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APPLICATION OF LEAN TECHNOLOGY IN CONSTRUCTION INDUSTRY

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Abstract- This article shows the theoretical background of techniques used for lean implementation. Many lean construction tools and techniques are in embryonic state, but they are getting popularity because they affect bottom line of project. Among the existing management system and concepts for better management of project and good economic status of project we are implementing lean tools. This article explains last planer system, increased visualization, First-Run study, Huddle meetings, Five S's and Fail-safe quality.

Keywords: Last Planner, WWP, PPC.

I. INTRODUCTION

Koskela introduce idea of construction as production. lean production tools are not directly used to construction industry. There are many tools in production industry but we are not using these tools in construction industry. These tools required some modification for implementation in construction industry. In lean, there are up to 40 tools but all tools are not more effective.

External delay sources

In world many construction projects are delays due to many problems such as political problems, economic problems; therefore, there is need to understand these problems carefully. The factor which are affected are depend on external or internal sources.

These sources include political, economic, social, technological, legal and environmental. Simply called as „PESTEL". There are the main sources of construction industry.

Total lean construction tools

Extended lean construction tools

1	Fail Safe for Quality	21	Last Planner System (LPS)
2	Construction Process Analysis	22	Check Sheet
3	5S	23	Kaizen
4	Work Structuring	24	FIFO line (First In, First Out
5	Statistical Process Control	25	Set up reduction
6	Concurrent Engineering	26	Bottleneck Analysis
7	Muda Walk	27	Suggestion schemes
8	5 Whys	28	Multi Process Handling
9	Synchronize/Line Balancing	29	Check Points & Control Points
10	Heijunka	30	Preventive Maintenance
11	Failure Mode and Effects Analysis	31	Kanban (Pull System)
12	Team Preparation	32	Work Standardization
13	SMART Goals	33	Visual Management
14	Total Productive Maintenance (TPM)	34	Poka-Yoke (Error Proofing)
15	Time and Motion Study	35	Six Sigma
16	Value Stream Mapping	36	Daily Huddle Meetings
17	Just-In-Time	37	Root Cause Analysis
18	First Run Studies	38	PDCA (Plan, Do, Check, Act)
19	Pareto Analysis	39	Jidoka/Automation
20	Continuous Flow	40	Quality Function Development (QFD)

II. METHODOLOGY

Project Details

Location- Keshav Nagar, Mundhva, Pune
Total area of plot-18,70,767.63sq.ft. Total deduction-1,64,806.24sq.ft.

Total gross plot area-17,05,961sq.ft.
Total amenities space 15%-2,55,890.44sq.ft.
Total net plot area-13,05,059.55sq.ft.
Project Start Date- 30.04.2016 Baseline
Finish Date- 31.05.2019

1.1. Last planner system

The most effective tool in lean construction is last planner system. This tool contains other some tools which are Master schedule, Reverse phase schedule(RPS), Six week look

ahead(SWLA), Weekly work plan(WWP), Percentage plan completed(PPC). The sequence of implementation is Master schedule, Reverse phase schedule(RPS), Six
week look ahead(SWLA), Weekly work plan(WWP), Percentage plan completed(PPC). Sequence of implementation set up an efficient schedule planning.

1.1.1. Master schedule

This gives us over all project schedule with mile stones. Reverse phase schedule is based on master schedule.

Ex. 17 story building (RCC work)

1st sub substructure- 45 days up to plinth level
First slab- 21 days
Second slab-15 days
Third slab -10 days
LMR to OHWT- 30 days
Total – 260 days (8m 20 days)

1.1.2. Reverse phase schedule (RPS)

Pull technique is used to develop a schedule that works backward from completion date by team planning. The reverse phase scheduling is developed by a team consisting of all the last planners. Without considering actual field factor reverse phase scheduling is less accurate than weekly work plan.

Ex. Top slab of OHWT- 20Daysin Hand Back Calculations

Top slab of OHWT	Shuttering	R/F	Concreting
Side Wall of OHWT	R/F	Shuttering	Concreting
Bottom Slab	Shuttering	R/F	Concreting
Bottom slab of LMR	Shuttering	R/F	Concreting

4days – for concreting
2days for shuttering and R/F
Then back calculations

1.1.3. Six week look ahead (SWLA)

Six week look ahead shows kind of work supposed to be done in future means in next six weeks. In look ahead window, the first week comes after WWP meeting. For design process, the look ahead window could be 3 to 12 weeks. (Ballard 2000) All six week look ahead duration and schedule were based on Reverse phase schedule. This tool reduces the uncertainty of work.

1.1.4. Weekly work plan (WWP)

The key terms in this tools are should, can, will. „Should" can indicate work that require to be done according to schedule requirement. „Can" indicate the work that can actually be accomplished. „Will" reflect the work commitment which will make after all constraints are taken into account. This tool is similar to kanban system. Based on SWLA, actual schedule, safety issue, quality issue, material need, manpower, construction method, backlog of ready work and problem that occurs on field.

