# A STUDY ON IMPLEMENTATION OF LEAN PRINCIPLES AND PRACTICES IN A CONSTRUCTION PROJECT

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**Abstract**
**Modern Projects in India are facing various delays and other time consuming issues, such as delay in completion, repeated works, poor workmanship these things in return affects not only the project but also the value of the firm. The aim of the study is to implement the lean tool for overcoming these problems, based on the literature studies, the suitable lean tool identified was Last Planner System. The strategy undertaken to implement LPS is the collection of various data, preparation of schedules, interactions and discussions with the engineers and the workers.**
**Keywords**
**Last Planner System, Percent Plan Complete, Schedule, Grade Separator**

## Introduction

India as a developing country faces many problems in construction industry such as lack of detailed and documented previous data concern risks and lack of adapting modern techniques. Projects have been considered as temporary based production systems, which need to be designed, planned, produced and delivered within a specified time. Fast track projects with long, complicated supply chains involving many players and subject to multiple, extensive process design changes have complex flow management that has failed miserably. As a result, the industry is characterized by delays and often has suffered cost and time overruns. In general, a very high level of wastes/non-value added activities is confirmed to exist in the construction industry. Several studies from various countries have confirmed that, wastes in construction industry represent a relatively large percentage of production cost The existences of significant number of wastes in the construction have depleted overall performance and productivity of the industry, and certain serious measures have to be taken to rectify the current situation. One of innovative approach in this regard is "Lean Construction which was introduced to construction industry in 1990s based on a successful manufacturing theory, i.e. lean production.

It has been contended by the Lean Construction Institute that about 57% of productive time waste can be found in the construction industry The conventional project management approaches have inadequacies in resolving the problems in the industry. In the United States, studies have been carried out by CII (Construction Industry Institute), which estimate that between 25% and 50% of the cost of construction Corresponds to waste due to the inefficiency of the traditional management system. According to (LCI) Lean Construction Institute, The construction industry is characterized by a ratio production/waste higher than that of the manufacturing industry. Nevertheless, lean manufacturing principles and techniques provide the foundations for minimization or total elimination of the waste faced by the industry. Lean construction has change the traditional view of labor flow, work flow reliability, and gives the value added construction.

Lean emerged in the late 1980's from Toyota Production System, and has since its conception become the normative management principle. Toyota was able to produce better quality products with fewer resources than the competition through focusing on the flow and reducing waste.

The fundamental differences between the construction industry and the traditional manufacturing industry require a different way of applying Lean. The construction industry is characterized by on-site projects, leading to high development costs and a lower degree of standardization. Lean Construction is a recent development in how to reduce waste and manage the flow, and it addresses the needs of the construction industry. Much attention has been placed on the unique characteristics of construction. This indicates the need for addressing different kinds of construction projects in order to capture their unique characteristics.

Lean is a term to describe an effective, high-performance method for managing organisations and delivering their core purpose in the most efficient and effective manner while continuing to develop for a sustainable future. Lean is an ethos, a way of doing business. It seeks to maximise the generation of customer value by driving out all forms of waste, ensuring 'right first time' quality, reducing timescales and minimising cost.

## I. LITERATURE SURVEY

**Sheila Belayuthan et al. (2016) :** This research observes to seamlessly improve the manufacturing (time and cost) and environmental (sediment pollutants) variables via making use of the concept of lean production towards achieving a cleaner earthworks operation. A case study on the project located at Rauls, a place in Malaysia is considered where, a lean based methodology proposed by "Womack and Jones" that mixes special statistics series techniques (interview, statement, web site report) are used. Findings of the observe recommend that lean allows smooth. Positive improvements were found in phrases of time and price reduction via 42.7% and 24.9% respectively. The environmental element, Rainfall Erosivity is decreased by 41.8%, therefore reducing the danger of soil erosion and sediment production. Ultimately, the proposed methodology may want to seamlessly improve both dimensions of manufacturing and environment at its supply, which satisfies the intention for purifier earthworks operation.

