A MENTORING APPROACH TO IMPLEMENT LEAN CONSTRUCTION

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ABSTRACT

This study was motivated by the need to implement lean construction in a concrete division recently established by a general contracting firm that has been an advocate of lean for several years. After observing difficulties to implement lean in the first project undertaken by this concrete division, the research team decided to adopt an alternative approach focused on mentoring and continuous improvement. The objective of the study was to support the concrete team in its development of desired lean behaviors, i.e., focus on process improvement based on continuous cycles of revealing problems and discussing root causes, brainstorming solutions, learning, and changing current practices. The method used in this study was action research, with the researcher being an active participant in the team. The implementation was carried out based on three strategies: (a) lean training, (b) adoption of the Last Planner™ System, and (c) continuous improvement workshops. The team then assessed the outcomes of this intervention. The contributions to practice observed in this case study stemmed from a focus on learning (i.e., problem identification, analysis, and solving) in a team environment. Changes in behavior were observed as well as greater awareness of how current practices could be improved. Changes in current practices were a consequence of this greater awareness. Contributions to theory are highlighted in this paper, as we attempt with this research to expand the understanding of means to adopt lean construction in order to successfully effect change in current practices.

KEYWORDS

Lean implementation, Mentoring, Toyota Kata, Continuous improvement

INTRODUCTION

This research was motivated by the identification of a practical problem with theoretical relevance. A general contracting firm, that has been an advocate of lean construction for several years, opened a concrete division to realize self-performed work. Personnel hired for this concrete division had no previous experience with lean construction.

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The first concrete project (Case 1) was carried out for another general contractor. It was a large project and opportunities for improving production efficiency were observed. Problems were observed, for instance, deviation from the production rates established in the estimate for that project. The team then sat down with the estimator and developed a detailed plan that reflected how work should be done in order to achieve the estimated production rates. The plan was developed through a series of workshops and focused on understanding how the crews should perform the work, including crew sizes, sequence of work and how each crew member should move from one activity to another (standardized, individual work-flows).

However, the attempt to implement the plan was not successful. Several decision makers were involved in the implementation process, and specifically those responsible for pre-planning (office) activities vs. execution (field) activities differed in their understanding of the root cause(s) of problems and how they should be solved. Consensus was not reached about the best approach to solve the problems at hand, and the devised plan for execution was not implemented. This situation motivated this research. This Case 1 enabled us to go deeper in understanding how to bridge the gap between developing a solution and implementing the solution in order to effect change.

PROBLEM AWARENESS AND GAP IN KNOWLEDGE

Difficulties to achieve success in top-down or one-way implementations of solutions are not unfamiliar to many companies undertaking efforts to implement lean. In any organization, different people have different interests and agendas. Those who are passionate about any change in the organization have a vision. This vision will be embraced by those who see it as supporting their interests and opposed by those who do not (Liker and Meier 2006). The degree of support and opposition will vary depending on a number of factors, such as how strongly it supports or violates interests and beliefs, how strongly those are held, and the degree to which the organizational culture supports alignment around common goals (Liker and Meier 2006). Change should always be pursued with caution. Push it too hard, violate too many interests, and you will create a block of organized resistance that can stop the change process in its track (Liker and Meier 2006).

In search for an alternative to the implementation approach used in Case 1, we came across different studies that emphasize two main aspects: (1) engaging teams in the transformation effort, and (2) having leaders as mentors.

Two research projects dedicated to understand the elements that contribute to achieving successful businesses transformations emphasize the humble leader who supports teams moving in a desired direction as a key component of success (Logan et al. 2008, Collins 2001). Bennis and Biederman (1997) challenge leadership as an inherently individual phenomenon. They argue that the myth of the triumphant individual is deeply ingrained in the American psyche, while, in contrast, throughout history, groups of people, often without conscious design, have successfully blended individual and collective effort to create extraordinary things.

The idea that groups can help people learn, bring out the best in people, and create much of what is good in the world can be traced back to the 1960s, with the group dynamics and humanistic psychology movement (Dyer et al. 2013). This movement emerged as a result of the large oppression seen in organizations, that was stifling

creativity and innovation. Within this context, the T-groups emerged (T stands for training). The assumption underlying T-groups was that individuals and particularly organizational leaders were impaired by the authoritarian assumptions they held about those they worked with and needed to change their assumptions about people and ways of doing work. Traditionally, managers in organizations operated using theory X assumptions (people are basically untrustworthy and lazy) but should have been basing their actions on theory Y assumptions (people essentially are good and want responsibility) (McGregor 1960).

