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INFLUENCE OF MULTIPARTY IPD CONTRACTS ON CONSTRUCTION INNOVATION

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Construction is often cited for challenges in adopting new innovations, slow diffusion of innovations through the industry, and significant barriers to adoption for firms. These boundaries that divide firms by area of expertise, timing of involvement, and alignment with project goals offer little incentive for seeking innovative solutions, or may even penalize firms that pursue innovative solutions. The rise of multiparty contractual agreements have enabled discussion regarding means of increasing collaboration, decreasing the negative effects associated with fragmentation, and ultimately increasing the potential for innovation in the delivery of construction projects. This paper seeks to analyse the barriers associated with innovation in the construction industry and explore the opportunities for improving the adoption and diffusion of innovation through the use of multiparty Integrated Project Delivery (IPD) contracts. We seek to study these opportunities and barriers using the lens of innovative capacity, defined as the abilities and willingness of firms to engage in inter-organizational, collaborative and distributed novel activities. With projects viewed as multi-organizational instances of work, the use of these new contracts offer interesting new potential for collaboration and innovation. Insights from a case study IPD project are provided based upon a lessons learned workshop for a first time IPD owner with their signatory team members, facilitated by an IPD expert.

Keywords: IPD, innovation, case study, innovative capacity

INTRODUCTION

The construction industry has been noted by many for its lack of innovation. While there have been advances that suggest the potential for innovation in general, the nature of the procurement and contracting models common in capital facilities projects situate the risk for pursuing innovative products or processes heavily with designers and contractors, the competitive models for procuring firms limit the potential gains for firms that pursue new ideas. This paper delves into the use of multi-party Integrated Project Delivery (IPD) contracts as a potential enabler to addressing the long-standing limitations of the construction industry procurement models through the lens of innovative capacity. A case study is introduced where an institutional owner, with an interest in innovation to drive improved project outcomes, employs a five-party IPD contract.

The use of IPD contracts has been increasing over the past decade in the USA. The creation of standardized contract forms by such agencies as The American Institute of Architects (AIA, 2009) and the Associated General Contractors (AGC, 2009) suggest the

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growth and recognition of the organization and contractual terms. Kent and Becerik-Gerber (2010) differentiated IPD from traditional delivery systems based upon three attributes: use of a multiparty agreement, early involvement of all parties, and shared risk and reward amongst contract signatory firms. In more recent work by El-Asmar *et al*., (2013), it was shown that the 12 IPD projects outperformed the 23 non-IPD projects on six out of nine performance areas, including schedule, quality, reduced project changes, communication, labour, and environmental outcomes.

In a similar study, though not focused exclusively on IPD, Franz *et al*., (2017) identified the use of integrated methods and the development of cohesive teams the primary drivers of more successful cost, quality, and schedule outcomes in a study of 200+ completed building projects. The development of integrated and cohesive teams were found to be enabled through project delivery strategies that included early engagement of the builder and specialty trades, transparent financial contracts for contractor reimbursement, and qualification-based selection of the builders and trade partners. The University of Minnesota, in conjunction with the Integrated Project Delivery Association (IPDA) of Canada and the Lean Construction Institute (LCI), just released their third round of IPD case studies (2016) with a focus on the "How and Why" of IPD success. The authors highlight a few notable findings and observations: 1) the "uniformity of success" across the projects regardless of type, region, and owner, 2) the consistent emphasis on selecting and building a successful team, and 3) the criticality of identifying the means and methods to collaborate identified, but was a unique set of tools, for each project. These studies suggest that strategies that enable the team to collaborate more effectively will lead to more successful projects. However, they and others stop short in identifying how the potential for innovation may be enabled by integrated teams and methods on the studied projects.

INNOVATING IN CONSTRUCTION PROJECTS

Macomber (2003), uses game theory, financial modelling, and return on investment analysis to demonstrate the lack of incentives for construction industry firms to invest significant funds into the pursuit of innovative solutions. In his summary and discussion he identifies four areas that offer potential opportunities for innovation in the industry, supply chain optimization, knowledge management, BIM, and "wrap-up" financial thinking; all of which rely upon inter-organizational collaboration. As Henisz *et al*., (2012) define in pursuit of a unified theory of project governance, the construction industry suffers from horizontal, vertical, and longitudinal boundaries that limit the potential for collaboration, much less innovation, across firms. This aligns with findings by Gann and Salter (2000) that project-based firms need to work across organizational boundaries and networks of suppliers and partners to support innovation. Similarly, Egan (1998) suggests integrated contractual arrangements, such as design and build, supply chain management, and partnering, as drivers for innovation in construction. Ozorhon (2013) found a common root of innovations in four case study projects through the need for a driver, in his research the pursuit of sustainability goals that was championed by the owners, to align the teams' objectives for pursuing innovative solutions on design and construction projects.