This promotes two-way communication and team planning. It improves safety quality, the work flow, material flow, productivity and relationship among team members.

1.1.5. Percentage plan completed (PPC)

This tool is the measurement matrix of LPS. we calculate PPC taking percentage of number of activities that are completed as planned by total number of activities that are planned at that period.

Number of activities that are completed as planned/ total number of activities that are planned at that period. X100

These values are highly variable and usually range from 30%-70% without lean implementation. To achieve higher values i.e. more than 70%, implement lean tools.

X PPC- Actual /plan =10/9=0
Y PPC- Actual /plan = 11/11=100
Z PPC- Actual /plan =15/15=100
PPC- Actual /plan =2/3=67%

1.2. Increased visualization

Communicating key information effectively to the work place through posting various signs. These sign help to communicate with labor and other staff. From these sign we give safety instruction, quality instruction and other important instruction. Labels around construction site. Worker can remember element such as workflow, precaution, real process of any activity.

1.2.1. Mobile signs

Mobile sign are designed and posed on construction site for better understanding of workers.

1.2.2. Project milestone

The project completion date sign board is posted on site everywhere which help to more involvement of worker in project execution on time.

Figure 1.Project outcome statement

1.3. Huddle Meetings

Daily startup meetings are conducted on construction site. Where team members give the status of work and that days planning to labors as and site staff. In this meeting staffs are included. This is the open communication.

Figure 2. Huddle meeting

Progress control board

These boards include the tasks which are to be performed at the particular day according to the planning and are updated twice in a day; initially after the lunch and secondly at the end of the day. If the task remains incomplete at the end of the day then RNCs (Reason for Non-Compliance) are written in front of the task and discussion is also held next morning how to overcome the delay and what can be done to prevent the same in the future.

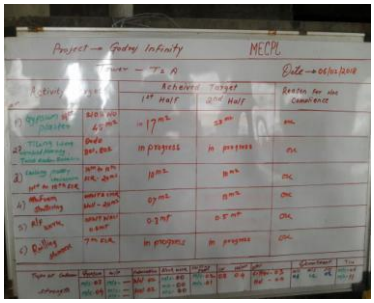

Figure 3.Progress control Board **1.4.**

First run studies

This is use for redesign the critical activities. Studies commonly used videos files, photos and graphics to show process or illustrate the work instruction. PDCA (plan, do, check, act) is suggested to develop the study.

1.4.1. Plan

First select work process to study. Assemble people for task then analyze process steps and try to eliminate steps.

1.4.2. Do

Try out ideas on first run **1.4.3.**

Check

Check for safety, quality and productivity.

1.4.4. Act

Communicate the improved method.

1.5. Five 5's

The 5"s process is about "a place for everything and everything in its place" This tool improve safety, productivity, quality and set up times improvement. Reduce cycle time.

1.5.1. Sort (Sari)

Separating needed tools or part and remove unnecessary material. Housekeeping must be proper.

1.5.2. Straighten (Seiton)

Neatly arrange the tools and materials for ease of use. Stack them properly.

1.5.3. Standardize (seiketsu)

Maintain the first 3s.

1.5.4. Shine (seiso)

Clean up the area where work is ongoing.

1.5.5. Sustain (shitsuke)

It refers to create the habit of conforming to the rules.

1.6. Fail – safe for quality

Shingo (1986) introduce Poka-Yoke device as new element that prevents defective part from flowing through the process. Fail safe for quality relies on the generation of ideas that alert for potential defects. Both elements safety and quality requires action plan that prevent bad outcomes. Safety is track by safety action plan i.e. list of main risk items prepared by each crew.

Waste Management

Steel

Waste Management Charts – Waste Management Charts are also displayed at each tower which shows the eight types of wastes. Which focus on reducing the wastes in the process in order to generate more value thus increasing the productivity.

Scrap recycle chart is also being displayed at the steel yard showing where and which shape the scrap steel can be reused. There has been a significant reduction in the wastage of steel which has been reused from scrap in the form of hooks, small stirrups, chairs etc.

Figure 4 Steel Management

Concrete

Even waste concrete is being used for making paver blocks in front of offices and labour camp

2. Record collected

Record collected include

Last planner: meetings memos and various forms of schedule, action task with duration, action task with duration, actual completion dates, reason for not completing assignment as planned.

Increased visualization: photos and documents of implementation process.

Daily huddle meetings: meetings minutes and result of interviews

First run interviews: videos, photos, field observation data for crew productivity study, working procedure and estimated and actual unit cost for studied items.

The 5's process: photos, meeting minutes.

Fail safe for quality: photos, recommendation for quality improvement.

III. CONCLUSION

This paper reviewed the effectiveness of lean construction tools that are suitable to apply in construction firms.

The last planner system is mostly useful tool in lean tools.

Training is a key aspect of implementation and success of last planner system at site

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