In his book *Drive,* Pink (2007) suggests that the secret to outstanding teams is motivation 2.0: an intrinsic motivation to accomplish something great, rather than incentives and punishment (motivation 1.0). The idea of being intrinsically motivated towards achieving a goal can be traced back to the theory of goal setting, developed by Locke and Latham in 1990. Teams achieve higher performance when they have a set of goals to pursue (Locke and Latham 2013).

Those studies provide support for what Rother (2010) describes as Toyota's unique way to lead, manage, and develop people, that produces improvement, adaptation, and superior results: the Toyota Kata. Kata are improvement and leadership routines, described as follows:

Toyota's improvement kata is a continuously repeating routine (1) in consideration of a vision, direction, or target, and (2) with a first-hand grasp of the current condition. (3) A next target condition on the way to the vision is defined. When we then (4) strive to move step by step toward that target condition, we encounter obstacles that define what we need to work on, and from which we can learn.

To ensure that improvement happens and that people internalize the continuous improvement process Toyota emphasizes 'doing:' managers and leaders at Toyota teach people by guiding them in making real improvements in real processes (performing an actual activity over and over, under the observation and guidance of an experienced mentor).

RESEARCH OBJECTIVE

The difficulties to implement lean construction observed in Case 1 and in the literature review that was carried out in search for a solution, motivated us to start a journey towards implementing lean through a mentoring approach. The objective of Case 2 was to support the concrete team to develop desired lean behaviors, i.e., focus on process improvement based on continuous cycles of revealing problems and discussing root causes, brainstorming solutions, learning, and consequently changing current practices.

RESEARCH METHOD

The learning from Case 1 motivated an intervention in the second project undertaken by the concrete division (Case 2). This second project differed from the first in that the superintendent already had experience with lean construction. An opportunity was identified to introduce lean concepts and bring all team members on board by introducing lean behaviors through mentoring. Developing the desired lean behaviors in the team was a major goal of this intervention, this included: (a) creating the ability

to reveal problems in a blame-free environment, (b) focusing on learning and continuous improvement, (c) promoting the ability to acknowledge problems and work on their solution as a team, and (d) coupling learning with action.

In order to achieve that, some strategies were planned: (a) adoption of the Last Planner™ System (LPS) for the concrete scope of work, (b) lean training focused on behaviors (no blame culture, focus on learning, open communication, reliable promises and collaboration), and (c) realization of continuous improvement workshops.

Figure 1 shows the implementation timeline. The intent of the lean training was to coach project participants on lean principles and desired behaviors. The LPS along with visual management helped to improve collaboration between the concrete team and the subs and GC. The continuous improvement workshops had as intent to improve communication among concrete team members and create a shared understanding about the desired behaviors we were trying to create in the project. Although it was called a continuous improvement workshop, in this project we carried out only one workshop due to time constraints. The results were used to develop a lessons learned document, used in the next project.

Project Execution	Feb (start)	Mar	April	May	June	July	Aug (end)
LPS	x	x	x	x			
Training				x	x	x	
Cont. Imp. workshop					x	x	x

Figure 1: Implementation timeline

The authors chose to study the contributions of a mentoring approach to implement lean construction by using action research. Because the implementation of would require participation and exploration by all members of the project team (Greenwood et al. 1993), it was decided that action research was the most appropriate methodology to use for research of this nature.

Action research can be focused on a single project, but differs from more familiar case study research in that "the researcher is not an independent observer, but becomes a participant, and the process of change becomes the subject of research" (Benbasat et al. 1987; Westbrook 1995).

In order to evaluate the impacts of the intervention made in this project, some criteria to gauge success were established. The assumption behind such criteria is a cause and effect chain with the ultimate goal of changing team's behavior: (a) team openness to change (acceptance to engage in research effort), (b) change in use of language (adoption of lean concepts and understanding of other team members concern), (c) change in understanding (ability to understand problem systemically considering other member's input), and (d) change in behavior (team's attempt to couple learning to action).

