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A Systematic Approach Of Implementing The Last Planner System In A Building Construction Project In India

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Abstract
The work described in this paper is to demonstrate the productiveness of implementing Last Planner System to improve construction planning process in an Institutional building construction project in India. The Last Planner System (LPS) has been implemented on construction projects to increase work flow reliability, improve productivity, greater collaboration with field personnel and sub contractors, and completing the project within the stipulated duration and carrying out smooth workflow. Consequently, this research centered on improving building construction processes in India, reports the findings from the implementation of the Last Planner System on an Institutional building construction projects in India.
The initial state of production plan reliability within the project was observed to be highly unreliable with a high degree of variability. However as the implementation commenced, production plans were stabilized with an improved reliability in the schedules. The results from this study demonstrate that although an Institutional building construction process is a linear process, a number of benefits were still recorded in terms of improving construction planning and organizing processes, during the implementation.

Keyword: Last Planner System, Master schedule, Look-ahead schedule, Percent planned complete, Make work ready planning.

Introduction
There are numerous challenges and problems facing the construction industry all over the world. Construction projects are famous for being over-budget, late and burdened with scope creep. Many of the problems facing the construction industry, such as delays, over-budgeting and poor quality, have been extensively discussed. The traditional construction management approach has been effective in solving some of these problems. The Construction Management has been defined as the overall planning of a project by allocating the appropriate resources to finish the project on time, at budget and at targeted quality. Successful project management can be achieved by bringing together the tasks and resources necessary to accomplish the project objectives and deliverables within the specified time constraints and within the planned budget.
Construction processes are becoming much more complex and therefore a coherent management approach should be developed to solve the chronic problems and difficulties of the construction projects. Lean Construction (LC) was introduced and defined by The Lean Construction Institute (LCI) as “a production-management-based approach to project delivery-a new way to design and build capital facilities”. Having seen intrinsic improvements in manufacturing, implications of lean production principles to the construction changed the method of work done through the delivery process. The main purpose of lean production system is to maximize value and minimize waste by using the appropriate lean techniques. Despite the significant differences between the features of construction and manufacturing, they almost share the same goals and pursue same principles such as system optimization through collaboration, continuous improvement, focus on customer satisfaction, work flow by eliminating obstacles and non-added values and creating pull production.

Lean Construction And Last Planner System
Building construction is a process that is ripe for the picking with potential process improvements, but Lean principles must be adapted from manufacturing to construction for this to be successful (S M Abdul Mannan Hussain et al., 2014). The difficulty in construction is that every project is different and has a different team of people working on it that get supplies from different sources. To overcome this difficulty requires a change in thinking. Glenn Ballard and Greg Howell of the Lean Construction Institute have produced extensive research into how lean manufacturing principles can be adapted to the construction industry in order to change the construction industry’s collective mindset. They have

recognized that while every construction project is different, they are comprised of construction operations which are similar between projects. Instead of viewing a project simply as piecing together some engineer's design, we must look at the project as a temporary production process, in which the focus is on making that production process the best it can be. If that same focus successfully eliminates waste and maximizes value, the project is then considered to be "lean" (Ballard & Howell, 2003).

Ballard and Howell have developed a detailed Lean Construction protocol, known as the Lean Project Delivery System TM (LPDS). LPDS seeks to redefine the traditional phases of construction, and focuses on applying lean principles to the design, supply chain, and assembly of a construction project. It recognizes that each phase of construction is highly dependent on those that came before it and will come after it, and places a strong emphasis on improving the overall project production system (Ballard & Howell, 2003). Their research has shown that the LPDS is also a superior management system. Even partial implementations have yielded substantial improvements in the value generated for clients, users and producers, and also a reduction in waste, including waiting time for resources, process cycle times, inventories, defects and errors, and accidents. The two major project management components of the LPDS are the Last Planner TM System (LPS) and Reverse Phase/Pull Scheduling.

LPS is a system that uses a weekly planning schedule which is focused on the work that can currently be completed, and strives to ensure that what the original project schedule says should be occurring during that week can occur during that week. (Alarcon & Calderon, 2003;Ballard, 2000a; Hamzeh, 2009). LPS breaks the schedule down into four levels:

A. Master Schedule.

The master schedule is broken down by project phases. These phases are typically project milestones that are set by the owner.

