Ninth International Conference on Construction in the 21st Century (CITC-9)
"Changing the Field: Recent Developments for the Future of Engineering and Construction"
March 5-7, Dubai

The Role of Organizational Culture in the Lean Construction Transformation

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Abstract

The traditional methods for delivering construction projects have great room for improvement, despite the best intentions, many projects leave the stakeholders dissatisfied with the results, as schedule overruns and budget excesses occur far too often. Studies by the Construction Industry Institute, The McGraw Hill Engineering News Record and the Lean Construction Institute indicate that projects delivered by the lean methodology are likely to save 5 to 10% or more of project cost and to reduce schedules to a similar extent. The adoption of lean requires significant changes in organizational culture. (Izquierdo 2010, Angelo 2010). This paper discusses some of the strategies needed to change organizational culture, making reference to a lean project team that modified its culture. A case study of the expansion of a health care facility identified how the project culture was redirected from the traditional mode to a lean environment within the time frame of a project. A later discussion with construction professionals provided perceptions on the adoption of the lean methodology. The study results underscored the importance of a lean culture in the successful deployment of lean projects, and provided guidelines for improvement.

Keywords

Lean construction, Lean culture, Integrated Project Delivery, Integrated Form of Agreement, Lean transformation, Building Information Modeling

1. Introduction

There is clearly a need for change in the construction industry as many projects that have been delivered through traditional forms of contract have had unsatisfactory outcomes in cost and schedule. They often do not meet clients' quality expectations (Alarcon and Mesa 2012, Lichtig 2006). These shortcomings have been linked to a lack of communication, coordination, and integration as well as other factors. There is extensive waste in the industry, in the range of 25 to 50 percent in coordinating labor and in managing, moving, and installing materials; a broad range of values for "wasteful activities" (1.6 – 93.1 percent, with an average of 49.6 percent (Horman and Kenley, 2005). The U.S. – based Building SMART Alliance at the National Institute for Building Sciences estimates that more than 50 percent of the cost of a building is waste; compared to other industrial sectors, the construction sector has experienced consistently rising costs over many years. Construction industry practitioners have been continually seeking to apply better technologies and processes to improve project delivery, but the rate of change has been hampered by the lack of a unified motivation to change the organizational culture. The incremental adoption of initiatives such as Lean Project Delivery (LPD) and Integrated Project Delivery (IPD) has had positive results. This success has been

mostly due to proactive project owners who have set the stage for the close integration between all parties that is needed to create a so-called Lean environment. The McGraw Hill Company's Smart Market Report (2013) cited many lean benefits reported by survey respondents. The percentages of respondents reporting medium and high levels of achievement were: Higher Quality Construction 84%, Greater Customer Satisfaction 80%, Greater Productivity 77%, and Improved Safety, 77%. Ballard & Kim, (2007), documented significant positive outcomes with lean projects – both tangible and intangible. They documented savings of 10% or more and high levels of satisfaction for owners as well as project team members. In some cases both costs and schedules were reduced by 10 percent or more (CII Report 234-11)

2. Lean Construction

Lean Construction (LC) is an innovative project delivery approach that addresses many of the shortcomings of traditional project management. It has several interpretations, including Lean Project Delivery, Integrated Project Delivery, and Collaborative Project Delivery. It came into existence as a response to industry concerns over low construction productivity, commonly observed errors, delays, cost overruns, and safety (Forbes and Ahmed 2010). It was developed to address deep-seated systemic inefficiencies in construction delivery, in the way increasingly specialized stakeholders interact. Lean construction aims to address these interactions in a comprehensive manner.
It is based on the "lean" manufacturing principles that are a foundation of the Toyota Production System (TPS) (Howell 1999). Lean construction relates to both design and construction and seeks to maximize value for project owners and minimize wastes; it draws on the Toyota Production System that identified seven wastes and five lean principles (Womack et al., 1996). Lean *production* pursues the ideal to: "(1) do what the customer wants, (2) in no time, and (3) with nothing in stores" (Tommelein 2015). Lean Construction is also defined as "a holistic facility design and delivery philosophy with an overarching aim of maximizing value to all stakeholders through systematic, synergistic, and continuous improvements in the contractual arrangements, the product design, the construction process design and methods selection, the supply chain, and the workflow reliability of site operations" (Abdelhamid 2013). Integrated Project Delivery (IPD) was developed to improve innovation in lean projects by moving money across boundaries (Alarcon et. al., 2013). IPD is defined as a delivery system that seeks to align interests, objectives and practices, even in a single business, through a team-based approach.

