

# IMPLEMENTATION OF LAST PLANNER SYSTEM AND CHALLENGES ENCOUNTERED IN AN INDIAN RESIDENTIAL CONSTRUCTION PROJECT

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**Abstract** - Conceived in manufacturing, Lean construction is an alternative to traditional project management approach. Lean thinking has a long history of generating radical improvements in fields like manufacturing, services and construction. But comparing lean manufacturing with lean construction, the former is more developed than the latter. There have been some theoretical developments in lean construction but their implementation on ground is negligible, being only implemented in developed countries.

One of the most commonly used tools of lean is Last Planner System (LPS) which achieves goals through social process of collaboration. It is a short term project planning system to produce predictable uninterrupted workflow by creating a set of commitments that coordinates the actions of all stakeholders. LPS is a bottom-up approach whereas traditional project management uses a top-down approach. In LPS, control is handed over to comparatively lower ranks on site rather than to the higher in the hierarchy.

**Key Words:** Lean Construction, LPS , Master Plan, Pull Planning, Look-ahead plan, Percent Planned Complete

## 1.INTRODUCTION

Glenn Ballard and Greg Howell created the LPS in 1980s to improve the predictability and reliability of construction production. It is a short term project planning system to produce predictable uninterrupted workflow by creating a set of commitments that coordinates the actions of all stakeholders. It improves the relationships and makes decisions collaboratively at the lowest possible level.

### 1.1 Last Planner Principles

- Plan in greater detail as you get closer to doing the work.
- Produce plans collaboratively with those who will do the work.
- Reveal and remove the constraints on planned tasks as a team.
- Make reliable promises.
- Find root causes and preventions.
- Learn from breakdowns.

### 1.2 5+1 Crucial Conversations in LPS

To build trust among the key project performers (the last planners, i.e., head mason on site, site engineers, etc.) and the overall project managers, LPS creates planning and evaluation conversations at each step and at the right time. These conversations are critical to the collaboration of multiple stakeholders. The conversations are:

1. **Collaborative Planning (Should):** What should be done after design establishes. Use **pull planning** for production sequence.
2. **Make-Ready Planning (Can):** Make-ready planning gets the upcoming work ready (i.e., constraint free) so that it can be done on time.
3. **Production Planning (Will):** Collaboratively agreeing on the tasks for the next week. Weekly work planning establishes a set of promises to be fulfilled by the concerned people.
4. **Production Management (Did):** Daily commitment management supports the last planners in staying on track with their promises so that the work did get done.
5. **Measurement, Learning & Continual Improvement (Learn):** Learning together about the production processes from their performance at least weekly.

#### +1. First Run Studies (PDCA Cycle)

First Run studies are a part of continuous improvement process for critical processes. The PDCA (Plan-Do-Check-Act/Adjust) cycle was introduced by W. Edward Deming who introduced the concept in Japan in 1950s. First run studies are used to design and improve work methods through field observations. The implemented improvements become the new standard work method and we repeat the process to enable continuous improvement.

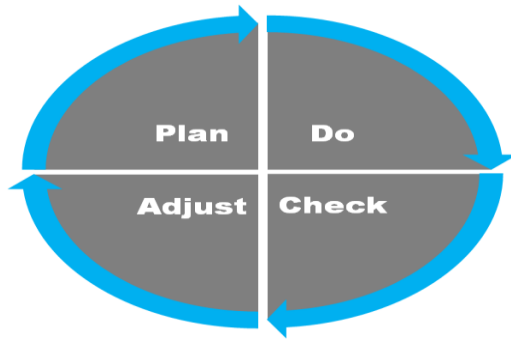


Fig.-1 PDCA Cycle

## 2. OBJECTIVE

The main aim of this study is to implement LPS in a residential construction project, analyze the challenges faced, provide solutions for the challenges and learn from failures in the path.

## 3. METHODOLOGY

- 1) Data Collection- It includes direct observations and document analysis.
- 2) Data Analysis- Data is evaluated to see the status of current project.
- 3) Implementation-To implement LPS and VSM simultaneously.
- 4) Root Cause Analysis- Root causes for incompleteness of targets will be evaluated using 5-Why's Technique.
- 5) Results- To study the results after implementation of LPS.

