MANAGEMENT OF PRECONSTRUCTION USING LEAN: AN EXPLORATORY STUDY OF THE BIDDING PROCESS

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ABSTRACT

The study of office-related activities and their management in the Architecture, Engineering, and Construction (AEC) industry has been overlooked in the construction management literature. With that in mind, the authors of the present paper call attention to the need to manage information and shield projects from variation starting from the initial stages when service providers are chosen in projects where competitive bidding is used. The nurturing proposition of this paper is that regardless of the project delivery method being used, Lean Construction concepts can be used to shield projects against risk and unintended variation brought to projects due to the nature of the competitive bidding process. The paper presents a series of practical examples of how preconstruction office activities and documents are often handled in the AEC and discusses these examples vis-à-vis Lean Construction concepts and practices aiming to promote continuous flow. This exploratory study illustrates how the use of lean techniques in the bidding phase might facilitate the screening of subcontractors in hard bid environments, and contribute to reducing project risk and uncertainty, regardless of the delivery method. The paper concludes with practical recommendations regarding the management of bidding activities and topics that merit further investigation.

KEY WORDS

Preconstruction, office activities, bid process, making ready process, pull planning

INTRODUCTION

Part of the work related to finishing the job on time and on budget is related to managing the flow of information that supports site activities. Along these lines, activities developed at the office level in preparation to start construction or during the construction phase are ubiquitous and value enabling, that is, they support value adding activities that contribute to create the physical product on site. Office-related processes in the Architecture, Engineering, and Construction (AEC) industry represent a parallel system that works to support activities performed by those in the field, however their management is often overlooked by researchers. Practitioners often refer to communication as being the number one issue related to success of construction projects, plans and specifications alone rarely communicate all the intent

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of designers. That said, managing the flow of information from the bid phase to project completion can be viewed as an essential part of construction projects.

With that in mind, the authors of the present paper want to call attention to the need to manage information and shield projects from variation starting from the initial stages when service providers are chosen through a bidding process in projects where competitive bidding is used. The nurturing proposition of this paper is that *regardless of the project delivery method being used, Lean Construction concepts can be used to shield projects against risk and unintended variation brought to projects due to the nature of the competitive bidding process.* Thus, the paper provides a literature review that supports the argument that more attention is needed to support the study of preconstruction activities, more specifically those related to the competitive bidding process, and the use of Lean Construction (LC) as a way to reduce the risks and the uncertainty inherent with this process. Due to space limitations, the authors have focused the discussion on the bidding process. This paper is part of the authors' ongoing efforts to understand preconstruction and office-related processes from a production system standpoint and the use of LC as a theory to derive explanations for the performance of these processes and how they can be improved.

THE NEED TO STUDY PRECONSTRUCTION PROCESSES

Previous studies have often focused their attention on the final output of office tasks that process information necessary to carry out field work. Communication breakdowns were front and center in the work of Terry (1996), who pointed to problems that caused financial, schedule, and legal problems. Terry (1996) shared a number of cases and called attention to how these problems happen (e.g., fragmentation of responsibilities, mistakes in product specifications, and wording of specifications and contracts), and how they could be avoided, but the processes that contributed to the failures were not addressed in detail. Studies like Ibbs et al.'s (2007) and Serag et al.'s (2010) investigated the impact change orders have in project performance, but no discussion regarding how these could be avoided through a proper exchange of information from the preconstruction phase or how the changes were managed in the back-offices were not offered. Usually the literature on the management of construction documentation focuses on the final outcomes of a process without taking time to evaluate the processes themselves.

Laufer et al. (1993) studied the prebid and the preconstruction processes to identify which types of plans are developed and by whom, which formats are used, and who gets involved in different sub stages of these two major phases in a construction project. Laufer et al.'s study demystified the notion that developing a schedule is front and center to the planning process. Other construction documents in different areas of planning (e.g., engineering and method, site layout and logistics, organization and contract) combined received as much as five times more attention than scheduling alone. Nevertheless, the study of scheduling tools, algorithms, and its impact on construction projects still tends to dominate much of the discussion about planning in the Construction Engineering Management (CEM) discipline.