These studies suggest consensus around the barriers to innovation being rooted across a range of cost, risk, leadership and structural organisation issues. More broadly, construction management research is no stranger to discussions of innovation. Debates tend to follow the interventions of governments to improve the productivity and value of national sectors, often with a particular concern about the fragmentation and the way construction parties relate to each other. The traditional adversarial relationships, and the high degree of conflicts and disputes are seen as root causes to the perceived problems of the industry (Blayse and Manley, 2004).

Research on innovation in construction is extensive, but also heterogeneous and often non- cumulative. We would categorise it into four main areas:

1. *Team and Actor Willingness*: Research that identifies structural characteristics and various barriers to, and challenges of, innovation. Much of this rehearses well-understood features of construction, such as fragmentation and specialisation, competitive tendering, improving project to firm learning, site-based conditions or economic pressures (e.g. European Commission, 2009; Blayse and Manley, 2004). Often recommendations, whilst well evidenced, are generic and speculative, such as increasing collaboration and enabling earlier supply chain involvement. Whilst these are useful in identifying the potential benefits that IPD and other collaborative contracts might offer, there is less attention to the specific activities and outcomes that might generate opportunities for innovation.

2. *Innovative Tools and Processes*: Research that deals with single or specific types of innovations, such as new technology use, whether process technologies such as BIM, products such as low carbon materials or building technologies, or new processes such as Integrated Project Delivery / Public Private Partnerships as innovative contract forms or Lean construction (e.g. Nam and Tatum, 1989; Baxter and Berente, 2010). These studies provide insight into processes through which innovations are embedded or implemented into practice, they inevitably prioritise one particular solution or innovation over a more systemic mapping.

3. *Contextual and Institutional Barriers*: Demonstrator / proof of concept research, such as sustainable innovation, low carbon homes, IT use and prefabrication processes, which larger scale implementation or exploitation are left as 'next steps' (e.g. Shapira *et al*., 2014; Thuesen and Hvam, 2011). Whilst instructive on the utility of specific innovations these studies tend to neglect (intentionally, for the most part) the organisational and institutional contexts required to enable successful implementation, or support broader spread of innovative processes or technologies. We might argue contractual arrangement can form part of this context.

4. *Spread and Management of Innovation*: Research that seeks to explain the specificities of construction, managerial, and contextual factors influencing the process of innovation, often drawing on organisational and project management studies, such as evaluations of specific 'real world use' of new information technologies (e.g. Mitropoulos and Tatum, 1999; Harty 2008). They perhaps get closest to revealing the practices and outcomes of innovating, and the often unforeseen and serendipitous paths innovations take. However, they are also often oriented to micro-level detail rather than interrogation of the institutional and contextual backdrop that might constrain or enable the broader uptake of innovative solutions.

All of these studies have merit and contribute much to an understanding of innovation in construction. They are also evidence of the extensive innovation consistently and routinely occurring within construction activities. Firms and projects are highly successful at implementing innovation in specific contexts and niches. This categorisation is not meant to be a thorough evaluation of the many innovation-oriented studies in construction, nor a critique of those studies. But it does serve to identify differences in scale and focus. The units of analysis vary from the innovation itself, to groups of actors, project, firms, supply chains or sectors. As noted above, often the topics follow current government or pan industry recommendations, whether Total Quality Management (TQM), or Lean, or BIM.

Innovative Capacity

The consideration of innovation as a positive project outcome or differentiator of project success is well established - indeed taken for granted - and we do not challenge this here. Together, these four areas point towards a need to consider the innovation itself, the activities and practices of 'doing' specific innovation on projects, and the broader contexts and institutions of construction projects that help or hinder both their performance, and their subsequent spread. Without claiming a new or universal theory of innovation, for the purposes of this paper, we would suggest the term 'innovative capacity', denoting both the willingness and ability of construction actors and organisations to engage in innovation, to capture these various aspects. It can consider the characteristics of the innovation itself, the propensity of actors and teams to engage in innovation, potentially incorporating motivations, incentives and risk mitigation, and organisational and institutional barriers (or enablers). In our case, we intend to use this concept to help understand how the emerging use of IPD could enable innovation to emerge and grow despite the recognised challenges to innovation on projects.