2.1 Origins of lean construction

Koskela (1992) addressed the application of manufacturing techniques to construction. His study, titled "Applications of The New Production Philosophy to Construction", characterized construction as a form of production. Modeling the Toyota Production System (TPS) Koskela sought to reduce the seven wastes, i.e., non-value-adding activities as identified by Shingo and Ohno (Ohno 1988). Howell *et al.* (1993) addressed the combined impact of work flow variability and dependence, and their implication for the design of operations. Through collaboration with Koskela, Howell, and others, Ballard pioneered the development of The Last Planner® System (LPS). The LPS was based on the concept of reducing the hierarchical layers of construction management and empowering field-based actors in the construction process to optimize the allocation of available resources in the weekly planning, scheduling, and execution of work. Ballard further refined the LPS, transitioning from weekly work planning to look ahead planning, and to phase scheduling. This refinement focused on managing flows in the construction process, reducing flow variation from the plan, and on using buffers to limit the impacts of any remaining variability in these flows. (Ballard, 2000a). He subsequently developed the Lean Project Delivery System LPDS (Ballard 2000b, 2008).

2.2 Philosophical differences

Conventional construction is based on craft production methods, carried out by many different specialists. They are interdependent, yet they typically have separate contracts with a central entity, such as a general contractor or construction manager. These contracts place project team members in adversarial roles, with penalties for underperformance. In turn, construction profit margins are subject to many areas of risk such as price increases or labor shortages. Consequently, the parties tend to have minimal communication and proceed quickly, often interrupting or obstructing others whose work precedes theirs.
Lean construction, on the other hand actively controls processes and uses metrics in planning system performance to assure reliable workflow and predictable project outcomes. Performance is optimized at the project level, whereas current project management approaches reduce total performance by attempting to optimize each activity. The LC philosophy emphasizes having work flow between team members' crews without interruption. Consequently, there is more cooperation between disciplines with a joint focus on completing the overall project as opposed to having self interest in their work tasks alone.

3. Creating a lean culture

Keiser 2012, cited several practitioners who experienced lower costs, shorter schedules, improved safety, and better quality (Lichtig 2010, Izquierdo 2010, Angelo 2010). These practitioners closely linked the benefits with the degree of adoption of a lean culture in their organizations. The creation of a lean culture involves having stakeholders embrace the principles of *respect for people* and *continuous improvement.* Additional steps are needed to inculcate these values in the hearts and minds of people with opposing, and long established, beliefs and attitudes. Lichtig, 2010, points to the need for a lean transformation to make a lean journey successful, and links it to the element of effective leadership. Project characteristics vary widely, as do the project teams. That creates a challenge for those who provide or support the lean function. Some companies have detoured from lean because of an inability to create a company-wide transformation (Keiser, 2012)

Leaders must visibly lead the change - senior managers (in the project delivery team) must decide to commit to lean, and declare this to employees. This declaration must be followed with a steady effort to align the organization with a lean culture. The lean transformation is organizational, and continuous, not sporadic. The organization must provide resources - training, facilitation, and equipment such as computer systems. Initially, a consultant may be needed to fill this role, whether external or internal).
Training should be just-in-time – when people start work on their projects they should already have the necessary lean training, but not too long before. As observed in a UK study three key issues influence the readiness of organizations for undertaking a lean journey: lack of adequate lean awareness and training; lack of top management commitment; and culture and human attitudinal issues. (Sarhan and Fox, 2012),

A willingness to change is essential: Lean methods require new behaviors. One cannot effectively enforce change, but skillful management can lead people to derive intrinsic satisfaction from outstanding performance. A "Shared vision" places all stakeholders on the same page (Macomber and Howell 2005). The work force aligns itself with the direction set by a leader, based on a sharing of beliefs and a positive view of the future. A Study Action Team ™ (SAT) is recommended to develop the shared vision. Members may start as a reading group and focus on learning as much as possible to bring about change.

