing IPD, participants represent different functions and cooperate with each other throughout the design stage. Consequently, cross-functional cooperation turns out to be a factor of the utmost importance to drive the development of the project towards success (Pinto & Pinto, 1990; Henke et al. 1993; Song et al., 1997; McDonough, 2000; Troy et al., 2008). With regard to previous research, Pinto and Pinto (1993) indicate that the ‘common denominator’ of definitions of cross-functional cooperation is ‘joint behavior toward some goal of common interest’. The constructs presented in Table 1, are communication-related and are mainly obtained or inferred from the literature review with regard to cross-functional cooperation, lean construction and IPD method. Based on the mentioned fact that cross-functional cooperation is a crucial factor for project success and, that, as commented earlier, lean philosophy (Ballard, 2000; Choo et al., 2004; Lapinski et al., 2006) and IPD principles (Eastman et al., 2011; Korkmaz et al., 2010; Li et al., 2013; Molenaar et al., 2009; AIA, 2007) improve project outcomes, the hypothesis brought into this report by the authors is that these constructs during project delivery processes will influence progress loops leading them
to result in either positive or negative progress (i.e., measured through comparisons of budgeted and tracked cost estimates due to the available data in the study case).

Table 1. Study Constructs Relating to Cross-functional Cooperation in Project Teams

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Description</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timing of Key Decisions</td>
<td>Extent to which members influence decision-making at the proper moment to optimize impact.</td>
<td>AIA (2007), Troy et al. (2008), Korkmaz et al. (2010).</td>
</tr>
<tr>
<td>Integrated Communication</td>
<td>Degree to which project structures and procedures allow participants to share information and influence all areas related to their functions.</td>
<td>Troy et al. (2008), Eastman et al. (2011).</td>
</tr>
<tr>
<td>Owner’s Requirements</td>
<td>Degree to which project team members possess clear at any point of the project and consistent information at about owner’s requirements.</td>
<td>McDonough III (2000), Koskela and Ballard (2006), AIA (2007), Troy et al. (2008).</td>
</tr>
<tr>
<td>Consistency of Commitments</td>
<td>Extent to which project team members keep their work commitments to other team members.</td>
<td>Ballard (2000).</td>
</tr>
</tbody>
</table>

CASE STUDY
The case study is an institutional renovation project delivered via contractually followed IPD (AIA, 2007), located in a Midwest state in the United States. The project size is 240,438 sq. ft. with a budget of $11.7 million. Design phase of the project was the main focus of this case study and included four stages: program validation, conceptual design, design development and construction documents. The project was delivered in two years after the design phase was kicked off and turned over to the owner in late 2012. The number of participants involved in the decision-making process of the project was over one hundred including owner’s representatives, architects, engineers, contractors, subcontractors and consultants.

The project was majority of team members’ first experience with the contractually followed IPD, therefore, the owner required them to attend IPD training sessions during its delivery. Project management adopted lean tools throughout the project delivery process and worked with a consultant to facilitate their implementation. These tools included: (a) a commitment log (i.e., where project team members indicated their sound commitments to tasks and followed the interdependencies among all other tasks in the project team); (b) feedback and reflections in each team meeting via plus/delta method (i.e., pluses referred to communication matters that were properly done, whereas deltas indicated those that could be improved).

METHODOLOGY
The researchers collected the meeting minutes of all case study’s design phases. Due to confidentiality reasons, the names of participants were blocked and coded according to their roles before data was given to the research team. These meeting minutes- documents included more than 350 pages containing decisions made, tasks performed, comments on pluses and deltas, and project cost estimate updates over more than fifty meetings throughout the design.
The authors analyzed this data qualitatively and, using Marks et al. (2001)’s framework of team processes, developed process maps of the design phases. These process maps (Lapinski et al., 2006) help visually represent action and transition phases (Marks et al. 2001), activities executed, and communicational matters along with the dates they occurred in the project delivery process (Table 2).

After coding the data, the investigators allocated the constructs, defined previously in the literature review section, in the process map under those action/transition phases where they can address the indicated tasks properly performed and areas for improvement based on team’s self-evaluation (bottom Table 2). Later, progress loops were selected throughout all design phases (i.e. validation, conceptual design, design development and construction documents) in such a way that each one of them embraces a period of the design process were the project cost significantly increases (negative progress loops) or decreases (positive progress loops). This way of proceeding yielded progress loops that embraced a number of action and transition phases (Figure 1). Finally, the authors examined how constructs were performed under each progress loop. If the number of positive observations (i.e. reflections related to tasks properly performed based on team’s self-evaluation) associated to a determined construct outreached the negative ones (i.e. reflections related to areas for improvement based on team’s self-evaluation), then it was considered that the construct had been successfully satisfied. Otherwise, it was not.