## 4. CURRENT STATE OF THE PROJECT

### 4.1 About the project

A well-renowned company is building residential blocks in New Chandigarh area. I chose one of the blocks there for the purpose of this research. This block consists of S+3, 3 & 4 BHK flats on different plots of area 1434 sq.ft. to 2450 sq.ft.

### 4.2 Direct observations on site

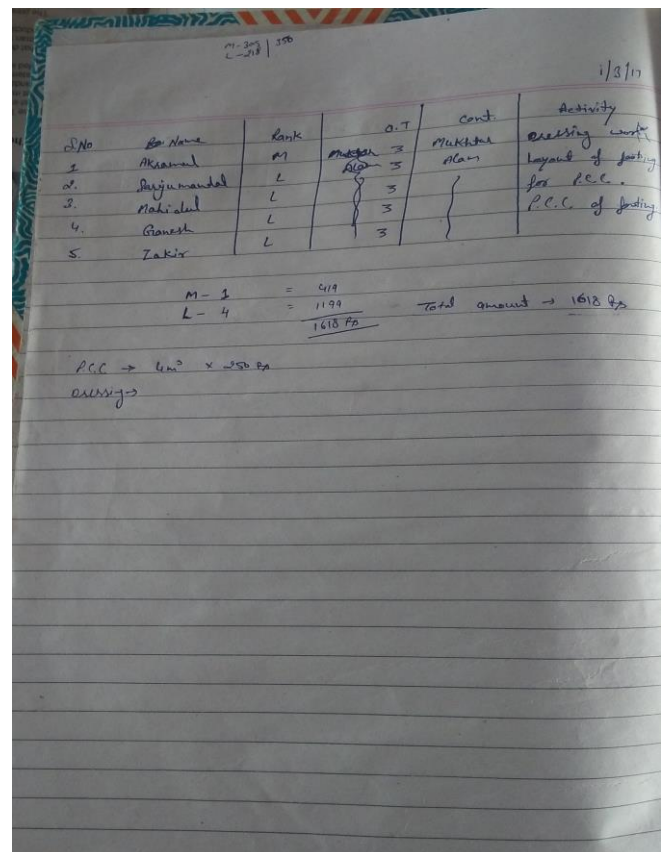
After I reached there, for few weeks I just observed what was happening around. During this period I came to know that there is no separate department for planning and quality control. The planning and coordination among various sub-contractors was done by the Assistant General Manager Mr.X. All the site engineers reported him whenever there was a problem or when he gets to know about a problem. Basically, the approach was that of **fire-fighting**.

There was **one instance** when the ready-mix cement concrete did not reach the site where it was intended to. Mr.X talked to the supplier and he said that the trucks are in

the block itself but the site engineer told that the RMC had not reached the site. Just by chance, I met the truck driver who was standing in a wrong block as he was perplexed about where to go and asked me that is it the same address. I then explained him the way to the correct block. One another day the site engineers were waiting to place the RMC for 2 days because conduits were not placed yet.

There were several other instances like this because there was no prior planning and instruction to the last planners and there was **only one person who was handling the coordination** of at least 4 blocks. A similar situation existed in the quality department, in fact here also there was only one head Mr.Y who used to visit the site for inspection after the work was completed and would do destructive tests which resulted in more cost and time wastage. There used to be a laboratory around 13 km from the original site but it was abandoned because it was thought to be an additional cost. Therefore, no quality tests were performed on the site nor was there any laboratory. As most of the buildings have same design there so every activity was performed as it is and there were no checks.