RESEARCH METHODOLOGY

To study the concept of innovative capacity in the context of IPD, a phenomenological approach was pursued using the case study of an institutional owner. The case study serves as an opportune project for two reasons: first, the owner explicitly identified innovation as a qualification in the team selection process, as well as a motivating factor for pursuing IPD. Second, this is the owner's first use of a multi-party contract. The owner is experienced in delivery of capital facilities projects, but new to the use of IPD contracts, offering the unique opportunity to see how the contractual model may enable the development of innovative capacity.

Case Study

The Pennsylvania State University is delivering demolition and reconstruction of the Agricultural and Biological Engineering (ABE) building of approximately 7,000 m2 (77,000 ft2) of new construction, and, renovation of the 1,500 m2 (16,000 ft2) existing structure and historical facade. The project will incorporate new graduate education labs, research labs, offices, classrooms, a fermentation facility, and a maintenance shop. The team will be pursuing LEED certification, currently trending toward Gold, for a total estimated construction cost of €27 million ($30 million), with a construction start in early September 2016 and completion in winter 2017. The IPD contract engages the owner, designer (architect and engineer), general contractor, mechanical contractor and electrical contractor as the five signatory partners. Penn State selected the general contractor and designer as a team, followed shortly by selection of design-assist specialty contractors.

To develop this case study across the entire design phase, the project was tracked from the beginning of the design process to the early stages of construction; however the emphasis of this analysis is based on data collected at a Lessons Learned workshop hosted by the project team in early October of 2016, as the demolition of the existing building was underway and the team was transitioning between the design and construction phases.

RESULTS

The Lessons Learned workshop engaged more than a dozen participants from the five signatory partners over a full day, and was facilitated by an IPD expert. The workshop had ten items on the agenda, ranging from the selection process and on-boarding, to the contract and financials, and down to the collaborative methods being used, such as collocation and the cluster organization. For each topic, the individual participants brainstormed topics regarding the process and challenges observed, these were aggregated on a central wall using sticky-notes, and then a discussion of the collective topics was facilitated, with insights from the more than 100 IPD projects the facilitator had experienced.

Figure 1: IPD team brainstorming discussion items.

One of the focal and re-emerging topics at the workshop was that the project team was trending over-budget, by approximately $1 million (£ 750,000). The team was using a Target-Value Design approach to pursue the target cost for reaping the 'shared reward' that enabled the profit and potential incentive pool of funds for the signatory firms. While the discussion did not focus on the innovative solutions pursued or executed, it did emphasize the team's use of new processes, collocation strategies, and new organizational approaches to enable the team to be innovative.

In particular, two processes were discussed to highlight both the opportunities and challenges the team observed. First, the use of the Lean Construction Institute's Last Planner was attempted during the design process. Last Planner has been well defined and has grown in use over the past decade in the context of field construction planning, enabling the foreman for work crews to engage in a heterarchical approach to detailed task scheduling for crews. The translation of the Last Planner approach to the design process is challenging - design is by its nature iterative. It is quite difficult to have an engineer or architect clearly define the time and outcomes of design tasks in the same level of detail and specificity as construction tasks.

In the discussion at the Lessons Learned workshop, the team identified many benefits, and challenges. The coding indicates which of the four areas the noted items relates, regarding the enabling or hindering of innovative capacity based upon the workshop discussion. The discussion and captured feedback were coded based not on the team’s perception, but on the indicated barriers or enablers that aligned with the factors noted:

- (I) - Innovative tool or process,
- (T) - Team and Actors' willingness to engage,
- (C) - Context or institutional barriers, such as communication challenges, and,
- (S) - Spread and Management, or dissemination across firms and projects.