B. Phase Schedule.

Each phase has a schedule that is broken down into construction activities. Phase schedules are developed using pull scheduling techniques, which are described in more detail below. The phase (and master) schedules both represent what "should" be done on the project within the specified timeframes.

C. Lookahead Schedule.

The look ahead schedule is typically generated for each week between 2-6 weeks out from the current date. The purpose of the look ahead scheduling is to examine the activities that "should" be done to make sure that they "can" be done as scheduled. This process involves three steps:

- Breaking down activities into assignable tasks.
- Ensuring the operational design for the tasks to be performed is feasible.
- Removing constraints from the tasks.

D. Weekly Work Plan.

The weekly work plan is generated for the current week and the next week. If a task is "made ready", meaning it has passed the three checks included in look ahead planning, it is added to the weekly work plan and assigned to the people that will actually be doing the work. When a task is added to a weekly work plan, it is being moved from what "can" be done to what "will" be done.

E. Percent Plan Complete (Ppc).

PPC is a metric which is used to measure the success rate of LPS. PPC is calculated after a weekly work plan has been executed, and is simply the number of tasks that were completed divided by the number of tasks that were assigned. Alternatively, PPC can be defined as dividing what "did" get done by what was projected "will" get done. A high PPC means that LPS is allowing for reliable work forecasting, and that tasks made ready are being completed as scheduled.

Reverse Phase or "Pull" scheduling is the technique used to develop the phase-level schedule that is used as a basis for implementing LPS. It a highly collaborative and cooperative project scheduling method which requires all parties involved in any given phase of construction project to work together in scheduling the project starting with a completion milestone date and working backwards (Ballard & Howell, 2003). Each phase's milestone date comes from the master project schedule, which usually contains very aggressive timeframes. The purpose of starting at the end and working backwards is to ensure that only tasks which release work to others (e.g. pull) are being worked on at any given time. Reverse phase scheduling is typically performed in a large room with a representative of every organization that does work within the phase. Each organization puts each of their construction activities on a sticky note, and includes what they need to be done before they can start their work on that activity. By starting at the end and working backward, the schedule will be sequenced in a pull manner. Typically, after the first iteration of scheduling, the time needed to do the work will exceed the time allotted to that phase by the master schedule. This is when collaboration is necessary to shorten activity durations, either by finding innovative ways to work with other organizations within the phase, or by removing time buffers from each individual activity, and placing them into one shared time buffer for the entire phase. Since each activity will not use 100% of their originally scheduled time buffer, the compiled time buffer will be smaller than the sum of the individual activity buffer. This result in an innovative, "fluff free" schedule that will almost always meet the time allotted for the phase by the master project schedule.

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Fig.1. Last Planner System conversation

Case Study Of Global Edge School (Kokapet, Hyderabad)

A. General

The current project is the one proposed by Global Edge School regarding the construction of a new school building at Kokapet, Hyderabad. The Global Edge School, established in the year 2005, is a co-educational school. The school has three branches, one in Madhapur and the other in Banjara Hills and in Kukatpally. The institution is an educational and research initiative of the M. Baga Reddy Educational Society. The school has good infrastructure, updated equipment, highly skilled & qualified academicians and also dynamic principals. The school provides quality education from Nursery to X and follows the CBSE syllabus.

The project consists of 75000 sq ft. built area which is divided among 3 floors and each floor having a built area of about 25000 sq ft. Cellar section of the building is made for parking and the remaining three floors were for classrooms, staffrooms, toilets, storeroom, computer lab, auditorium and other laboratories for students. The estimated cost of the project is about INR 46, 995, 873.94 and is expected to complete within 17 months from the execution of the construction. The building is a tri-story educational building structure of RCC/Wooden structural type.

B. Research Activities At The Site

Step 1: After getting the design information and drawing the work is structured and Master Schedule is prepared.

Step 2: After preparing Master Schedule, its current status is forecasted by selecting, sequencing and sizing work which can be done accordingly Look- ahead Schedule is prepared.

Step 3: Look ahead schedule is prepared based on the information that is made ready by Screening and pulling which is a workable backlog of selecting, sequencing and sizing the work that can be done through weekly work plan. The Weekly Work Plan is thus prepared by optimizing the resources and the work is completed accordingly.