One positive thing was the daily attendance register for both the laborers and site engineers. In this register, number of laborers and number of site engineers required for each activity along with their names and the designated activity were written. The register looked as follows:



S.No	Name	Rank	a.T	Cont	Activity
1	Akshay	M	3	Mukherjee	Creating work layout of footing
2	Bhujumandal	L	3		for P.C.C.
3	Mahindar	L	3		P.C.C. of footing
4	Ganesh	L	3		
5	Zakir	L	3		

$M - 3 = 411$   
 $L - 4 = 1199$   
 $1610 \text{ Rs}$   
 Total amount  $\rightarrow 1618 \text{ Rs}$   
 P.C.C.  $\rightarrow 4 \text{ m}^2 \times 150 \text{ Rs}$   
 casting  $\rightarrow$

Fig.-2 Daily Attendance Register with designated activity

### 4.3 Traditional Project Management

The head followed the traditional approach to construction management. Scheduling was done at the head office prior to the project execution and it was **pushed** to the site teams to follow as a single plan during the whole project. There was no knowledge and implementation of the LPS. **Traditional planning** included following steps:

**1. Master Plan:** A master plan in the form of Gantt Charts or a timeline was created for each of the blocks and handed over to the senior site engineer. In a block, the senior site engineer was head under whom there were many junior engineers. The junior engineers were responsible for the construction of 4 plots whose design was provided to them in advance.

**2. Push Planning for Material Requirement:** All the material requirements had to be given by junior engineers to the senior site engineer who communicated the same to the project head i.e., Mr.X in this case. The budget was made for the whole month according to the drawings and a copy of the same was provided to the project head who was responsible for procurement of the material. Thus, push planning was used where the end item quantity needed was procured irrespective of its demand on site.

For instance, total reinforcement of 12.57 tonne was procured in one go for foundations and column and slabs of upper ground floor.

**3. Storage of materials:** There was no proper place for storage of the material and half of the materials lie on the site itself mostly in the stagnant water from curing. There was a small shed where material which was not currently in use was put and that too in a haphazard manner. So some of the material even got spoiled there.



Fig.-4 Temporary Storehouse



Fig.-5 Poor site management (Aerated Concrete Blocks stored in open)



Fig.-3 Shuttering getting spoiled

**4. Monthly Work plan:** A monthly plan was made in the office by the assistant of the project head and it was provided to the site engineers as a target. The targets were hardly met due to many obstacles and poor planning and coordination.

for Sep Month.

Plot No	FLOOR	Completion Date
557 L	SF	07-09-16
557 M	SF	08-09-16
557 N	SF	09-09-16
487	UGF	09-09-16
488	UGF	10-09-16
523 AB	AB SF	25-09-16
523 AC	AC SF	28-09-16
523 AD	SF	28-09-16
523 AE	SF	28-09-16
523 H	SF	30-09-16
523 N	SF	30-09-16
523 O	SF	30-09-16
523 P	FF	10-09-16
523 Q	FF	10-09-16
557 H	UGF	30-09-16
557 I	UGF	30-09-16
557 J	UGF	30-09-16
557 K	UGF	30-09-16

Fig.-6 Floor target of different plots for September month (SF-Stilt floor; UGF-Upper Ground floor; FF-First floor)

SLAB TARGET FOR SEP. MONTH

S.No.	PLOT No.	FLOOR (SLAB NO)	DATE OF CASTING (YEAR)	STATUS
1	487, 488 (03)	1st floor (S <sub>3</sub> )	5-9-16	OK
2	487, 488 (03)	2nd floor (S <sub>4</sub> )	21-9-16	
3	S23 X, Y (02)	STILT (S <sub>1</sub> )	9-9-16	
4	S23 V, W (03)	STILT (S <sub>1</sub> )	26-9-16	
5	S23 AA, 2 (02)	V.G.F. (S <sub>2</sub> )	11-9-16	
6	S23 AA-2 (02)	1st floor (S <sub>3</sub> )	27-9-16	
7	S57 F, H, I (04)	1st floor (S <sub>3</sub> )	18-9-16	
8	S35, S36 (02)	V.G.F. (S <sub>2</sub> )	20-9-16	
9	S37, S38 (02)	V.G.F. (S <sub>2</sub> )	23-9-16	

Fig-7 Slab targets of different plots for the month of September

#### 4.4 Disadvantages of not using LPS

As it is clear from the current state of project:

- 1) There is low productivity on site as **“Workers keep waiting for work”**.
- 2) It results in cost overrun and delay in the whole project.
- 3) There is no flow of information or materials on site.
- 4) Lack of coordination leads to office politics lowering the productivity further.
- 5) The control of the schedules is in the hands of the Assistant General Manager who make the plans in his office and who hardly visit the site. Therefore, he/she is not exposed to the constraints faced on site and does not consider these constraints while planning. Whereas, the LPS addresses this problem as it gives effective control over the plans to the site supervisors and engineers who are called as the **“last planners”**.