The need to manage massive flows of information and documentation in construction projects is ubiquitous, regardless of the type of delivery method adopted or the use of modern technologies such as Building Information Model (BIM). Take

for example, change orders, which often times are a result of design omissions, changes in owner's intent, but also occur due to intended/unintended misinterpretation of bid documents. Changes are present in traditional and non-traditional delivery methods such as design-build projects (e.g., Riley et al. 2005, Perkins 2009), and in new integrated project delivery (IPD) and relational contracts (e.g., Post 2011), even if they are less frequent and less costly in IPD projects when compared to traditional delivery methods. Projects that have used BIM and Virtual Design and Construction (VDC) report fewer change orders (e.g., Khanzode et al. 2008). However, anecdotal evidence suggested by specialty contractors indicates that change orders still circulate through the different parties in a project although in an informal way, which leaves specialty contractors at a loss when changes happen and cannot be proven and properly priced and accounted for.

Last but not least, general contractors (GCs) have to manage subcontractors who are awarded parts of a project but have no contractual relationship amongst themselves; they are linked by the coordination efforts of the GC. Tommelein and Ballard (1997) stress the need to coordinate specialty contractors and manage interdependencies from very early stages using LC concepts. They highlight the need to manage these interactions from a production system standpoint using LC concepts to reduce risk that is born out of uncertain situations surrounding projects, and result in additional contingency factors added to bids.

THE BID PROCESS

In the design-bid-build (DBB) delivery model, contracts are typically awarded to the contractor with the lowest responsive bid. Since the majority of the work associated with most building projects is performed by subcontractors, GCs are heavily dependent on their subcontractors to win the bid and successfully complete the project. To improve their odds of finding the lowest responsive subcontractor for each bid package, the GC must solicit more subcontractors to bid the project. While this improves the odds of finding the subcontractor with the lowest price, and thus increases the GC's risk of winning the bid, inviting more subcontractors to bid creates more work for the GC in terms of evaluating subcontractor bids. Employing techniques related to Last Planner System™ (LPS™) during the preconstruction phase, to shield preconstruction processes, contributes to ensure that more subcontractors will provide a GC with quality bids and improving scope coverage while increasing the productivity of assessing the bids (Reginato and Graham 2011).

There are two major issues related to lump sum bidding. First, there is a lot of risk borne onto the GC by selecting a subcontractor solely on the basis of the lowest price. Qualifications become secondary to a subcontractor's bid price because price is the only arbiter of a winning bid for the overall project. Secondly, many subcontractors (and their suppliers) submit their bids to GCs near the end of the bidding process to prevent having their bids shopped by GCs. Bid shopping is the unethical practice of a contractor disclosing the bid price of one subcontractor to another in an attempt to obtain a lower bid price (Degn and Miller 2003). As such, many GCs are selecting subcontractors bids based on price and in a very short period of time and are not able to fully vet each subcontractor's bid to ensure that it is complete (Zwick and Miller 2004).

Anecdotal evidence has shown that some GCs have been able to mitigate the risks associated with hard bidding in DBB projects by implementing a pull schedule and the "make ready process" to ensure that they receive enough bids and that they can vet them ahead of the final bid time (Reginato and Graham, 2011). The ultimate milestone is to receive enough qualified bids that, when packaged together, results in the lowest overall project bid price. The goal of using LPS™ techniques in this phase is twofold: plan the activities of bidding process using a backward pass with specific milestones; and working diligently throughout the bid stage to screen potential risks and constraints related to multiple bidders. This is fundamentally different from simply following bid instructions which indicate how and when proposals should be turned in and analyzed. By using LPS™ techniques the GC has a chance to identify and work with potential bidders throughout time, screen their qualifications and their proposals for scope coverage (something that cannot be done at the last 5 minutes of the bidding window).

