

Lean Principle - An Approach towards Effective Construction Management

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Abstract—From the past few years, the productivity of construction industries at the global level has been declining. Lean construction is a better approach to improve the situation. Lean construction results from the application of a new form of production management to construction. Lean construction have some essential features which include construction, concurrent design, aimed at maximizing performance for the customer at the project level, a clear set of objectives for the delivery process, and the application of project control throughout the life cycle of the project from design to delivery. In general, lean construction projects are easier to manage, safer, completed sooner, and cost less and are of better quality.

Keywords: *Lean principles, Lean Construction, Lean implementation techniques.*

1. INTRODUCTION

Lean principle was invented for manufacturing industries but in present, time has changed the world of knowledge work and management. It inspires the practice of continuous change for the better. Womack and Jones gave the five principles of Lean manufacturing in their book “The Machine That Changed the World”. The five principles are considered a recipe for improving workplace efficiency and include: 1) identify value, 2) mapping the value stream, 3) creating flow, 4) using a pull system, and 5) pursuing perfection.

Identify Value: Value is what the customer is willing to pay for. It is most important to discover the actual needs of the customer. Sometimes customers may not know what they want or are unable to illuminate it. Interviews, surveys, demographic information, and web analytics are the techniques that can help you to solve and discover what customers value. By using these techniques you can reveal what customers want, how they want the service to be given, and the price that they can afford.

Map the Value Stream: In this principle, the goal is to take a reference point by using customer's value and identify all the activities that come up with these values. Some activities considered as waste which do not add value to the end customer. There are two categories of waste: non-valued added but necessary and non-value & unnecessary. You can check that what customers are getting exactly is what they want by reducing and eliminating unnecessary processes, while at the same time reducing the cost of producing that product.

Create Flow: The flow of the remaining steps needs to run smoothly without interruptions or any delays, after removing the wastes from the value stream. Some strategies like leveling out the workload, breaking down steps, creating cross-functional departments, reconfiguring the production steps and training employees to be multi-skilled and adaptive are for ensuring that value-adding activities flow smoothly.

Establish Pull: The biggest waste in any production system is listing. The goal of a pull-based system is to limit listing and work in process (WIP) items while ensuring that the requisite materials and information are available for a smooth flow of work. The needs of the end customers are the key to create pull-based system. Customer needs can be satisfied through value stream and working backwards in production system.

Pursue Perfection: Wastes are prevented through the achievement of the first four steps: 1) identifying value, 2) mapping value stream, 3) creating flow, and 4) adopting a pull system. However, the fifth step of pursuing perfection is the most important among them all. It makes Lean thinking and continuous process improvement a part of the organizational culture. Every employee should strive towards perfection while delivering products based on the customer needs.

The use of lean principle in construction activities is also known as “Lean construction (LC)”. Lean construction (LC) is a method of projected aimed at reducing costs, materials, time and effort. Essentially, the methodology is to decrease the bad and increase the good. Through the use of principles of lean-construction, the desired outcome would be to maximize the value and output of a project while minimizing wasteful aspects and time delay. This outcome is produced when standard construction approaches are merged with a clear and concise understanding of project materials and information and two sets of management archetypes, planning and control. This may seem complex to understand, but the essence of this system to use what is necessary without extra. This can only be done by strategic planning and action by a management group and with the help and aid of all workers.

2. OBJECTIVES

- To study lean principles and its methodology.
- To study existing application of lean principles in construction.

3. LITERATURE REVIEW

O. Salem¹, J. Solomon², A. Genaidy³, and M. Luegring⁴ conducted A field study to evaluate the effectiveness of some lean construction techniques including last planner, increased visualization, daily huddle meetings, first run studies, the 5s process, and fail safe for quality. The data collection methods included direct observations, interviews, questionnaires, and documentary analysis. The effectiveness of the lean construction tools was evaluated through the lean implementation measurement standard and performance criteria. It was found that last planner, increased visualization, daily huddle meetings, and first run studies achieved more effective outcomes than expected. (1)

Devin J Merker take two construction companies, a leading lean contractor and a non-lean contractor, were interviewed to evaluate the different lean construction “journeys” taken by each company. The interviews and analysis in this study primarily focus on the lean culture, use of lean construction tools, common barriers, lean education, and industry outlook from each of the companies.

O. Salem, M.ASCE¹; J. Solomon²; A. Genaidy³; and I. Minkarah, M.ASCE⁴ gives techniques developed for lean construction which can be used in construction industry. They also give the difference of lean construction tools like last planner, five S’s, huddle meetings, etc.