#### 5. FUTURE STATE OF THE PROJECT

##### 5.1 Implementation of LPS

LPS and VSM were applied to the extent possible for the remaining work on plots 466 Z26, Z25, Z24, Z23, Z22, Z21, Z20, Z19 in the month of April, 2017.

**1. Master Plan:** A master plan was created already for each of the blocks and handed over to the senior site engineer. The junior engineers were responsible for the construction of 4 plots whose design was provided to them in advance.

**2. Pull Planning:** Pull planning is scheduling a phase of work backwards from the end-date. It identifies important activities in that phase in reverse order and last planners make sticky notes on the project timeline. Although we did not made sticky notes but the last planners did discuss the phases of work in the various steps and identified important activities to be completed by various junior engineers and tried to implement pull planning.

Pull planning was also used in the procurement of materials. The reinforcement was not procured in bulk but according to demand. For instance, reinforcement for the foundations of 2 plots was procured first which was 4 tonne. After the completion of foundation, reinforcement for column and slab (monolithic construction) was procured which was 8.57 tonne. Similarly, concrete was used as per demand. It was estimated that slab work required a total of 80 cubic meters of concrete and thereafter, it was procured accordingly.

**3. Look-Ahead Planning:** In this step, plans are made in advance for at least 4 weeks and utmost 6 weeks. A 4-week i.e., 1 month plan was already made in the office. The only addition we did was to involve the site engineer to help make the plan to accommodate the previous incomplete

**5. No monitoring or learning:** Despite the incompleteness of targets, there were no learning’s from past mistakes and every uncompleted target was just postponed for next time. No one from planning team or site engineer monitored the progress and neither tried to enhance the productivity of the site.

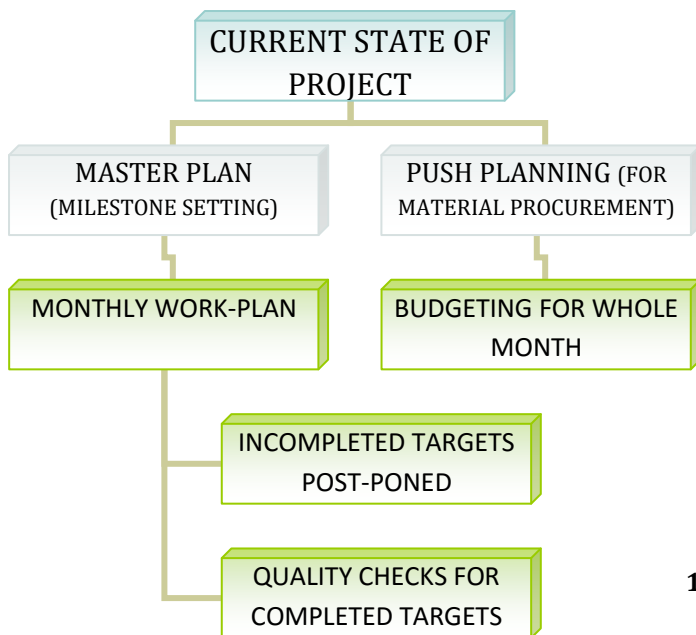


Fig-8 Flow Chart for current state of the project

targets and make achievable targets considering the problems which can be faced on the site. We came up with the following monthly work-plan for April, 2017 where the darkened bars represent the work/activities already completed:

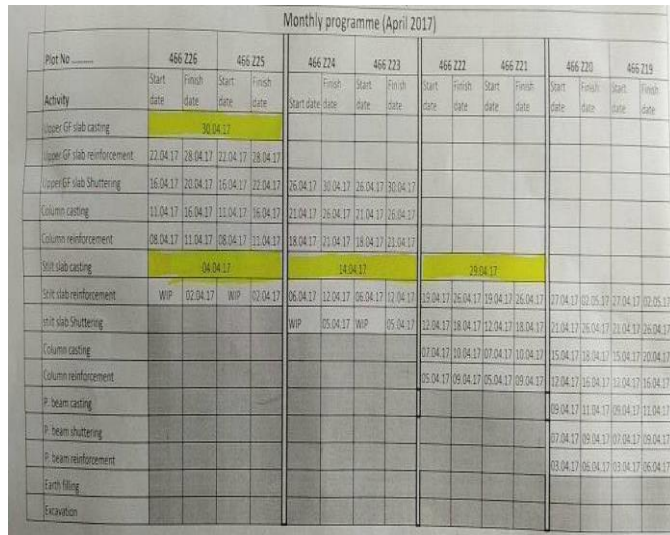


Fig.-9 Monthly work-plan for the month of April, 2017

2. **4. Weekly Planning:** Work-plans for every week were made. First week of April 2017 was planned and a table was made to see how much targeted work was actually achieved. The following table shows the weekly plans for plots 466 Z25,466Z26 :

Day (April,2017)	Activity	Target Date for 466Z26 466Z25	Actual Completion Date
1	Stilt Slab Reinforcement	2 <sup>nd</sup> April	3 <sup>rd</sup> April
2	Stilt Slab Reinforcement	2 <sup>nd</sup> April	3 <sup>rd</sup> April
3	Stilt Slab Reinforcement	2 <sup>nd</sup> April	3 <sup>rd</sup> April
4	Stilt Slab Casting	7 <sup>th</sup> April	8 <sup>th</sup> April
5	Stilt Slab Casting	7 <sup>th</sup> April	8 <sup>th</sup> April
6	Stilt Slab Casting	7 <sup>th</sup> April	8 <sup>th</sup> April
7	Stilt Slab Casting	7 <sup>th</sup> April	8 <sup>th</sup> April

Table 1 Week 1 Target and actual completion date

Day (April,2017)	Activity	Target Date	Actual Completion Date
8	Stilt Slab Casting	7 <sup>th</sup> April	8 <sup>th</sup> April
9	Column Reinforcement	11 <sup>th</sup> April	13 <sup>th</sup> April
10	Column Reinforcement	11 <sup>th</sup> April	13 <sup>th</sup> April

11	Column Reinforcement	11 <sup>th</sup> April	13 <sup>th</sup> April
12	Column Reinforcement	11 <sup>th</sup> April	13 <sup>th</sup> April
13	Column Reinforcement	11 <sup>th</sup> April	13 <sup>th</sup> April
14	Column Casting	16 <sup>th</sup> April	19 <sup>th</sup> April

Table 2 Week 2 Target and actual completion date

Day (April,2017)	Activity	Target Date	Actual Completion Date
15	Column Casting	16 <sup>th</sup> April	19 <sup>th</sup> April
16	Column Casting	16 <sup>th</sup> April	19 <sup>th</sup> April
17	Column Casting	16 <sup>th</sup> April	19 <sup>th</sup> April
18	Column Casting	16 <sup>th</sup> April	19 <sup>th</sup> April
19	Column Casting	16 <sup>th</sup> April	19 <sup>th</sup> April
20	Upper GF Slab Shuttering	20 <sup>th</sup> April	24 <sup>th</sup> April
21	Upper GF Slab Shuttering	20 <sup>th</sup> April	24 <sup>th</sup> April

Table 3 Week 3 Target and actual completion date

Day (April, 2017)	Activity	Target Date	Actual Completion Date
22	Upper GF Slab Shuttering	20 <sup>th</sup> April	24 <sup>th</sup> April
23	Upper GF Slab Shuttering	20 <sup>th</sup> April	24 <sup>th</sup> April
24	Upper GF Slab Shuttering	20 <sup>th</sup> April	24 <sup>th</sup> April
25	Upper GF Slab Reinforcement	24 <sup>th</sup> April	1 <sup>st</sup> May
26	Upper GF Slab Reinforcement	24 <sup>th</sup> April	1 <sup>st</sup> May
27	Upper GF Slab Reinforcement	24 <sup>th</sup> April	1 <sup>st</sup> May
28	Upper GF Slab Reinforcement	24 <sup>th</sup> April	1 <sup>st</sup> May

Table 4 Week 4 Target and actual completion date  
Upper GF Slab Casting was done from 2<sup>nd</sup> May to 5<sup>th</sup> May, 2017.