In broad strokes, pull planning a specific project or specific deliverable consists of having stakeholders to lay out the chain of tasks necessary to deliver the final product by a defined milestone. During the pull planning session, participants should make explicit the logic of a network of commitments, requirements, and specific handoffs necessary for their tasks to be delivered as planned. Contingency should not be added to tasks, buffers are only added if deemed necessary by the team. Dates for the delivery of handoffs are coordinated among participants and commitments are made to produce the final deliverable (Ballard 2008).

In this environment, the make ready process (and its related constraint analysis) supports the planned network of commitments through judicious analysis of its tasks and potential roadblocks or constraints that might prevent the tasks from happening as planned (Ballard and Howell 1998). Once constraints to the flow of work are identified, specific people are assigned to work on removing these constraints which in the bidding process might be related to lack of information (plans, specification, details, and quantities), service provider background check (performance in previous projects, classification as disadvantaged business, availability, lead times), defining bid instructions, screening bids for accuracy and coherence with bid instructions (scope of work, divisions covered), among others.

PRECONSTRUCTION ACTIVITIES

Laufer et al. (1993) in their study of prebid and preconstruction processes divided the period of time before field operations commence into two distinct phases: prebid planning (PBP) and preconstruction planning (PCP). The distinction between the two is that PBP takes place before a bid is submitted and PCP occurs after and lasts up until the start of field activities. However, anecdotal evidence reveals that the distinction between the two phases is blurred depending upon the type of contract and delivery method. For example, project buyout, which consists of procuring suppliers and specialty trade partners/subcontractors (Zwick and Miller 2004), is typically done before the submission of the final bid for a lump sum contract, while it is commonly done after the award of a GMP contract. Further evidence of this blurring is the change in nomenclature used by GCs, with estimating departments being more frequently referred to as preconstruction departments.

Whatever the name or phase used, there are a host of planning and organizing activities that must be performed before the start of field construction operations in order to ensure that a project is properly executed. Preconstruction activities, simply stated, involve those activities performed before the field operations associated with the construction of a physical structure. Typical preconstruction activities include budget cost estimating, preliminary project scheduling, site planning, design coordination, and constructability and value engineering analyses. Which activities are included in preconstruction depend on the contract and delivery model adopted. For the purpose of this paper, design-related processes are not discussed as part of the preconstruction activities as in DBB projects the design is supposedly complete before the bidding process starts and is not part of the preconstruction activities developed by the GC.

PRECONSTRUCTION AS INTEGRAL PART OF THE CONSTRUCTION PROCESS

Preconstruction is rapidly evolving and becoming a more integral part of the construction process, yet there is scant research dedicated to it. Traditionally, preconstruction was considered its own distinct phase, whereby an owner, typically in a private-sector project, would engage with a GC or agency construction manager to provide preconstruction services.

The benefits of preconstruction for contractors include that it allows for early project involvement and an opportunity to sell the owner on the contractor's capabilities. Additionally, the GC's personnel that were accustomed to performing estimating and scheduling for projects without preconstruction activities went from being a source of cost for the GC to a source of revenue. GCs that are skilled at procuring preconstruction contracts have been able to turn their estimating departments from an overhead cost to profitable preconstruction departments.

There are benefits for the owner as well. Preconstruction services contracts allow the owner to obtain early involvement from contractors. This early involvement allows owners to get preliminary budgets (which are useful for obtaining financing), procure key subcontractors and suppliers for long-lead items, and have a contractor work with the designer to provide design coordination, constructability reviews, and value engineering options. If done properly, preconstruction services, while costing the owner an up-front fee, will actually reduce the overall cost of the project.

All parties benefit from reduced risk. Long lead items can be procured before the plans are at the 100% construction documents stage. Similarly, with early involvement from a GC, specialty contractors, such as HVAC, plumbing, and electrical contractors can be bought out before design is 100% complete and be involved in the design process of their respective work packages. This early involvement allows for a greater buyout period, which allows the contractor and owner to be more discriminating in terms of selecting specialty contractors, as well as less schedule risk for the entire project.