The research plan was to implement Last Planner System in three phases of the project comprising of 8 weeks of implementation and PPC calculations. These phases are:

Phase 1- Structure works;

Phase 2- Super structure works &

Phase 3- Finishing works.

At the end of each phase (8 weeks) a comparison and review of the implementation was carried out. Conversely, during the implementation, the look-ahead schedule and the constraint analysis chart were used to allow for the anticipation of future needs for materials, equipment and labor. They ensured tasks were ready to start when required with a certainty of labor, equipment and material requirements. The constraints identified during the constraint analysis were grouped under eight categories; contract, designs, submittals and documentation, operations, equipment, labor, weather and materials. This classification helped facilitate an enhanced co-ordination with the responsible persons resolving particular constraints identified.

The PPC charts and reasons for non-completion forms on the other hand were used throughout the implementation process. These reasons for non-completion were also subdivided into eight categories; contract, designs, submittals and documentation, operations, equipment, labor, weather and materials. A weekly PPC's of 8 weeks was measured and is shown in Table 1 to Table3.Figures 2 and figures 3 shows the PPC analysis for the first phase, i.e. 8 weeks within the project. At the end of the phase, a meeting was held to evaluate the implementation process, discussing the lessons learnt from the implementation.

TABLE.1. Comparison of 8 weeks of PPC (19/11/14 – 21/01/15)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
19/11/2014	5	6	11	45%
26/11/2014	8	6	14	57%
03/12/2014	10	4	14	71%
10/12/2014	9	6	15	60%
17/12/2014	8	3	11	72%
07/01/2015	8	2	10	80%
14/01/2015	6	1	7	86%
21/01/2015	6	2	8	75%
TOTAL	***60***	***57***	***90***	***67%***

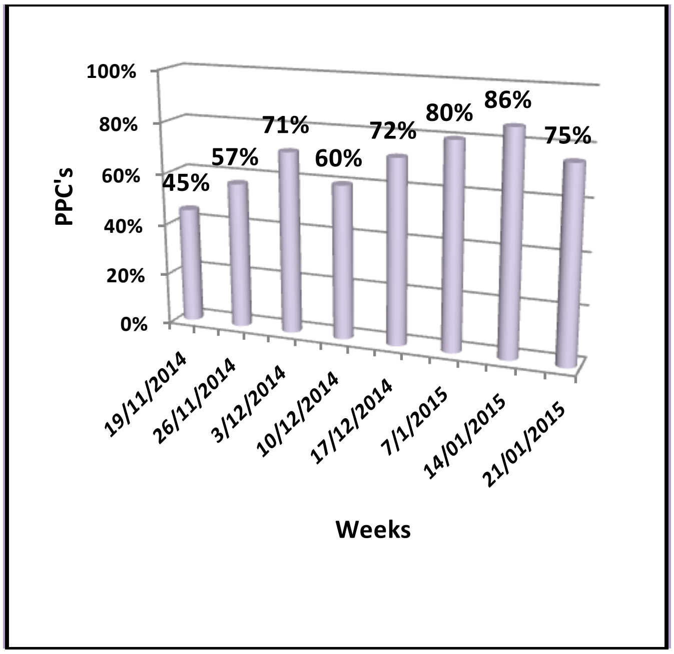

Fig.2. Weekly PPC's for 8 weeks (19/11/14 – 21/01/15)

From the review of the implementation process, it was observed that the involvement of all parties in the project was crucial for the success of the implementation process. Similarly, the reasons for incomplete assignments were analyzed and documented for corrective actions to be taken during the next weekly meeting