**S M Abdul Mannan Hussain et al ;** The objective of the project was to improve site management, with the implementation of lean tool In their research LPS was implemented to the residential building. Researchers divided the project methodology into three phase's pre-implementation, implementation, post-implementation, these phases had many procedures such as data collection, questioner surveying, direct and indirect observation etc. researchers concluded that implementing LPS project can be completed two months before the actual duration , reduction in overall cost of the project and increase of quality in performance can be identified

**Aakanksha Ingle et al:** This paper highlights the cost and benefits of the potential contribution of lean construction to the achievement of productivity enhancement and waste minimization in construction industry. There is need for waste minimization and enhancement of productivity in construction activity. Productivity is critical determinant of cost efficiency. Case study method, it is an exploratory study. In this paper researcher 's wants to explore lean construction concept and its applicability in Indian construction industry by using Five-S model, by survey on L&T and few best practices done in L&T were listed.

**Gholamreza Heravi and Mehdi Rashid :** The objective of the study was to develop the methods for implementing and developing the lean construction plan (LCP) in this study LCP was developed through proper approach & defining the non-value adding activity and choosing the appropriate lean tool. To implement the developed plan, an evaluation of the progressive improvement of repetitive subprojects is utilized as an effective approach. In this research a real project was taken for the application of lean, when the tools were implemented and validated the performance of the project was increased by 19% and they mentioned that LCP cannot be easily implanted easily it requires the proper planning.

## II. OBJECTIVES

1. To develop master plan and schedule for the project.
2. To reduce cost and duration of the project

## III. SCOPE OF THE PROJECT

To deliver the construction process by providing best quality, lowest cost and shortest lead time through elimination of Wastes.

## IV. METHADOLOGY

**Literature Study**; Study of previous journal paper was carried out

**Data collection and Analysis;** This step involves the site visits, interaction with head engineers, site engineers, and supervisors and collecting of data like number of activities in each event, expected duration of each activities, resource needed and availability of resources on site and also to observe the ongoing work.

**Work Breakdown Structure**; WBS is a hierarchy of work that must be accomplished to complete a project. Each project has its own WBS. Each WBS element may contain more detailed WBS levels, activities, or both.

**Duration Calculation**; Calculating the number of days required to complete the task.

**Scheduling of Activities**; Scheduling is a basic management tool, which consists of tasks events and other resource required. Schedule can be two types short term schedule and long term scheduling

**Implementation of lean Principles;** The lean principles can only be applied fully and effectively in construction by focusing on improving the whole process. This means all parties have to be committed, involved, and work to overcome obstacles that may arise from traditional contractual arrangements

**Comparison of Results;** this step involves comparing the traditional construction with the modern construction after implementing the lean principles.

## V. LEAN IMPLEMENTATION

**Master Schedule ;**The master schedule is produced during front end planning and represents the milestone level of project planning specifying the timing of the various phases a project goes through.