LEAN CONSTRUCTION AND PRECONSTRUCTION PROCESSES

These aforementioned benefits can be magnified if the project team is using lean techniques during the preconstruction phase. The identification of specific tasks, the removal of constraints, as well as the planning activities in greater detail as the time to execute those activities draws closer are possible if the important members of the

design and construction team are brought together before field operations commence (Gil et al. 2001). In fact, if the designer, GC and key specialty trade partners are actively participating in the planning of the project during the preconstruction phase, then pull planning for the entire project can be performed, creating buy-in from all major project contributors and potentially reducing the amount of future change orders.

The benefits are customarily realized for projects utilizing design-build (DB) and integrated project delivery (IPD) methods, particularly if the designers and builders are co-located. However, the benefits of preconstruction activities are less pronounced or nonexistent in traditional delivery models, such as DBB. A major reason for this is that many contractors expend less energy performing preconstruction activities for DBB projects, choosing instead to *indiscriminately* hard bid all the work they intend to subcontract to the lowest bidder and coordinating field work *after the project has been awarded*. Also, there is often no contractual incentive to perform preconstruction activities in DBB projects. The contractor does not have the opportunity or the financial incentive to perform design coordination or to perform a preliminary budget estimate to inform the owner of the project's approximate cost ahead of the actual bid. There are also *no contractual ties* between the design team and the construction team, so pull planning and other lean techniques *involving AEC participants* are difficult to perform.

Many GCs that have shown a proclivity for implementing lean techniques in construction field operations tend to gravitate towards projects with delivery models and contracts that foster lean thinking and shy away from traditional DBB delivery models. However, with the recent downturn in the construction industry, many of these contractors have found themselves competing for DBB hard bid projects. With the recent downturn in the economy and the scarcity of capital available for construction projects, lump sum contracting has become increasingly popular for owners seeking the lowest up-front cost for projects. Anecdotal evidence has shown that lump sum bidding is not solely related to DBB projects, as some DB projects are also contracted using lump sum contracting. While lump sum projects carry a lot of bidding risk with them, some contractors are using lean techniques in the bidding process to mitigate risks.

There are several benefits to be gained from implementing lean in preconstruction for DBB projects. Reducing the risk of subcontractor selection and obtaining several bids to choose from (increasing the chance of receiving the lowest bid) are major benefits (Reginato and Graham 2011). The following section discusses how lean techniques can be used to improve the bidding process for GCs bidding DBB lump sum projects.

OPPORTUNITIES TO IMPLEMENT LEAN CONSTRUCTION TO IMPROVE PRECONSTRUCTION PROCESSES

This section indicates potential areas and opportunities where Lean Construction can be used to improve preconstruction processes. The main areas of improvement and recommendations were drawn from anecdotal evidence provided by industry practitioners, the literature reviewed, and the broad literature on LC implementation.

DEVELOPING RELATIONSHIPS WITH SUBCONTRACTORS

As previously mentioned, GCs are highly dependent on their subcontractors when providing the lowest responsible bid in lump sum building projects. Therefore, GCs want to understand the capabilities of the subcontractors that they are considering for any given project. GCs will oftentimes have had a past working relationship with many subcontractors. But to assess those subcontractors for which they have no prior experience, GCs will frequently have subcontractors complete a subcontractor prequalification form. Prequalification forms gather information on the subcontractor's corporate financial strength, bonding capacity, past project experience, etc. The point of the forms is to assess the capabilities of a subcontractor for performing particular scopes of work and they are key to mitigating the risks associated with selecting a subcontractor that is incapable of performing the task for which they are bidding.

However, most prequalification forms are not project specific. Also, there is no legal requirement that a subcontractor fill out GC-specific prequalification forms. Subcontractors are not required to be prequalified by GCs as a condition to submit bids to them and GCs are not obligated to select subcontractors that they have prequalified. Therefore, if the GC wants to prequalify a subcontractor that has not already completed a prequalification form, they must request that the subcontractor complete the form prior to a particular project. Subcontractors that do not meet the prequalification standards set by the general contractor, whether in general or for a specific project, can be excluded from the bidding process.