Table 1: Benefits and challenges from implementing the Last Planner in design

Benefits (Plus)	Challenges (Delta)
(I)- drove collaboration	(C)- not effective in design, hard to get some team members to commit to the process
(T)- theory was well explained	(T)- process was constantly interrupted
(I)- great tool for engaging team members	(C)- team had trouble defining clear commitments
(I)- one cluster was quite successful internally using the process	(C)- the 'what' of the handoffs was often unclear
(T)- concepts and thinking were very useful	(T)- chaos in commitment communication
(T)- allows input from team members that might otherwise be overlooked	(I)- sometimes team got too detailed

In the discussion that followed, the team confirmed that the process and use of the Last Planner system was valuable for enabling the team to collaborate, specifically citing some of the outcomes from the electrical system collaborations that resulted. The implementation into design was not as effective as they would have liked, and they identified the designers' preference for a week or two-week cycle to the design, as opposed to a more daily discussion and update that is typically used in construction. The application into the design phase was challenging in that the novel process was new, particularly to the individual designers. The level of detail expected was not something the design team was familiar with providing, and the need to be able to specify the information and detail of what they needed from their colleagues was considered challenging to clearly articulate. Despite these challenges, the attempt and engagement of the entire team in the use of the innovative process was consistently agreed to add value. The implementation was where the team felt there was room for improvement. In addition, there was discussion that the team needed a facilitator for the use of the Last Planner in design that was both familiar with the process of using the Last Planner system, but also experienced and knowledgeable in the design process.

The second approach for creating capacity within the team that highlights the opportunity related to team colocation. The team was geographically distributed, and met face-to-face, typically on a monthly basis for three to four days; which the team referred to as 'Big Room' meetings:

Table 2: Benefits and challenges noted from the team's use of the 'Big Room'.

Benefits (Plus)	Challenges (Delta)
(T) - team-building events were effective	(C) - save time for problem solving
(I) - good collaboration at meetings	(I) - limited space
(I) - effective flow of meetings	(C) - 3 days per month ‘not enough’
(I) - frequency (monthly) OK	(T) - too many attendees, not enough focus
	(C) - agendas for big room were late
	(C) - too much “we need more time”

The discussion that followed the brainstorming focused on the need for more face-to-face interaction, as well as better use the limited time available. The team agreed that having face-to-face time was extremely valuable. It contributed to the sense of team, with the team-building events facilitating close interactions. The team felt that they worked well together when they met in person, and that the meeting structure flowed well, with the frequency being ‘acceptable’ given the project constraints. There was near universal agreement that more face-to-face interaction was desirable, but given the budget constraints on the project no obvious solutions emerged. Regarding the challenges based on this limited interaction, the space that was available was small given the size of the team. Due to team size, the ability to focus on specific discussions was at times wasteful for the large group and the balance of how they spent the time working in smaller breakout cluster meetings was seen as an area they should have planned more effectively. This would have given the Big Room meetings more of a ‘charrette’ approach, believed to be more productive by the team.

DISCUSSION

Innovative capacity considers the abilities and willingness of firms to engage in inter-organizational, collaborative and distributed novel activities. The two processes identified were new to most of the team members. The topics and discussions reflect the team’s engagement in collaborating across organizational and disciplinary lines.

The contractual arrangement itself, as the framework that is being considered, is identified based on three original elements cited by Kent and Becerik-Gerber (2010). The agreement brings together the concepts of overcoming the contextual and institutional barriers, but targeted at enabling the team and actors within the signatory partners. By putting all of the decision-making authority, and flexible budget, into their hands, the incentive of the companies in concept aligns with the overall success of the project, however this is a new context for most industry participants. As noted in the two examples, all of the areas in which the innovative tools instigated collaboration amongst the teams was well received. It was often the contextual changes that created the challenges for the team members. The ability to adjust their behaviour, as well as justify decisions and practices to their home firms, were the most challenging elements. The institutional training for disciplines and traditional contractual arrangement create challenging barriers, even when the barriers themselves are no longer in place.

The early involvement of all parties is somewhat vaguely defined. As the facilitator stated it, at times the contract 'mumbles' to allow the team to determine for themselves what is best for the project. For the case study project, the lab requirements encouraged the early engagement of mechanical and electrical trade partners. In this case, the longitudinal fragmentation of the industry is overcome to allow for novel participation at the earliest stages of design. The nature of the contract encourages the team to engage more parties at this early stage, so they can help validate the program and develop the contract itself, to which they are committing. By enabling this engagement, the design process and system development are more likely to be successful in meeting the team's commitment. While the path innovations take can seem random, having the flexibility amongst the team members to inform that path is of critical importance to repeating successes.