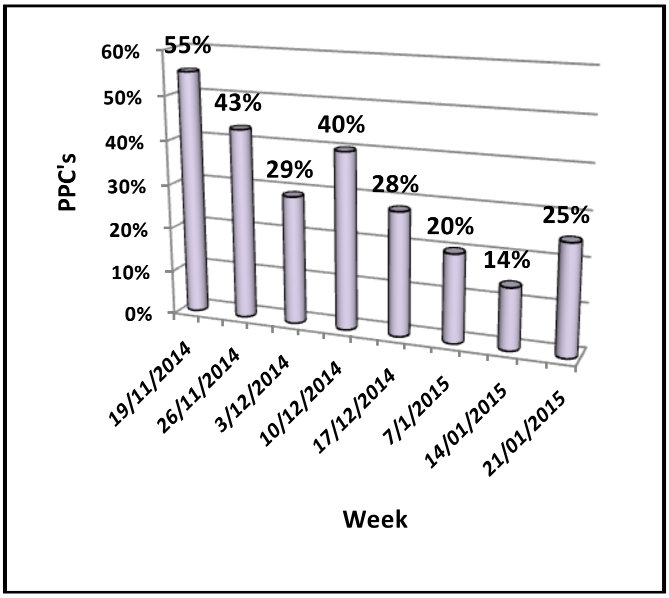

Fig.3. Reasons for incomplete assignments (19/11/4 – 21/01/15

The reasons for the incomplete assignments within the first phase of 8-weeks are shown in Figure 3. The reasons are as follows: Pre-requisite works, Rework, Material, Equipment, Incomplete Design information, Poor weather, Submittal, Labor Supply. The figure demonstrated that equipment break down was the most frequent reason for incomplete assignments. This was followed by incomplete design information; a lot of details were not included in the vertical and horizontal alignments designs. This made it difficult setting-out the project and calculating the levels for the cut and fill. In the same vein, this led to a lot of rework; which had the third highest frequency of 24. Other reasons for incomplete assignments included; submittals (late request), poor weather and materials unavailability, pre-requite work and labor supply. Although this analysis for incomplete assignments was limited to the category presented.

Furthermore, weekly PPC's were calculated for next 16 weeks with an evaluation process carried out after 8th weeks for the 16th week of the project. The evaluation process basically evaluated the implementation process with the project team also discussed the lessons learnt from the implementation. Table 2 and figure 4 shows the PPC measure for the second phase which commenced on the 28th of January 2015 till 18th March 2015. Similarly, Figures 5 showed the reasons for incomplete assignments within this phase.

TABLE.2. Comparison of 8 weeks of PPC (28/01/15 – 18/03/15)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
28/01/2015	8	3	11	73%
04/02/2015	7	2	9	78%
11/02/2015	9	4	13	69%
18/02/2015	9	3	12	75%
25/02/2015	8	3	11	73%
04/03/2015	10	2	12	83%
11/03/2015	11	4	15	73%
18/03/2015	9	3	12	75%
TOTAL	***71***	***22***	***93***	***76%***

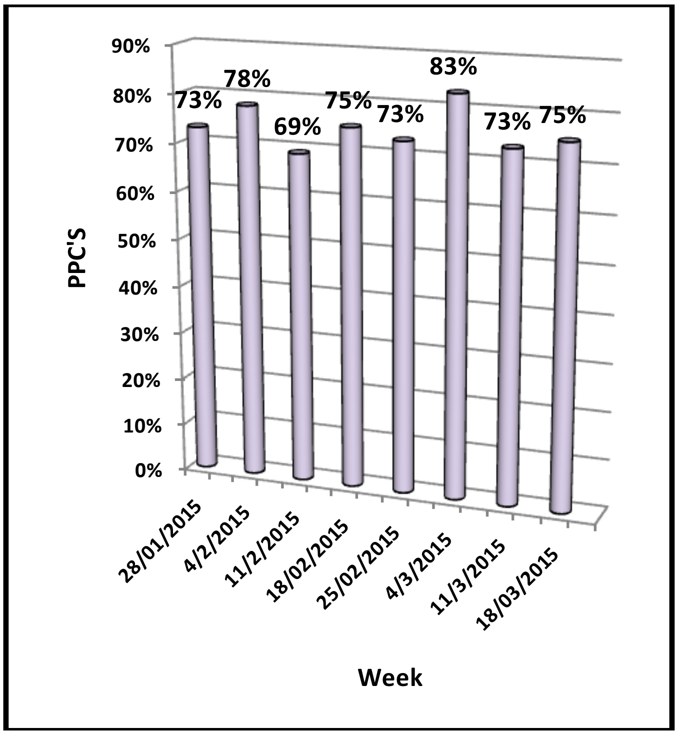

Fig.4. Weekly PPC's for 8 weeks (28/01/15 – 18/03/13)

From Table 2 and Figures 4 it is observed that the average PPC within this period was 76% which was a remarkable improvement from the previous evaluation whose PPC was averaged at 67%. In addition, the highest PPC value of 83% was recorded on the week commencing from the 4th of March 2015, while the lowest PPC value of 69% was recorded on the week of 11thFebruary 2015. Furthermore, the reasons for the incomplete assignments within these 8-weeks are shown in Figure 5. It was identified that pre-requisite work was the most frequent reason for incomplete assignments and delays as a result of waiting for a task to be completed before another starts. This was basically because of the nature of the stage that the project had reached; i.e. this was the stage where most of the activities were dependent on the earth works.