In addition to understanding the capabilities of each subcontractor in general, the GC must understand the subcontractor's intent for each project, specifically what scope of work they intend to bid on and perform if selected. To understand the scope of work each subcontractor is bidding, GCs contact as many qualified subcontractors as possible and prescribe to them the scope of work that they want them to cover for each bid package using a scope check list. This process has been enhanced by savvy GCs to include a lean planning component. Since the bid day is known and fixed, some GCs build a pull schedule starting with bid day and work backwards to ensure adequate time is allocated for contacting subcontractors, providing them with scope letters, and assessing submitted scope letters. The order of operations is: 1.Contact subcontractors; prequalify if necessary; 2. Provide a scope letter to subcontractors interested in bidding the project; 3. Receive the completed scope letters from subcontractors; 4. Receive actual bids.

By receiving a completed scope letter ahead of bid day, the GC can assess whether or not the subcontractor properly understands the required scope of work and will be providing a responsive and complete bid, mitigating risk to the GC. Subcontractors that provide incomplete scopes can be consulted by the GC to provide the required scope or disqualified. All that is left to do on bid day for the GC is to sort the bids from subcontractors with complete scopes in order of price and select the lowest one. Subcontractors, by being able to submit their final bid price late in the bidding process, minimize their risk of bid shopping. This activity can be part of the make ready process in that it refers to screening potential bidders ahead of time to allow the GC to have a better understanding of their capabilities. This is a method for mitigating risk because it prevents unqualified bidders from turning in bids at the last

minute when the GC does not have any time left to verify if the bidders' credentials are appropriate for the project.

PARTICIPATION OF SMALL BUSINESS ENTERPRISES AND UNDERREPRESENTED MINORITIES

In public-sector work, the overwhelming amount of which involves lump sum contracting, there is often a requirement to involve companies that are underrepresented in construction work. The requirements differ wildly depending on the government agency, but two common ones in the State of California are requirements to include small business enterprises (SBE) and disabled veteran business enterprises (DVBE). The participation of these enterprises is often set by the contract by way of goals, incentives, or requirements. Goals for SBE and/or DVBE participation are commonly set at 3% (we will use the 3% value as an example for the rest of the paper) of the contract value, meaning 3% of the total contract value must be performed by a certified SBE or DVBE firm. Goals often require a good faith effort to meet or exceed the 3% level. That is, it is not always required that a contractor reach the 3% level, but rather GCs must be able to prove that they made a reasonable attempt to reach the 3% level of participation.

Incentives, which can be used in conjunction with goals, allow the contractor to reduce the value of their bid by a certain percentage for the basis of lowest responsive bid purposes, making their bid more competitive. That is, if a GC meets certain SBE and/or DVBE goals or requirements, their bid price is lowered by some percentage, but if the GC is awarded the contract, it will be so for the full contract amount. A sample incentive chart is shown in Table 1. Lastly, certain percentages of participation may be required to be met in order for a GC's bid to be considered responsive. Again, the level of participation required is set by the agency.

Table 1: Example of requirements for DVBE participation

DVBE Percentage of Participation	Incentive Percentage Based Low Price Award	Incentive Points Based on High Score Award
3% up to 3.5%	1%	1
3.51% up to 3.99%	2%	2
4% up to 4.5%	3%	3
4.51% up to 4.99%	4%	4
>5%	5%	5

Whether goals, incentives, or requirements are used, GCs are required or incentivized to recruit businesses that meet the required project criteria and are certified. The process of locating certified businesses must start before bid day for two primary reasons. First, contractors will want to know ahead of bid day if they feel they can meet the goals or requirements outlined in the bid documents. If they cannot meet the goals, they must show that they made a good faith effort to meet the goals. If the GC cannot meet requirements, they should abandon the bidding process in order to avoid submitting a non-responsive bid and accruing unnecessary costs or joint venture with a GC that is capable of locating and contracting with certified businesses. Secondly, the certifications of the businesses being used to meet SBE and/or DVBE requirements must be included with bids (or at least their certification numbers). It is up to the GC to validate the certifications to ensure they are current.