Table 2. Example Process Map Illustrating Data Coding, and Analysis Procedures for the Study Covering one of the Progress Loops During Validation Stage of the Design Phase

<table>
<thead>
<tr>
<th>Meeting Date</th>
<th>01/05/11</th>
<th>01/05/11</th>
<th>01/12/11</th>
<th>01/19/11</th>
<th>01/26/11</th>
<th>01/26/11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phases in Episodes</td>
<td>Transition-Phase</td>
<td>Action-Phase</td>
<td>Action-Phase</td>
<td>Action-Phase</td>
<td>Action-Phase</td>
<td>Transition-Phase</td>
</tr>
<tr>
<td>Progress: Cost Deviations</td>
<td>6.8%</td>
<td></td>
<td></td>
<td></td>
<td>17.9%</td>
<td></td>
</tr>
<tr>
<td>Activities</td>
<td>Criteria and Process Design To Include Consultants into Design</td>
<td>Selected Conceptual Plans Development</td>
<td>Development of Conceptual Plans</td>
<td>Development of Conceptual Plans</td>
<td>Validation of Conceptual Plans &amp; Project Performance Discussion</td>
<td></td>
</tr>
<tr>
<td>Tasks properly performed based on team’s self-evaluation</td>
<td>Not given.</td>
<td>Good agenda; met goals of the meeting.</td>
<td>Right people influencing decisions; enough discussion to move forward with confidence.</td>
<td>Good discussion; good graphics, established a shared understanding.</td>
<td>Not given.</td>
<td>Right people influencing decisions; good discussion to move forward with confidence.</td>
</tr>
<tr>
<td>Areas for improvement based on team’s self-evaluation</td>
<td>Not given.</td>
<td>Problems during the meeting: technology failure impacting participant attendance; inefficient use of time;</td>
<td>Some designed discussions missed input of important parties; not specific instruction for deliverables; not stuck to meeting instructions; not adequate time.</td>
<td>Missing influence of some participants on certain design decisions.</td>
<td>Earlier MEP contractors’ influence on decisions; not clear owner’s requirements.</td>
<td>Technology failure impacting participant attendance in meeting; no influence of participants on decisions</td>
</tr>
</tbody>
</table>
The quality of this exploratory study is supported by three tests (Yin, 2003): construct validity, ensured by the data collected containing the meeting minutes of more than fifty meetings throughout the design stage; external validity, addressed by a well accepted theory (marks et al., 2001) to look into the case study; and reliability, which is satisfied by the processed map developed which breaks down the information included in the meeting minutes and a database of codes that was kept systematically to analyze data.

RESULTS

The design process goes through eight cost-related progress loops (Figure 2), four negative (i.e. progress loops 1, 3, 5 and 7) and four positive (i.e. 2, 4, 6 and 8). The percentage of cost variation at each progress loop is calculated as the percentage of the cost variation produced between the start and end of the progress loop over the initial project budget (i.e. $11.7 million). Progress loops 1 and 2 exert the greatest variation on cost, and progress loop 3 generates the highest cost variation per week: at the beginning of the design, progress and changes are easily carried out causing a significant impact on project outcomes. While design advances, progress speed slows down and cost estimate tends to stabilize around a determined cost as in progress loops 4, 5 and 6. Late important modifications are difficult to introduce and entail a notable increase of project cost as in progress loop 7. Hence, it is remarkable that in the last progress loop (No. 8) team members are able to considerably bring down the project cost estimate.

Observed instances relating to study constructs in each of the progress loops are reported below in Table 3. Results show that meeting efficiency, integrated communication, and influence in decision-making possess the greatest numbers of reports during project team meetings. They continuously receive attention from team members, suggesting that they are the most important factors for project success. With regard to meeting efficiency, team members continuously strive to elaborate efficient agendas for meetings by indicating procedures, rules, attendants and goals to be accomplished. Participants foster integrated communication by making decisions such as utilization of BIM models (3D models with the estimate and schedule attached, Eastman et al., 2011), continuous education on IPD of all team members, combining or breaking-out MEP work sessions and sharing resulting summaries, reaching consensus on terminology to be used in shared reports, and limiting side conversations. Timing of key decisions is mentioned few occasions because once participants start influencing decision-making, team members evaluate their influence on decision-making rather than speculate on the consequences of having introduced them at another point of the project. Team members continuously pay close attention to the parties that should be influencing the decision-making process: once they highlight ‘the valuable input from the building staff’, and, at another time, complain because of ‘missing representation for flooring and lightning’.