The use of shared risk and reward emerged, specifically in the context of the Big Room meetings. The team was given free rein to decide when and where to meet to support the design process. They chose to spend funds, which could have been shifted toward the shared reward pool, to have face-to-face meetings. They believed these interactions sufficiently valuable to overcome the costs of flying team members at regular intervals. When reviewing their evaluation, the team found the Big Room time valuable. The items they noted as detractors stem from the institutional norms - agendas do not provide enough time for problem solving. And these new, valuable interactions were not frequent enough - possibly due to their lack of experience with how valuable they would be when initially planning the meetings.

The two examples, while not comprehensive in the processes and elements related to their pursuit of innovative outcomes, are indicative of the team’s effort to create innovative capacity. The capacity is not targeted solely at innovation, but on the ability to create or enable new interactions amongst the project team members. The use of the IPD contract was targeted because of the potential for the team to pursue design options and solutions that are challenging, if not impossible, to fully explore in a more traditional contract structure. The contractual structure and the reimbursement methods are intended to create a safe space for teams. This enables team members to fail in pursuit of new designs, systems, or innovative processes, with the cushion of the rest of the team to vet the ideas before they advance too far. The contract also structures financial arrangements among the project team to create flexible capacity within the budget. As the facilitator framed it, the reason for the cost guarantee in the IPD contract was to remove the risk of failure as a barrier for designers and contractors to pursue more innovative ideas.

Table 3: Project comparison for unit costs

	% New Construction (by area)	Total Area (SF)	Cost / Area ($/SF)
Agricultural Engineering	70%	100,000	$450/SF
Chemical and Biomedical Engineering	100%	193,000	$746/SF
Materials Science and Engineering	20%	108,000	$604 / SF

With all of the signatory project team members absorbing this risk only against their final profit in the shared risk and reward pool, and with their project specific costs and overhead guaranteed, the financial risks are small, though not insignificant. While the project was not complete when this paper was published, a comparison of the unit cost for several Penn State projects is noted in Table 3. While there is a great deal of construction specific context, the two projects noted are similar in user type - labs and classrooms, within the same 3 year window of construction, and built on the same campus by the same owner. The ability of the Agricultural Engineering team to deliver the project at the same expectation of quality and performance as the sister facilities, for significantly lower unit cost is a strong testament to the team's challenges and need to pursue innovative processes and design solutions.

In addition, the interest among companies simply to participate in the efforts to employ the new project delivery method and contract structure that may be considered un-tested itself signals a willingness to collaborate and pursue innovative approaches. By choosing to participate, the firms engaging indicate a willingness to pilot new processes or novel mechanisms for collaboration amongst disciplines, as noted. This alone suggests capacity and willingness to pursue innovation. While the interest in participating demonstrates willingness, there are other considerations that have been documented related to integrated design not explicitly considered by the contract. The criteria and process for selecting the signatory partners is still new, and the ability to identify individuals and firms to further project goals is an on-going challenge. The willingness and drive of the individuals needs to meet, if not exceed, that of the firms they represent. Furthermore, how do you evaluate the potential for a designer or contractor to be innovative on a given project? Similarly, the specific challenges of the project scope and the level of complexity offer both challenges, and opportunities for innovative solutions, but often dependent on a sound technical foundation.

CONCLUSIONS

The pursuit of more effective delivery of capital projects is an on-going challenge in construction. We presented a case study in which an IPD project was undertaken as the delivery method enabling new processes for collaborating across organizational and disciplinary boundaries. Highlighting discussion from an internal team Lessons Learned workshop, two examples that represent the teams efforts to create innovative capacity amongst team members were presented. Innovative capacity was used to understand the manner in which the multi-party contractual model can enable innovative capacity as a broader understanding of the needed advance to allow innovation to more broadly grow and disseminate. The four areas of innovative capacity were defined and used to understand the opportunities and challenges observed by the case study project team.

While the context of the project is intriguing for seeing the pursuit of new and innovative processes, the use of a case study approach limits the ability to recognize the broader implications of the noted phenomenon. A formalized framework for innovative capacity should be developed to provide a basis for analysing the outcomes across projects and firms to better inform the application of these emerging contractual models. The use of IPD contracts is growing in the USA, and similar contract structures are emerging in parallel in different locals throughout the world. As elements begin to standardize, a larger study to recognize the critical elements of IPD that consistently enable project teams could be studied, but require a new lens to understand how they could grow innovation in new and broader ways across construction.

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