Data was collected by means of participant observation and face-to-face interviews. Participant observation was carried out from mid-March to mid-August. The researcher was present at the job site twice a week for 8 hrs (16 hours total). Activities developed included attending the subcontractor coordination meetings,

facilitating weekly meetings between the concrete team and steel, shotcrete and MEP subcontractors, facilitating workshops, and creating a lessons learned document. Interviews were carried out after project completion and covered the benefits and challenges of the intervention as perceived by key players. Project team members who participated in this study were:

- Project executive (previous owner of concrete company – no experience with lean),
- Project manager (previously working for concrete company – no experience with lean),
- Project engineer (temporarily assigned to this project – no experience with lean),
- Superintendent with concrete expertise (no experience with lean),
- Superintendent with lean experience (temporarily assigned to this project, with extensive experience working for GC and lean implementation)
- Superintendent from previous project, in which the problem was identified
- Researcher (Postdoctoral scholar supporting lean implementation on this project)

RESEARCH FINDINGS

CASE 1 - PROBLEM IDENTIFICATION

The motivation for this research was the improvement of cost performance in concrete projects carried out by a general contractor firm. This first case was carried out to further understand the problem and develop the rudiments of a solution. The research started with the observation of an ongoing project and analysis of crew's performance in the field. A detailed cycle plan for the execution of the concrete structure was developed by the team to maximize productivity. However, consensus was not reached about the best approach to solve the problem in hand, and the devised plan for execution was not implemented.

The main lesson learned in this project was the importance of involving all relevant stakeholders (top managers, mid managers, field supervisors) to collectively endeavour continuous improvement efforts: observing and acknowledging problems, understanding and agreeing on their root causes, brainstorming and developing possible solutions and most importantly, committing to work together towards the solution. In order to do that, there was a need to establish a communication channel, a decision-making system that allows decisions to be made by consensus, and a team that is committed to a continuous improvement effort.

CASE 2 – SOLUTION DEVELOPMENT

The intervention in Case 2 started with the implementation of the Last Planner System (LPS). Although the implementation was targeting only a portion of the project (concrete work) the rationale behind using the LPS was to improve the quality of work assignments to the concrete team and to establish a discipline of learning and

continuous improvement as a team. In parallel to the adoption of the LPS, a continuous improvement workshop was held involving field supervisors, project manager, project engineer and key participants in the planning phase, i.e., project executive and estimator. The implementation process was led by the researcher and the superintendent, who assumed a role of "lean mentors" to team members that had not been exposed to lean before. The observed results are described next.

Lean Mentoring

Differently from Case 1, improvement efforts started in the field and were led by the researcher and the superintendent. Both researcher and superintendent planned and implemented the activities based on an assessment of their contribution to the execution of work in the field. This was the first agreement made between them and communicated to the team: *"we will implement only techniques that will truly add value to the field."* This was key for the positive outcomes achieved in this study. The researcher was assigned full-time to the project, spending half of the time in the field and half in the office.

The superintendent had vast experience in implementing lean construction and assumed the role of a mentor in the field. The researcher also got involved in providing lean training for the office staff and helping the concrete division in adopting tools to support the practical application of lean principles.

Last Planner™ System (LPS)

The LPS was at the core of this implementation. It was implemented with as main intent to improve the quality of work assignments in the concrete cycle plans. The implementation focused on developing cycle work plans (similar to weekly work plans) based on the schedule that was agreed to with the General Contractor (GC). By contract, concrete should be poured every 10 days, so 10 day cycle plans were developed each week, after confirming the schedule with the GC and other trades.

Every week, the team would meet to review the work plan for the next cycle and discuss the performance indicators on the past cycle (analysis of Percentage of Plan Complete—PPC—and reasons for plan deviation). In the beginning PPC was calculated based on deviation-or -not of concrete pouring dates (similar to reviewing weekly PPC). Although such a metric is useful to keep track of missed pour dates, it poorly supported the understanding of reasons for plan deviation. The team then agreed to track daily deviations[1], which allowed them to better reveal problems that they could act upon. As a consequence, PPC dropped from 80% to 33% from cycle 2 to cycle 3. This generated a better opportunity to discuss reasons for plan deviation. The observed causes of that drop in PPC were discussed with subcontractors and solutions developed and agreed upon in a team effort.

Focusing on the learning aspects of the LPS and acting on the reasons for deviation allowed the team to gradually improve PPC from 33% in cycle 3 to 45% in cycle 4 and 78% in cycle 5. The reason for that improvement was better communication with the subs and agreement on how to improve workflow reliability.

[1] Tracking daily deviation meant that if work was planned to be finished on Tuesday, it had to be finished by Tuesday in order to not affect PPC negatively.