This rework was also recorded in Figure 5 as the second highest percentage of uncompleted assignments. The third reason given was the un-availability of materials. This was because of community disturbances from the youths around a neighboring community; this community was the only access to the project site and suppliers delivering materials to the site were delayed until government officials had to step in to resolve the situation. The fourth major reason for incomplete assignments was equipment break down. This was followed by incomplete design information; especially during the construction of the side drains which was carried out within this phase. Similarly, details of the fill levels were not indicated hence the surveyors had to establish one.

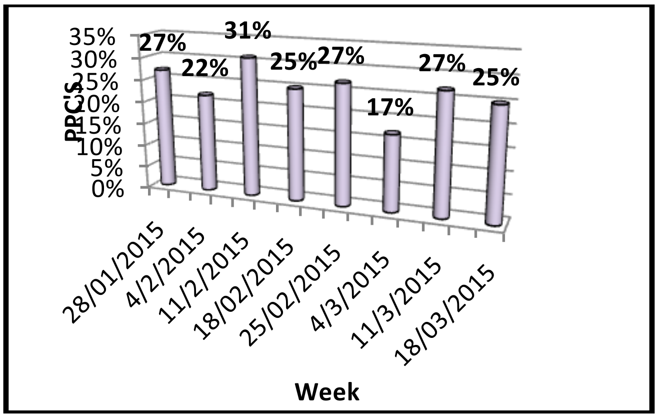

Fig.5.Reasons for incomplete assignments (28/01/15 – 18/03/15)

Finally, for the remaining 8 weeks to make up 24 weeks of the LPS implementation weekly PPC's were calculated and an evaluation carried out at the end of the 8 weeks. The project team discussed the lessons learnt from the implementation and evaluated the entire implementation process. Table 3 and Figure 6 shows the PPC measure for week commencing on 25th March 2015 to week commencing 13th May 2015 while Figure 7 shows the reasons for incomplete assignments.

TABLE.3. Comparison of 8 weeks of PPC (25/03/15 – 13/05/15)

Start date for week	No. of completed tasks	No. of uncompleted tasks	Total activities/tasks	PPC
25/03/2015	9	3	12	75%
01/04/2015	8	2	10	80%
08/04/2015	7	2	9	78%
15/04/2015	6	3	9	67%
22/04/2015	5	1	6	83%
29/04/2015	5	2	7	71%
06/05/2015	6	2	8	75%
13/05/2015	7	1	8	88%
TOTAL	***53***	***16***	***69***	***77%***

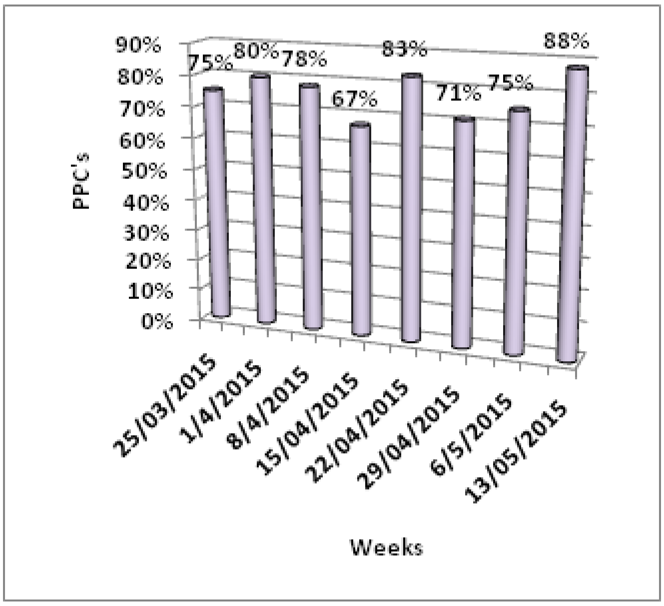

Figure 6 Weekly PPC's for 8 weeks (25/03/15 – 13/05/15)

From comparison of the 8 weeks PPC in Tables 6 and the chart of the weekly PPC's in figures 42 it is observed that the average PPC within this period is 77%. It was recorded that the highest PPC value of 88% was recorded on the week commencing from the 13th May 2015. However, the lowest PPC value of 67% was recorded on the week of 15th April 2015; the major setback on the project within that week was poor weather.