An Integrated Form of Agreement (IFOA), such as ConsensusDocs300, is a legally enforceable relational contract that incentivizes collaborative behavior between project team members. Standard commercial contracts are adversarial in nature, emphasizing penalties for underperformance. The IFOA seeks to align the commercial relationships of a construction project's design and construction participants as a temporary production system. Disputes are settled at the lowest possible level. It requires collaboration to bind team members as a network of commitments. It formally requires lean project activities including training, joint planning, performance measurement such as percent planned complete (PPC) and continuous learning. Completed assignments serve as a source of

learning for future improvements instead of being a search for sources of blame.

Building Information Modeling (BIM) provides many economies in construction projects (Eastman *et al.*
2008). It provides a reliable digital representation of the building available for design decision-making,
Construction scheduling, document production, construction planning, and performance predictions, and
cost estimates. BIM enables project teams to avoid clashes, and also to visualize building features that serve users optimally in terms of space as well as maintainability.

'Big Room' (Obeya in Japanese) describes a space where project team members can work collaboratively, and in close proximity. The Big Room environment can be created for project meetings with on-site trailers that are appropriately equipped with meeting rooms for "break out" sessions. The equipment may consist of wall-mounted schedule boards, A3 charts, projection equipment such as a Smart Board, and audiovisual equipment for long distance meetings.

3.1 The Last Planner System

The Construction Industry Institute identified five lean construction principles for securing superior project performance (PT 191): a) Customer focus b) Culture and people, c) Workplace organization and standardization, d) Elimination of waste and e) Continuous improvement and built-in quality. These concepts are embodied in the "3 Connected Opportunities" advocated by Lean Project Consulting, and adopted by the Lean Construction Institute (LCI): Impeccable coordination – it reduces unpredictability in workflow, organizing projects as production systems – the parties are equipped to maximize performance.
Projects are treated as a collective enterprise, e.g. sharing resources avoids duplication

The Last Planner System™ brings various disciplines together in planning work on a weekly (or daily basis) to promote seamless interaction, and making it possible for the foregoing principles to be implemented. There are three levels of schedules and planning tools: The master schedule; the look-ahead schedule is based on a six to eight-week time frame, and uses items "pulled" from the master schedule that are free of constraints. The weekly planner schedule delineates the work activities or assignments "pulled" from the look-ahead schedule to meet the completion dates in that schedule. The so-called Last Planner is the foreman or other professional who prepares the weekly schedule. This schedule also includes a buffer of work activities based on future work. Weekly accomplishment is measured as "Percent Planned, Complete (PPC). The reliability of the Last Planner System™ hinges on informed commitments in order to maintain the trust that is essential for avoiding waste. Eligible activities or assignments are those that have no current constraints, and that have resources available and assigned. At the level of weekly work plans the involved disciplines must be aware of the scope of upcoming assignments, using this knowledge to determine the resource requirements – labor, equipment, materials, information, etc. Above all, they should ensure they can deliver on their promises, i.e., to practice Reliable Promising (Lichtig, 2006)

Culture can be a barrier to the implementation of Lean Construction, as well as financial, legal, and technological factors. Management is responsible not only to empower them, but to have them confidently bring their skills to the inter-trade sequencing of activities. This requires transparency, yet many last planners may initially display a lack of trust and "hold their cards close to the chest" (Fauchier and Alves, 2013). With the passage of time, trust increases and transparency improves as well. Reliable promising may often not occur until people experience first-hand the consequence of others' failing to make reliable promises.

4. Case study observations

The best results of the lean methodology are obtained with projects that have the benefit of an integrated team from the early or pre-design phase. Given the newness of LC, that situation may not always occur. Nevertheless, significant benefits can still be obtained even if lean methods are introduced later in the project, provided that a culture of collaboration can be introduced. A 2013 case study of a health care facility construction project illustrated the importance of the project culture. The project started as a traditional one during the design phase, but the Owner later recognized the benefit of the lean methodology and sought to realign the project accordingly during the construction phase. As the team had had minimal experience with Lean, the Owner underwrote the cost of hiring a lean consultant to train team members and facilitate ongoing weekly planning activities.