Subhav Singh¹, KaushalKumar² provides a review of the literature using a systematic literature review of the lean tool and lean construction papers published in the time frame from 2008 to 2018. The findings of the study conclude that only a few tool and techniques were explored a number of times by the researchers. On the other hand, few countries were

dominating in terms of publication were the UK, and the USA has 15, 14 article respectively. (4)

Remon Fayek Aziz¹, Sherif Mohamed Hafez² discuss principles, methods, and implementation phases of lean construction showing the waste in construction and how it could be minimized. The Last Planner System technique, which is an important application of the lean construction concepts and methodologies and is more prevalent, proved that it could enhance the construction management practices in various aspects.

4. CASE STUDY

Finds a case study in which a general contractor (GC) implements and assesses the values of different lean construction techniques. The GC follows the human and technical learning through the implementation of lean construction. The GC agreed to implement and test six lean construction techniques which are: last planner, increased visualization, first-run studies, huddle meetings, the five S’s, and fail-safe for quality.(3)

4.1. Last Planner

4.1.1 Reverse Phase Scheduling: All subcontractors were encouraged to prepare a chart of their schedule on a wall display. Subcontractors could see how their planned schedules affected the completion time of a particular part of the project. Within a few weeks, planners started to rely on reverse phase scheduling to estimate activity durations instead of going back to the original master schedule.(3)

4.1.2.6-Week Look-Ahead: The project manager was not familiar with the look-ahead schedule, so the research team prepared the first look-ahead schedules. Once the project manager realized that the look-ahead schedule could provide an updated picture of the project assignments to be completed, he started to prepare it regularly. The project manager focused the constraint analysis on material issues. (3)

4.1.3. Variance Analysis: Cost variance was the only performance indicator at the start of the project, so it was difficult to introduce the variance of assignments as a meaningful performance measure. When assignments were not completed on time, the project manager provided the immediate cause, e.g., weather conditions or scheduling. By the end of the study, the project manager was able to identify the root causes of variances and set action plans to deal with delays.(3)

4.1.4. Percentage Plan Completed Charts: The research team prepared percentage plan completed (PPC) charts at two levels: project and subcontractor. Subcontractors were concerned about their weekly PPC value, so they tried to improve the quality of their own assignments. During the study, the project staff prepared the PPC charts and posted them in the site trailer.(3)

4.2. Increased Visualization

4.2.1. Commitment Charts: The GC's vice president addressed the project personnel to emphasize the importance of their safety to the company. The attendees were asked to give examples of how to maintain safety practices on a job site. At the end of the presentation, a commitment pledge was signed by all employees and posted in the trailer throughout the project.(3)

4.2.2. Mobile Signs: The project personnel provided their input on the design of the safety signs. After a brainstorming session, mobile signs were designed and later posted on various areas of the site. Most of them used colorful and funny expressions to attract the attention of all people on the job site.(3)

4.2.3. Project Milestones: The project personnel were not regularly informed of completion dates at the beginning of the study. Once the signs were designed, completion dates were plotted and posted floor by floor throughout the project. At the end of the study, most workers stated that they felt more involved in the execution of the project.(3)

4.3. Huddle Meetings

4.3.1. All-Foreman Meetings: An informal meeting of all project foremen was replaced with the weekly work plan meeting, which focused on the completion of assignments during the following week. The discussions during the meetings addressed overlapping activities and identified potential problems on the job site. Actions agreed to at the meetings were recorded in minutes and were reviewed the following week. (3)

4.3.2. Start-of-the-Day Meetings: Project personnel met at the beginning of each workday for 5 to 10 minutes to review the work to be done that day. Scheduling, safety, and housekeeping were the most common issues to arise during these meetings. Based on job surveys, at least 67% of the workers found value in the meetings. More than 42% of the workers provided some feedback during the meetings. Most of them stated that they are more likely to talk directly to their foremen during that time of the day. (3)

4.4. First-Run Studies „Plan, Do, Check, Act...

4.4.1. Plan: Two assignments were selected with input from the foreman, superintendent, and project manager: installing bumper walls and construction joints. Bumper wall installation was chosen because it is a high-cost activity, and construction joint installation was selected because of its high variability. (3)

4.4.2. Do: One flaw in the documentation was that most of the input came from the foreman instead of from the crew. The crew was focused exclusively on the completion of the task. The description of the activities could have been more detailed with input from the crew. (3)