Figure 2 shows an effort to improve workflow reliability and the resulting plan, which was signed by all participants in the meeting.

Figure 2: LPS meeting with subcontractors

The researcher also joined the team for the weekly coordination meetings in the field. This allowed an increased communication with the project manager from the GC side regarding the cause of emerging problems and how to solve them. The concrete team demonstrated interest in the GC's opinion about how to improve work. As a consequence, the GC gave constructive feedback and an environment of open communication and mutual respect was observed during the research.

The LPS weekly meetings also allowed more discussion about emerging problems and the need to acknowledge and solve them. A change in production sequence decided by top management required the field to acquire more material, which caused an impact on costs. The root cause of those impacts on costs were often not acknowledged or agreed to by all team members. As a consequence, awareness was created that in order to achieve real improvements, the efforts to implement lean should include not only team members involved in the execution phase, but also team members involved in pre-planning activities . A better communication channel was needed between office and field in order to achieve a comprehensive continuous improvement effort. The activities undertaken in that direction are described in the following section.

Continuous Improvement Workshop

One major problem observed in the field was caused by a decision made in the pre-planning phase. In order to improve team performance as a whole, field supervisors brought up the need to involve those team members in the continuous improvement activities. A decision was made to carry out a workshop, involving not only field staff but also those team members responsible for the pre-planning phase.

A total of 10 people participated in the workshop: project manager, project executive and estimator, project engineer, the two site supervisors and one site supervisor from the previous project who volunteered to participate. The project manager from the GC side also participated in the workshop and later on also in the survey.

The team was requested to answer a specific question: *"What is important for you to consider a concrete project a success?"* Data was analysed and compiled in a

matrix. A total of 83 statements were captured, along with their meanings. A workshop was then carried out to discuss the statements collected and group them by similarity. The workshop lasted for 3 hours and generated 29 criteria to improve project performance (Figure 3).

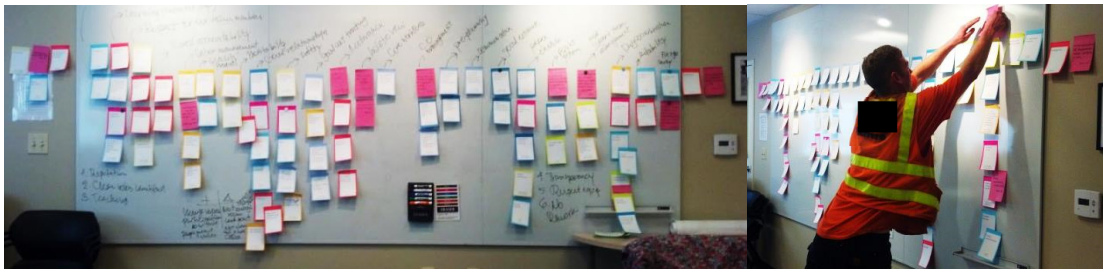

Figure 3: Building a shared vision of success

After this workshop, an exercise was carried out to identify the key drivers that would contribute to achieve the end results. The exercise followed a similar process as the one suggested by Morgan and Brenig-Jones (2012 p. 31). Subsequent actions where directed to improve some of the key drivers observed, i.e., transparency, good communication, learning, good relationships, motivation and field support from management. For instance, a greater focus on visual management to support field activities and increased communication to support production planning and control were results of this exercise.

A survey was also sent to all key players based on the identified criteria. The results were analysed and summarized in the chart shown in Figure 4, where the blue line represents performance indicators from 0 to 1 for each criterion.