With regard to meeting efficiency, results do not suggest any relationship with progress loops, that is, regardless of being satisfied or not, progress loops do not seem to be affected. Conversely, results support that integrated communication, influence in decision-making and timing of key decisions do affect progress loops leading them to be either positive or negative. If
all of them are satisfied, then progress loops are positive; on the other hand, progress loops are negative if at least one of them is not satisfied. Specially strong seems to be the influence exerted by integrated communication, which is the only one of these constructs influencing progress loop 8 that, as explained before, is positive under very unfavorable circumstances.

**Figure 2. Progress Track via Cost Estimates during Case Study’s Design Phase**

**Table 3. Observed Instances in the Project Meeting Minutes during the Design Phase of the Case Study Relating to Study Constructs**

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>No. of Observations</td>
<td>58</td>
<td>42</td>
<td>36</td>
<td>9</td>
<td>7</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Progress Loops (ordered from highest to lowest impact on cost)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>-</td>
<td>√</td>
<td>√</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>x</td>
<td>√</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>x</td>
<td>√</td>
<td>-</td>
<td>√</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>x</td>
<td>√</td>
<td>-</td>
<td>√</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>&lt;&gt;</td>
<td>x</td>
<td>&lt;&gt;</td>
<td>x</td>
<td>-</td>
<td>-</td>
<td>x</td>
</tr>
<tr>
<td>6</td>
<td>√</td>
<td>√</td>
<td>&lt;&gt;</td>
<td>√</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>x</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

√ Construct was satisfied in the progress loop: positive observations outreached negative ones
x Construct was NOT satisfied in the progress loop: negative observations outreached positive ones
<> Neutral observation for the construct. Positive and negative observations were balanced

**DISCUSSION**

This paper sheds light on communication dynamics within project teams in the AEC industry. First, it expands Marks et al. (2001) team processes framework by developing progress
loops. And second, it indicates what communication aspects improve project outcomes while growing progress. Unlike previous methodologies commented earlier in this paper which propose lean principles (e.g. align participants and project goals) (Lapinski et al., 2006) and IPD methods (e.g. bring contractors and subcontractors into the project since the beginning of the design stage (Korkmaz, 2010) or foster collaboration between team members (AIA, 2007)), this paper contemplates the possibility of positive or negative progress depending on whether outcomes are improved or not, and analyzes the key factors leading to positive progress. The case study dissected hereby consisted of an IPD project where all project team members were committed to collaborative decision-making, respect, trust, early involvement of participants, and open communication, allowing investigators to focus on examining other communication factors. Results suggested that cost-related progress loops tend to be positive when key factors such as integrated communication, timing of key decisions and influence in decision-making are satisfied. Otherwise, progress loops turn out to be negative.

According to the results reported, it is essential that project management in AEC projects foster integrated communication by embedding project teams in an environment where team members can easily share information, keep track of each other’s performance, be aware of any part of the project requiring their input, and combine their task performance and make it compatible with that of other team members. Additionally, it is important as well that project participants start influencing the decision-making process at the right moment possessing enough power, regardless of their position, to make final decisions in order to optimize the impact of their expertise on project.

CONCLUSION

This report has concluded that there are three main factors leading cost-related progress loops to be positive in IPD projects including integrated communication, timing of participants influencing decision-making and influence in the decision-making process. This paper has several limitations: first, results are extracted from a single case study’s design phase, nevertheless, the meeting minutes of a project provide abundant data and require an arduous work; and second, there might be external factors such as sudden increase in project scope and budget that can lead cost-related progress loops to be negative regardless of fulfillment of the key factors. Future lines of research will focus on IPD projects where team members pay closer attention to other factors such as empowerment, owner’s requirements and consistency of commitments, and evaluate how they affect project cost-related progress loops. Another possibility consists of investigating factors leading to positive progress loops related to other project outcomes different from cost such as, for example, time, quality or sustainability.

ACKNOWLEDGEMENT

This material is based upon work supported by the National Science Foundation under Grant No. SES-1231206. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

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