4.4.3. Check: The work performed was checked in a formal meeting attended by the project manager, the foreman, and the

crew. The research team led the meetings, looking for potential improvements and learning opportunities. Most of the participants tried to give their best suggestions as to what could be improved for the next repetition of the assignment. (3)

4.4.4. Act: Ideas suggested during the meetings were tested by the same crew, with support from the project manager and the foreman. The results showed more than 38% reduction in the cost of crash walls and 73% reduction in the cost of construction joints after the studies were completed. The actions implemented included new methods, changes in the composition of the crew, and a better sequence of activities. (3)

4.5. Five S's

4.5.1. Sort: The first level of housekeeping consisted of separating material by reference and placing materials and tools close to the work areas with consideration of safety and crane movements. (3)

4.5.2. Straighten: Next, materials were piled in a regular pattern and tools were placed in gang boxes. Each subcontractor took responsibility for specific work areas on the job site. (3)

4.5.3. Standardize: The next level included the preparation of a material layout design. The layout contained key information of each work activity on the job site. The visual workplace helped locate incoming material, reduce crane movements, and reduce walking distance for the crews. (3)

4.5.4. Shine: The next step consisted of keeping a clean job site. Workers were encouraged to clean workplaces once an activity had been completed. A housekeeping crew was set to check and clean hidden areas on the job site. (3)

4.5.5. Sustain: The final level of housekeeping sought to maintain all previous practices throughout the project. At the end of the project, this level was not fully achieved, in part because project personnel did not view housekeeping as a continuous effort. They had to be reminded frequently of housekeeping practices. (3)

4.6. Fail-Safe for Quality

4.6.1. Check for Quality: An overall quality assessment was completed at the beginning of the project. Most quality issues could be addressed by standard practices, and it seemed there was little room for improvement. During the execution of the project, however, some critical items appeared. (3)

4.6.2. Check for Safety: Safety was tracked with safety action plans, i.e., lists of main risk items prepared by each crew. Potential hazards were studied and explored during the job. Most hazards, such as eye injuries, falls and trips, and hearing loss, have standard countermeasures; however, in practice, workers have to be reminded of safety practices.(3)

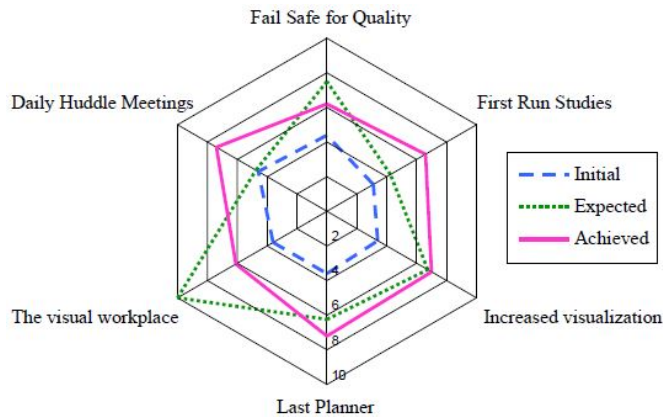


Figure-1 Implementation tools – Spider Web Diagram

5. MAJOR FINDINGS

- Last planner is a commonly used technique in lean construction methodology by the contractors and it is easy to understand.
- All the workers including managers and contractors need to take a daily look at the plan and check that they stick to the plan or not.
- Five S's is easy to understand but difficult to manage and apply in large scale projects.
- First run studies can be done in every scale of project as it is easier to plan, do, check, act in sequence. Normal level or small contractor can use it.
- These techniques are easy to understand but when it comes to actual application on the field, so many challenges are there for the planning team and the contractor also.

6. CHALLENGES FOR APPROACHING LEAN CONSTRUCTION TECHNIQUES

- **Control:** Causing a chain reaction of events to conform to a given plan or structure.
- **Directives:** An order issued by a group leader or manager that directs workers on what or how to do a particular activity.
- **Input:** The combination of directives, prerequisites and resources required for a project.
- **Output:** The final product resulting from the given project.
- **Prerequisites:** Information or work done by others that is necessary for the project.
- **Production Units:** A group of workers in a particular area, such as electrical engineers who work on one phase of the project, that depends on shared information, skills and materials.

- **Resources:** Things like Labor, tools, equipment and space, or anything that is needed for a project. Materials and information are not considered resources but these are what resources act on.
- **Work Flow:** The passage of information and materials through production units, which transfers the information downstream.

7. CONCLUSION

As per the study, lean construction techniques can be used in India as it can majorly reduce the time and cost. It also helps in managing the whole construction work as per design schedule. In India huddles meeting and last planner can be adopted in construction industry for a better future and growth.

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