**5. Percent Planned Complete (PPC):**

PPC for 1<sup>st</sup> week of April =  $(1.75 \div 2) \times 100 = 87.5\%$   
 PPC for 2<sup>nd</sup> week of April =  $(1.42 \div 2) \times 100 = 71\%$

PPC for 3<sup>rd</sup> week of April=  $(1.23 \div 2) \times 100 = 61.5\%$   
 PPC for last week of April=  $(1.6 \div 2) \times 100 = 80\%$   
 Average PPC= 75%

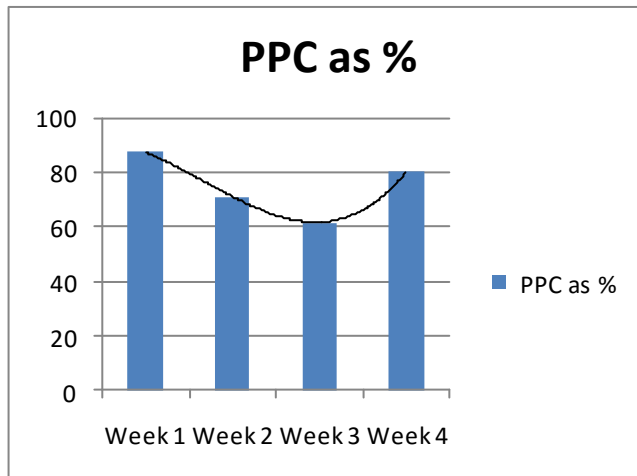


Chart-1 Histogram for percent planned complete

**6. Continuous Improvement:** After the completion of a month, percent planned complete was calculated and reasons for not completing the targets were identified. The constraints and problems faced on site were listed on a notebook and for the next time, they would be kept in mind. We discussed that the process does not end here and it was just the start of a new process called continuous improvement. The site engineers agreed that LPS and VSM better helped them to manage the resources and wastage of time and resources was significantly reduced.

## 6. IDEAL STATE OF THE PROJECT

### 6.1 Proactive Management

The ideal state of a project includes the proactive work-flow management methods which imply that the project is managed from the early stages of the construction project itself i.e. in design and planning stage. Information should flow freely from designers to project teams to last planners. There should be collaboration among every stakeholder and effective communication should take place.

### 6.2 Ideal Last Planner System process

An ideal last planner process includes the following steps:

- 1. Work Break-down Structure:** The whole project should be broken down into smaller fragments and still smaller activities to be performed on a monthly, weekly and daily basis.
- 2. Effective Communication:** The project should be discussed in a meeting which should involve management, planning team, sub-contractors, suppliers as well as the last planners.

- 3. Collaborative Process:** There should be weekly meetings among all the stakeholders and any differences regarding the plan of action should be solved collaboratively. Everyone should decide the future course keeping in mind the constraints faced by the last planners on the site.
- 4. Master Plan:** A master plan is created for the project showing the major milestones to be achieved and the time-line up to which these milestones must be achieved.
- 5. Pull Planning:** The material procurement and identification of critical activities must be according to pull planning. Material should be procured when needed and not in bulk. This will keep the inventory as low as possible. There should also be a proper place for the storage of materials.
- 6. Look-Ahead Planning:** Look-ahead plans should be made for at least 4 weeks and up to 6 weeks. Every target will be achieved on time. All the constraints are identified and removed before-hand so that there is no delay in the activities.
- 7. Quality-Checks:** All the testing of materials is done in a proper laboratory like compressive test strength of concrete cubes, hardness test of aggregates, etc. This will ensure that there is no destructive testing after the construction as it results in enhanced cost and delay in the whole project.
- 8. Weekly Planning:** Weekly work-plans are made and each activity is completed on time.
- 9. Feedback Mechanism and Learning's:** There is a proper mechanism for the feedback and any problems are immediately addressed. There will be weekly meetings where everyone will discuss the problems faced and learning's from past mistakes.
- 10. Continuous Improvement:** The management and the last planners will commit themselves on the path to continuous improvement and make improved plans in the future also.