The reasons for the incomplete assignments within these 8-weeks are shown in Figure 43

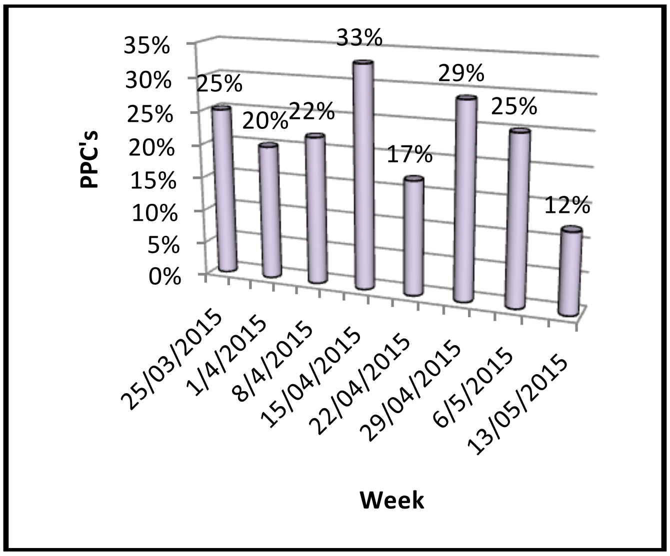

Fig.7. Reasons for incomplete assignments (25/03/15 – 13/05/15)

The reasons for the incomplete assignments are, it was observed that poor weather was the major reason for incomplete assignments within this phase and it had a chain effect of affecting pre-requisite work. The rains poured out heavily and caused most of the tasks to be suspended and this resulted in workers waiting for task to be completed before another starts. Similarly, submittal (late request) was the third highest reasons for incomplete assignments; and it resulted in delays as requests were submitted too late for decisions to be made that would enable particular activities to start on time

The fourth major reason for incomplete assignments was equipment break down. This was followed by incomplete design information; especially while constructing the pavements. Other reasons for incomplete assignments included; defects requiring rework, material unavailability and labor supply.

Findings

Observation:

It was revealed from the initial observations that there was no set out procedure for managing site activities. The site engineer gathered the project team every morning to assign work packages on a day to day basis. The back drop to this arrangement was that operators, subcontractors and suppliers did not know ahead of time what was planned out. This caused series of delays in the start-up process of the project. Nevertheless, it was observed that team-working was very evident at the site and responsibilities were well shared among the project team.

Implementation:

During the implementation of the last planner system, a lot of data was gathered and different forms were completed on site by the project team, and these forms include the look-ahead schedule, constraints analysis charts, PPC chart and the reason for non-completion forms. The implementation occurred in three phases of 8 weeks per phase. The average PPC's for the entire implementation period was 74%, with the highest PPC at 87% and the lowest at 46%.

Conclusion

This LPS implementation has shown that LPS, which is rarely implemented in a linear process like an Institutional building construction process, could enhance construction management practice in an environment which differs from places where it has been previously implemented and characterized predominantly by poor quality, cost and time overruns. On the whole LPS had a significant and positive impact on the project management process of the Institutional building project by enhancing planning practice, improving site logistics, removing constraints before they became obstacles and improving the entire site management.

Nevertheless, during the LPS implementation obstacles were encountered and these prevented the achievement of the full potential of the LPS implementation. Some of the obstacles include: cultural issues, lengthy approvals, resistance to change, sub-contractors involvement, supervision and quality control, fluctuation and variations. Besides its contribution in improving the project management practice within the study organization, it has contributed to construction management by illustrating that irrespective of the nature of the construction project or the environment within which the project is occurring, the LPS can still be successfully implemented to record improvements. Furthermore, the results from this case project can be used as a reference for organizations in India which look forward to improving their managerial practice. The study also suggest that implementing LPS in an Institutional building construction project in India can improve the process by encouraging collaboration among the project participants, transparency, trust and the reliability of the schedule.

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