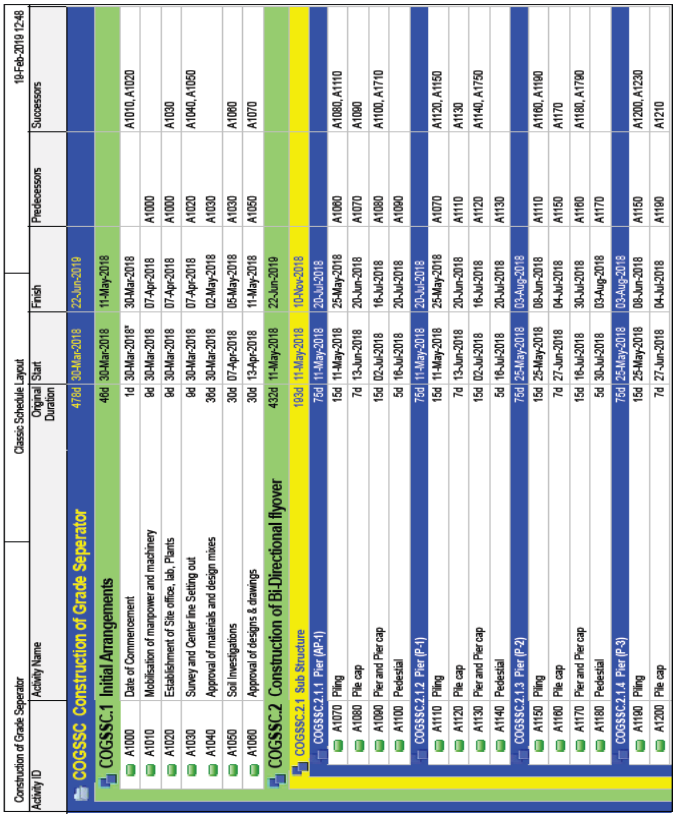


**Figure 1 Master Schedule**

**Last Planner System**

Ballard introduced a new method for applying lean in construction the Last Planner System (LPS). This model is based in a short term planning and control of operations approach and has been one of the most used models around constructions

The Last Planner planning cycle comprises the master schedule covering an entire project, the detailed phase schedule emerging from collaborative planning, the look-ahead plan with constraints analysis and the weekly work plan with measured percent plan complete.

**The Master schedule**: Selects the sequence of activities and identifies all the work packages on which obstacles should be removed and is elaborated by all the parties involved in the construction; it defines what should be done.

**Look ahead Plan***:* By having an outlook up to four weeks ahead, this plan controls workflow ensuring the workable backlog is sufficient for an activity to be completed; it defines what can be done.

Look ahead Schedule — Classic Schedule Layout

| # | SLNO | Activity Name | Activity ID | Original Duration | Start | Finish |
|---|---|---|---|---|---|---|
| 1 | | COGSASC 3 Look ahead Schedule | | 38d | 27-Feb-1908 | 02-Apr-1919 |
| 2 | | COGSASC 3.1 PILEING | | 28d | 27-Feb-1908 | 23-Mar-1919 |
| 3 | | Marking and Tiltpod Erection | A1000 | 1d | 27-Feb-1908 | 27-Feb-1915 |
| 4 | | Chiseling | A1010 | 5d | 28-Feb-1908 | 04-Mar-1919 |
| 5 | | Cage installation | A1020 | 1d | 05-Mar-1908 | 05-Mar-1919 |
| 6 | | Concreting | A1030 | 1d | 06-Mar-1908 | 06-Mar-1913 |
| 7 | | Excavting | A1040 | 1d | 14-Mar-1914 | 15-Mar-1913 |
| 8 | | Pile Chipping | A1350 | 3d | 15-Mar-1914 | 18-Mar-1919 |
| 9 | | Bar Bending | A1360 | 4d | 19-Mar-1914 | 22-Mar-1913 |
| 10 | | Concreting | A1370 | 1d | 23-Mar-1914 | 23-Mar-1919 |
| 11 | | COGSASC 3.2 PEDESTIAL | | 6d | 25-Mar-1914 | 30-Mar-1913 |
| 12 | | Marking | A1050 | 0d | 25-Mar-1914 | 25-Mar-1917 |
| 13 | | Inseting Bolt and Marking | A1060 | 1d | 25-Mar-1917 | 26-Mar-1913 |
| 14 | | Boltwelding | A1070 | 1d | 29-Mar-1914 | 30-Mar-1913 |
| 15 | | Concreting | A1080 | 1d | 26-Mar-1914 | 27-Mar-1913 |
| 16 | | COGSASC 3.3 PIER AND PIER CAP | | 19d | 27-Feb-1908 | 15-Mar-1919 |
| 17 | | Marking | A1110 | 1d | 27-Feb-1908 | 27-Feb-1913 |
| 18 | | Cutting | A1120 | 4d | 28-Feb-1908 | 02-Mar-1919 |
| 19 | | Assembeling | A1130 | 1d | 04-Mar-1908 | 04-Mar-1919 |
| 20 | | Welding | A1140 | 5d | 05-Mar-1908 | 08-Mar-1919 |
| 21 | | Grinding | A1150 | 1d | 11-Mar-1908 | 11-Mar-1913 |
| 22 | | Blasting and Painting | A1160 | 1d | 14-Mar-1908 | 14-Mar-1919 |
| 23 | | Erection | A1170 | 1d | 15-Mar-1908 | 15-Mar-1919 |
| 24 | | COGSASC 3.5 Beaing And Anchar Plate | | 3d | 27-Feb-1908 | 28-Feb-1919 |
| 25 | | Marking and Setting Center Po | A1330 | 1d | 27-Feb-1908 | 27-Feb-1919 |
| 26 | | Welding | A1340 | 1d | 28-Feb-1908 | 28-Feb-1919 |
| 27 | | COGSASC 3.4 END DIAPHRAGAM AND GIRDE | | 38d | 27-Feb-1908 | 02-Apr-1919 |
| 28 | | Marking | A1200 | 1d | 27-Feb-1908 | 27-Feb-1919 |
| 29 | | Cutting | A1210 | 5d | 01-Mar-1908 | 05-Mar-1919 |
| 30 | | Drilling | A1220 | 4d | 06-Mar-1908 | 08-Mar-1919 |
| 31 | | Welding | A1230 | 13d | 12-Mar-1908 | 22-Mar-1919 |
| 32 | | Grinding | A1240 | 3d | 23-Mar-1908 | 25-Mar-1919 |
| 33 | | Blasting and Painting | A1250 | 3d | 27-Mar-1908 | 28-Mar-1919 |
| 34 | | Erection | A12560 | 5d | 29-Mar-1908 | 02-Apr-1919 |