## 7. FINDINGS AND CONCLUSION

### 7.1 Differences in traditional project management, LPS and VSM

LPS is a **bottom-up approach** whereas traditional project management uses a top-down approach. In LPS, control is handed over to comparatively lower ranks on site rather than to the higher in the hierarchy.

In the traditional project management, project is broken down into smaller parts and activities. These activities are assigned time durations mathematically using the Critical Path Method (CPM). CPM considers float for the non-critical activities which means the time for which the non-critical activity can be delayed so that the total time of project is not affected. One disadvantage of CPM is that it does not consider the information and material flow as it would make the network very complex. But considering the

**dynamic nature and variability** of the construction projects, information and material flow representation and value added becomes very important. This uninterrupted flow of material and information is created with the help of Value Stream Maps.

LPS and VSM can be applied simultaneously for shorter processes rather than the whole project. It better helps to plan a small process than a single plan for whole project. VSM also helps to identify the non value-added activities and add value to the process.

### 7.2 Challenges faced before and during implementation

The site has a number of constraints. Similar challenges were faced by us before and during the implementation. Some of them are:

1. **Stubborn Attitude:** Although the Assistant General Manager was very cooperative but the site engineers were stubborn to changes. They had a no learning attitude but due to orders of the AGM, they agreed to implement the changes.
2. **Negligible access to documents:** The site engineers were not ready to share the details of plans as they consider it company's internal documents but thanks to the AGM who allowed us access to the documents on the condition that these should not be shared with anyone and should be used only for academic purposes.
3. **Material Unavailability:** Material did not reach on time due to delay from supplier's side. Although every requirement was communicated clearly but still there was a delay. For instance, in the 1<sup>st</sup> activity of the month itself, Fe 500 steel bars did not reach the site on time leading to one-day delay in the activity and shifting the schedules of other activities also. Similarly, sometimes RMC also did not reach on time.
4. **Conduiting not on time:** After reinforcement and before casting concrete, conduits are placed. Sometimes conduiting was not done on time which led to delays.
5. **Equipment Failure:** During column casting, the vibrator failed which resulted in delay of work. Equipments fail because there is no proper maintenance schedule for the equipments and no proper place for their storage.