The more aggressive the targets for SBE/DVBE participation are set, the more time will be required by the GC to locate and vet those businesses. Therefore, in terms of mitigating risks associated with meeting SBE/DVBE targets, GCs should set early milestones in a pull schedule to ensure timely completion. Locating SBE/DVBE businesses should begin prior to issuing scope letters in case the GC must also prequalify the SBE/DVBE businesses. Just because a company is SBE or DVBE certified does not mean that a GC will automatically choose them for a scope of work. The subcontractor, in addition to being certified, must be qualified.

MANAGING GENERAL CONTRACTOR PERSONNEL IN THE BIDDING PROCESS

Lump sum bidding requires variable effort to assemble the final bid. While one or a few people may be necessary to prequalify subcontractors, check SBE/DVBE status, and issue scope letters, fielding bids on bid day may require many people. As bid day approaches, the amount of people participating in the bid assembly increases. With each new person, the risk of variability increases since each new person has less intimate knowledge of the bid.

Most GCs do not have the luxury of employing enough people in preconstruction to readily supply the number of people required on bid day for a large lump sum bid. Therefore, they often pull field and/or office personnel to help in the bidding process to serve as trade specialists. However, since these people have other responsibilities in addition to the bid, they can rarely fully engage in the bid.

In order to reduce risks associated with bidding and risks associated with pulling personnel away from their other responsibilities, it is important for those staff members dedicated to the bid to provide make ready work for the trade specialists. The field personnel should have a list of qualified bidders and their associated completed scope letters ready for review so that they simply have to assess each subcontractor's bid price and select the lowest one. In order for that to happen, a member of the bid team must ensure that all of the required documents have been submitted in a timely manner, analyzed for their completeness, and catalogued for easy and timely access. Pull planning can help in this effort.

Even if done well, the process will not be that simple. Some subcontractors will not complete prequalification forms and others will not participate with defining their scope ahead of the bid. Therefore, as part of the bidding process, information regarding specific scopes and construction documents must be provided to trade specialists early enough so that they can study them ahead of bid day. Since they have on-going project responsibilities and may have constrained schedules, materials must be presented to them early enough so that they can study them when they have time to do so. This means the bidding team must collect the requisite information well in advance of bid day in order to properly accommodate the field staff.

CONCLUSIONS

The study of office-related activities in the AEC industry has been overlooked, particularly when it comes to the preconstruction phase of a project. As such, LC concepts, whose successful adoption in field activities has been well documented, have not been explored for their application in the preconstruction phase. LC techniques promote the continuous flow of work and the reduction of variability, both of which reduce risks associated with project completion. There is considerable risk

in assembling a bid for a project, particularly with a DBB delivery model. For GCs, these risks include selecting subcontractors solely on the basis of price without the opportunity to conduct adequate due diligence and not having adequate scope coverage. For subcontractors, the primary risk is having their bid shopped. All of these issues can lead to problems in the field after the bid has been awarded.

GCs have been found to employ LC techniques in the preconstruction phase to mitigate these risks. Some of the practices being used are implementing pull planning to ensure the timely delivery of scope letters, location of subcontractors that meet SBE/DVBE qualifications, and management of personnel on bid day. However, the evidence of LC in the preconstruction phase has been anecdotal and its implementation haphazard among differing firms. Preliminary discussions with GCs have revealed that use of LC techniques reduce risk and improve work flow, but the extent of the benefits is unknown.

Based on the benefits observed thus far, further investigation of utilizing LC is warranted. The authors of this paper intend use the feedback gained from it to further the study of preconstruction activities, specifically focusing on the use of LC as a means to reduce the risks associated with submitting lump sum bids for different project delivery models.

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