The project was very successful – delivered ahead of time and under budget, even including the consulting fees. For example, the probable cost in 2008 was $28Million. The project was re-mobilized in 2011with a Collaborative Project Delivery Team (CPD). With changing market conditions, the expected cost was updated to approximately $27 Million, with a schedule of 17 months. The owner challenged the CPD Team to save $2 Million through innovation & efficiency measures facilitated by a lean coach. The updated project was based on a base budget of $25 Million and delivered 14 months. The actual project budget was increased to accommodate additional owner's requirements. The CPD Team also committed to zero lost time injuries as part of the Conditions of Satisfaction (CoS). Due to changing needs, the owner asked for the project to be accelerated even more to reach completion in 12 months instead of 14.

A retroactive study was carried out to evaluate the factors that enabled the project team to accomplish early completion, and cost savings with minimal safety issues. Team member responses were recorded with a five-point scale, ranging from a minimum of zero to a maximum rating of 5. A portion of the results that relate to the project culture follows:

Drivers of schedule improvement
The original schedule was based on a traditional approach that did not complement the needs of the Collaborative Project Delivery Team (CPD) to meet an accelerated schedule dictated by the CoS. As described in the CoS, the project team agreed to meet schedule dates by working together across traditional contract boundaries to help remove any hurdles. They performed well in this respect, finishing 2 months ahead of schedule. The CPD team attributed schedule improvement to factors that were highly rated; on a scale of 1 to 5:
Contractors' responses are in Figure 1 below.

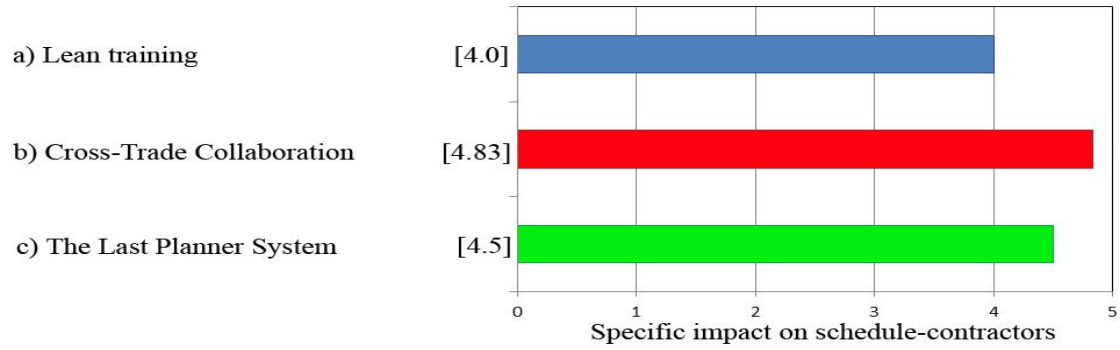

Figure 1: Case study observations – schedule improvement - contractors

The contractors rated all of the factors highly – between moderately (4) and very contributory (4.83) to schedule improvement. Designers' responses were in a similar range and they pointed to cross-trade collaboration as a key factor rated at 5/5.

Designers' responses are in Figure 2 below.