### 7.3 Root Cause Analysis (5 WHYS Technique)

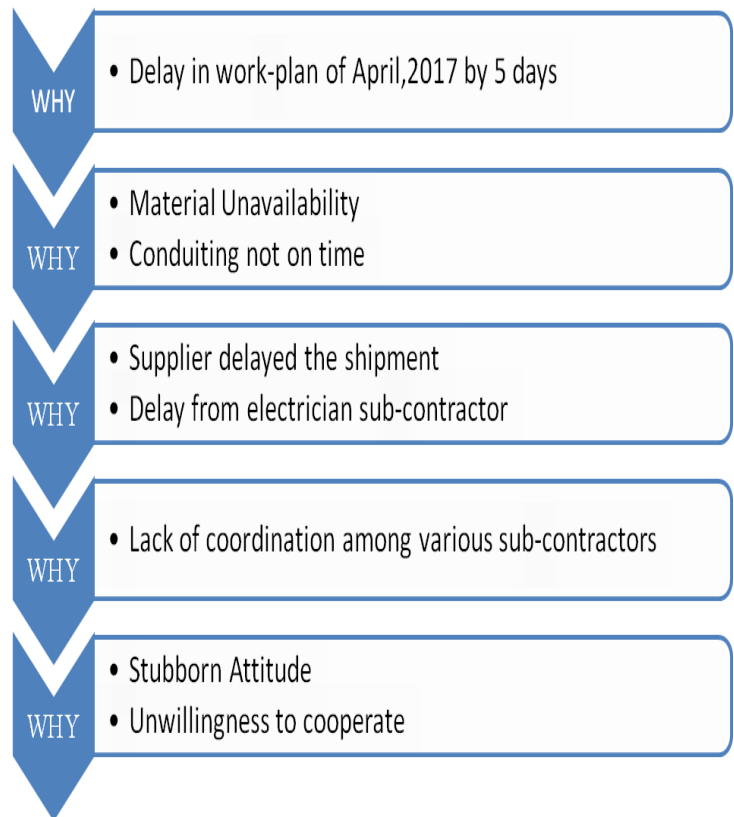


Fig.7.1 5 WHYS Analysis to find the root cause

### 7.4 Solutions for better implementation

The root-cause is the stubbornness and unwillingness to cooperate with each other and therefore if we want a better implementation then this attitude should be changed. This can be done by:

- 1) **Organizational Training:** Any organization interested in enhancing its productivity and revenues and wants to implement LPS and VSM must have a training program for the management and the last planners. This will give a motivation to the workers and enhance their interest in the process.
- 2) **Rewards:** Workers who would perform well shall be given some incentive in the form of bonus or gift. This will again boost their confidence and zeal to work better.
- 3) **Quality Certification for sub-contractors:** The sub-contractors should be hired on the condition that they have a proper quality certification and all processes should be followed religiously so that there is no problem of coordination and the sub-contractor also has an interest in enhancing the productivity while minimizing wastage.
- 4) **Shorter Processes:** Right now, in LPS at the most weekly meetings are held and considering the dynamic nature of construction, there is so much

that happen in a week. Therefore, daily hurdle meetings and shorter process cycles must be introduced to enhance the efficiency. Shorter Process Cycles would also enhance the information flow.

- 5) **Role of ICT:** Effective Communication is the key to the removal of coordination problems. With the increased usage of Internet and mobile phones in India, it has definitely helped in effective communication. Therefore, information and communication technology (ICT) must be used extensively and effectively to reduce time wastage and enhance collaboration of stakeholders.

- [7] Ballard, Glenn, and Gregory Howell. "Lean project management." *Building Research & Information* 31.2 (2003): 119-133.
- [8] Ballard, Glenn, Nigel Harper, and Todd Zabelle. "Learning to see work flow: an application of lean concepts to precast concrete fabrication." *Engineering, Construction and Architectural Management* 10.1 (2003): 6-14.

## 8. CONCLUSION

Lean construction aims to maximize value and minimize waste. Traditional project management industry is highly fragmented usually involving multiple stakeholders (e.g., structural designers, contractors, sub-contractors, investors and users) and they have to deal with complex information flows but they fail to collaborate resulting in conflicts. Whereas Last Planner System is a collaborative design process emphasizing group decision-making.

It is clear that LPS can substantially improve the cost, quality and time (CQT) and thus productivity of any construction project compared to traditional project management approach. Average PPC for this project was 75% which is much higher than traditional project's PPC. It should be kept in mind that the key to LPS is effective and useful communication, collaboration and cooperation which if achieved will enhance the productivity further.

## REFERENCES

- [1] Seppänen, Olli, Glenn Ballard, and Sakari Pesonen. "The combination of last planner system and location-based management system." *Lean Construction Journal* 6.1 (2010): 43-54.
- [2] Hamzeh, Farook Ramiz. *Improving construction workflow-The role of production planning and control*. Diss. University of California, Berkeley, 2009.
- [3] Macomber, Hal, Gregory A. Howell, and Dean Reed. "Managing promises with the last planner system: closing in on uninterrupted flow." *13th International Group for Lean Construction Conference: Proceedings*. International Group on Lean Construction, 2005.
- [4] BÄCK, MATTIAS, and RASMUS MUNTHER. "Visuell Planering Produktion."
- [5] Khan, Sheriz, and Patricia Tzortzopoulos. "Improving design workflow with the Last Planner System: two action research studies." (2015): 568-577.
- [6] Priven, Vitaliy, and Rafael Sacks. "Impacts of the Social Subcontract and Last Planner System Interventions on the Trade-Crew Workflows of Multistory Residential Construction Projects." *Journal of Construction Engineering and Management* 142.7 (2016): 04016013.