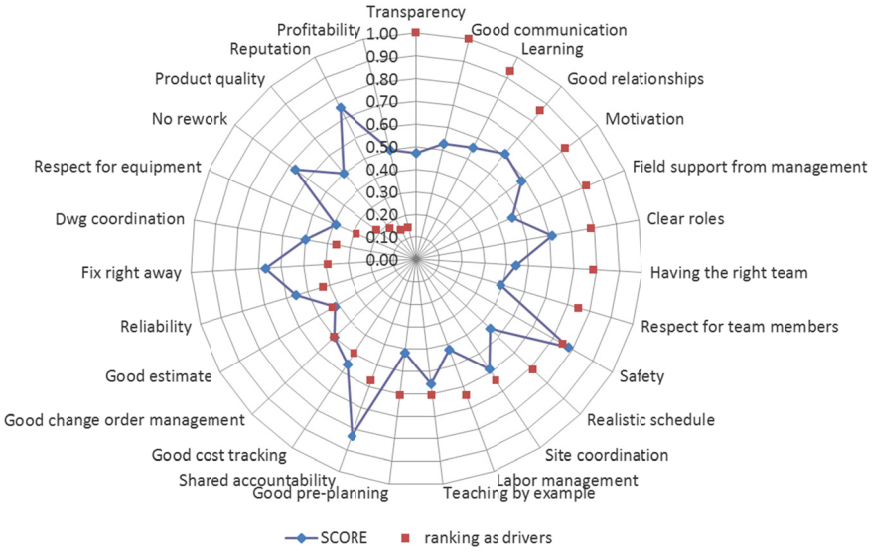

Figure 4: Survey results

Because the evaluation was carried out in June and the project was expected to finish in July, the team decided to use the results of the survey as a starting point for a lessons learned effort that would be taken to the next project. A workshop to discuss

the lessons learned was carried out. Based on the results of the workshop and follow up emails, the team developed a matrix with 77 countermeasures to current practices that could be improved. Those countermeasures would be adopted in the next project.

These countermeasures were grouped into categories shown in the chart shown in Figure 5. The blue line in the chart shows how many actionable items were included in each category. Having the team's input on this lessons learned exercise provided a more systemic perspective of opportunities for improvement and potential solutions to mitigate observed problems. Based on gathered data, the most important aspects to improve project performance are: developing leaders standard work, training, better production system design and adequate update of that design based on opportunities, and having an integrated team (first and last planners) engaged from the beginning on production planning and then production control.

Figure 5: Countermeasures organized by categories

TEAM'S EVALUATION OF THE RESEARCH

When the superintendent was interviewed about the outcomes of this study, the discussions enabled by the weekly meetings at the job site were the most beneficial aspect of the intervention from his perspective:

*"I remember sitting down on that picnic table**, discussing real issues to be addressed.** People started to **acknowledge things and decide** how to move forward."* – Superintendent

*"Some team members learned for the first time **that it is OK to talk about problems.** We could see his change in behavior as he started to get used to a lean environment."* – Superintendent

During participation in field meetings, improved collaboration was observed between the different superintendents of the concrete division and between the superintendents and the other partners in the field, especially the general contractor. The project manager from the general contractor side was an active participant in the continuous improvement effort, participating in the survey and providing his opinion on the concrete team's performance in a very constructive way:

*"We **increased interaction and communication** not only with the team, but with our GC, our subs, and that was very beneficial to the project."* – Superintendent

*"I observed that **communication and relationships were much increased**, especially between the two different superintendents who have different backgrounds and between the superintendents with the office staff."* – Concrete project manager

The continuous improvement workshop allowed all team members responsible for project success to be involved in the learning process. One contribution of this exercise was a better understanding of each other's perspective:

*"Having people's input was very beneficial for the project. It helped me manage the project more efficiently as everybody **became aware of what my intention was and what were the priorities**."* – Concrete project manager

*"The upper management is always concerned about field workers being careful with tools, which are expensive for the project. **It was nice to see that a superintendent brought that up.** Apart from that, I really appreciated **new values that were brought up** and I haven't thought about."* – Concrete project manager

One challenge of the continuous improvement workshop was brought up by a team member in what regards to truly acknowledging problems and root causes. What we learned is that we need to prepare the team to face and acknowledge that a problem has happened. If we do not have that acknowledgement, we cannot find the means for solving it in a collaborative manner. We learned that the starting point for that is to create an environment that is blame-free and focused on learning, in which team members feel comfortable to share problems and explore their root causes.

CONCLUSIONS

Observed in this case study was the establishment of a learning team, in which change and improvement was achieved by means of a team effort through talking about problems, analyzing their causes and developing solutions. The mentality to achieve something good and for the benefit of the whole team helped to persuade team members and other participants in this research to join the effort. Such mentality allowed the superintendent on this project to be recognized as a leader and have others following his example.

A factor contributing for the positive impact of this study was the establishment of a collaborative environment in the project, which itself was a result of a combination of factors. Those factors include the team's participation in the training together with those responsible for lean implementation, the presence of a lean mentor who was recognized as a leader in the field, and the establishment of a blame-free learning environment. The combination of these factors contributed to a 'mission-to-accomplish' feeling among team members and it was key to the increased collaboration and the desire to change things for the better.

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