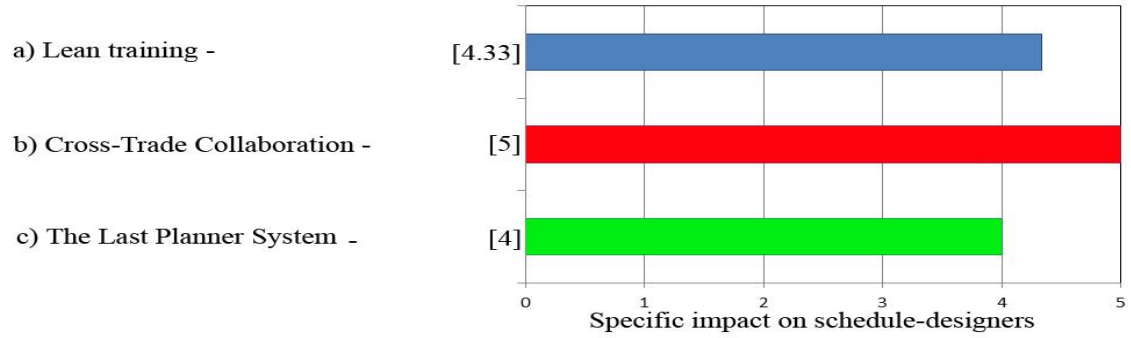

Figure 2: Case study observations – schedule improvement - designers

Comments on the case study:
The project team performed very well; not only did they save 10% on the budget for the hospital addition, but they also saved 2 months out of 14 on the schedule, i.e. approximately 14%. Contractors rated the Last Planner System very highly, i.e. 4.5/5. Designers also rated it highly at 4/5. Cross Trade collaboration was 4.8/5 for contractors, and 5/5 for designers. Given that neither contractors nor designers had had significant lean experience, the training provided was clearly a major success factor. This training was provided only when the job was mobilized at the site. It was rated at 4.5/5, and 4/5 respectively. With regard to safety, over 200,000 man-hours were utilized without a single reportable accident.

5. Discussion

An informal industry discussion was held recently with construction professionals to evaluate their readiness for adopting lean construction practices. They held high positions in their companies – presidents, vice presidents, and senior staff. The discussion questions included: the number of projects they had been involved in, their efforts to reduce the "7 wastes", their willingness to change operating procedures (to lean practices), their buffers in handoffs with other companies – measured in days, their willingness to pay for training i.e., percent of project value, and the perceived barriers to lean adoption.

The organizations involved covered a wide spectrum – most had had little or no experience with lean projects, while one of the largest, a specialty contractor had been involved in more than 10 projects. That company's comments displayed significant positive attitudes to the lean concept. Some contractors were actually working on a lean project and reported positively as being able to address several wastes – such as overproducing, idle time, inventory waste, waste, excessive motion, and defective production, but could not quantify the benefits. Their willingness to change operating procedures fluctuated between 0/5 to 5/5. The experienced company claimed to have addressed all seven wastes, reduced rework, and increased safety performance. They expressed high interest in lean projects (5/5) and were similarly willing to modify their operating procedures, and for management to lead, not delegate lean efforts. One respondent was willing to delegate but with management oversight.
On the question of empowerment – the less experienced companies showed some reluctance to delegate responsibility for scheduling in the Last Planner System to foremen (2/5). On the other hand, the experienced company was most willing to empower foremen (5/5), most likely having done so on the basis of lean project experience.
Overall, the results of the small sample obtained suggest that unfamiliarity of lean practices is an obstacle to adoption. The extent of expected benefits was not clear to them. They voiced the opinion

that training time and cost represented a significant burden – also that the whole process seemed to be time intensive for all parties. On the other hand, experienced practitioners admitted that resistance by staff and workers were barriers to adoption but suggested that the construction industry should embrace lean for greater safety, efficiency, and performance
It was pointed out that lean teams are able to follow their predecessors by mobilizing workers based on a promised date. Contractors who admitted to unfamiliarity with lean practices voiced a preference for allowing a buffer of three or more days before following the previous trade to avoid delays. On the other hand, experienced companies were willing to follow without a buffer.

6. Conclusions

The observations from the project retrospective and the recent industry discussion reinforced the great significance of a lean culture to implement change.
The literature reinforces the linkage between organizational culture and lean project success.
Lean projects call for a culture that relies heavily on collaboration between and across disciplines, promoting the success of the project as a means to enable their own success.
The leadership of construction organizations is responsible to drive the lean transformation within their companies. Ideally, Owner organizations are in the best position to advance lean in their projects by requiring it in their Conditions of Satisfaction, and also requiring integration between design and construction activities. Requiring an Integrated Form of Agreement is the most reliable way to promote lean behaviors. Significant lean benefits can accrue to projects even if the project team introduces lean methods after the start of a project.
The discussion with industry professionals indicated that many construction firms do not fully understand the lean construction methodology or its requirements.
Companies with a limited understanding of the lean environment have reservations about fundamental requirements such as empowering employees or minimizing the schedule buffers between activities.
Organizational culture as reflected in the success of the Last Planner System is improved by lean training of the project team.
Lean training from consultants can be an expeditious yet cost effective way to bring lean to a project – given the emerging status of lean, many designers and contractors lack those skills.
The Big Room environment in projects keeps all issues in focus, such as performance metrics and promptly addresses situations that could otherwise become constraints and cause delays. This collaborative approach leads to greater stakeholder satisfaction in projects.

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