**Figure 2 Look ahead schedule**

**Weekly Work Plan (WWP)**: Looks at short-term perspective and selects sequences and sizes of the work of the following week, detailing flows verification, and activities executions and respective responsible; it then defines what will be done.

Weekly Schedule 2 — Classic Schedule Layout

| # | SLNO | Activity Name | Activity ID | Original Duration | Start | Finish |
|---|---|---|---|---|---|---|
| 1 | | COGS2W Weekly Schedule 2 | | 7d | 06-Mar-1908 | 12-Mar-1915 |
| 2 | | COGS2W.1 Pileing | | 1d | 06-Mar-1908 | 06-Mar-1917 |
| 3 | | Concreting | A1000 | 1d | 06-Mar-1908 | 06-Mar-1917 |
| 4 | | COGS2W.3 Pier and Pier Cap | | 5d | 06-Mar-1908 | 09-Mar-1919 |
| 5 | | Welding | A1020 | 3d | 06-Mar-1908 | 08-Mar-1912 |
| 6 | | Grinding | A1040 | 1d | 09-Mar-1910 | 09-Mar-1919 |
| 7 | | COGS2W.5 End Diaphragram and Girders | | 7d | 06-Mar-1908 | 12-Mar-1915 |
| 8 | | Drilling | A1060 | 3d | 06-Mar-1908 | 08-Mar-1912 |
| 9 | | Welding | A1070 | 1d | 11-Mar-1917 | 12-Mar-1915 |

**Figure 3 Weekly work Plan**

**Percent Plan Complete**

PPC (percent plan complete) is the number of planned activities completed divided by the total number of planned activities, expressed as a percentage. PPC measures whether the planning system is able to reliably anticipate what will actually be done.

Percent Plan Complete (PPC %) =

$$\frac{Number\ of\ tasks\ completed}{Total\ number\ of\ Activities} \times 100$$

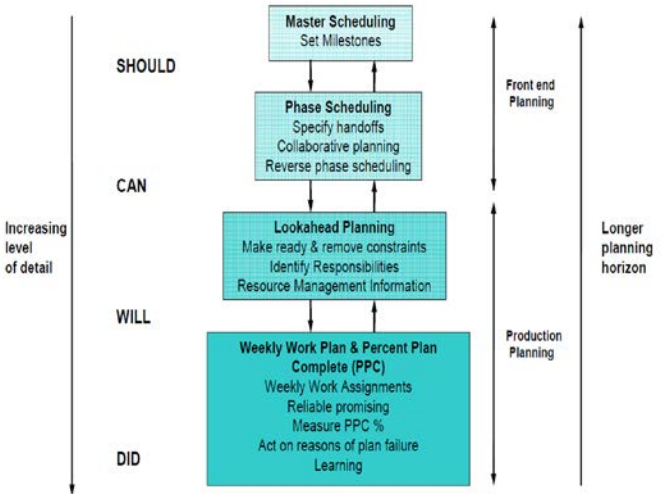


**Figure 4 Work flow of LPS**

## VI. PROJECT OUTCOMES

| Weeks | Total no of Activities | No. of Tasks Completed | No. of Incomplete tasks | PPC |
|---|---|---|---|---|
| 27/2/2019- 5/03/2019 | 11 | 8 | 3 | 72.7 |
| 6/03/2019 - 12/03/2019 | 5 | 3 | 2 | 60.0 |
| 13/03/2019 - 19/03/2019 | 6 | 5 | 1 | 83.3 |
| 20/03/2019 - 26/03/2019 | 6 | 6 | 0 | 100.0 |
| 27/03/2019 - 03/04/2019 | 4 | 3 | 1 | 75.0 |
| | 32 | 25 | 7 | 78.1 |

**Figure 5 PPC values**

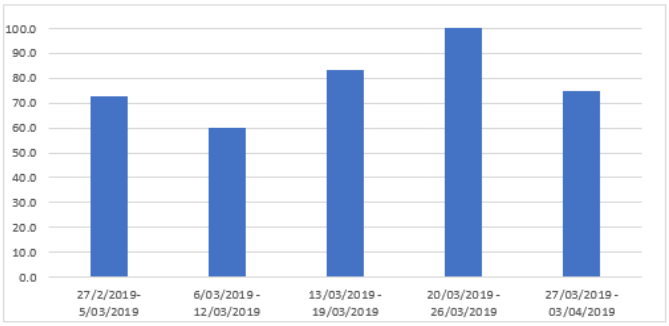


**Figure 6 Comparison of PPC**

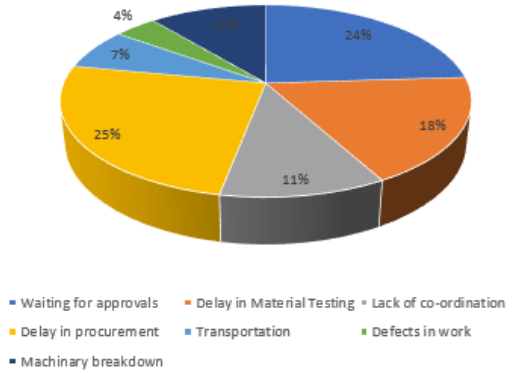


**Figure 7 Reasons for delay**

## VII. CONCLUSION

- The Master Schedule of the project was developed which includes the total number of activities that is 155 and the critical activities found to be 23
- Implementation of LPS reduced the cost and time of the project
- Although the project suffered from shortage of materials, the problem of material shortage was overcome by engaging in short term and look ahead planning together with regularly doing a constraint analysis to envisage possible constraints to the project before they occur

## VIII. ACKNOWLEDGEMENT

My most sincere and grateful acknowledgements to the holy sanctum of N.M.A.M.I.T. Nitte which is helping me to pursue the M.Tech., Construction Technology, thus helping me to make a bright career in engineering.

I express sincere gratitude to Mr. Sundip Shenoy, Assistant professor, Department of Civil Engineering, NMAMIT, Nitte Educational Trust for his kind support and guidance. I am grateful to Dr. UdayaKumar G, HOD, Department of Civil Engineering, NMAMIT, Nitte Educational Trust for his kind support.

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