

Implementation of Last Planner System for Improving the Construction Process

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Abstract- The aim of this research is to improve the construction planning practice and enhance site management by implementing the Last Planner System (LPS). LPS was implemented in a residential building construction project through an action research process. To reach this, design science research strategy was undertaken with different data collection methods. The data collection methods included questionnaire survey, direct and indirect observations and interviews with the construction team. However, the construction industry is associated with a number of challenges which impair its performance. These challenges were grouped and classified into six major barriers: these include: supervision and quality control, fluctuation and variations, subcontractor involvement, resistance to change, cultural issues, and lengthy approvals. The research findings identify benefits including improved construction planning; intensify site management and good communication and coordination between the parties involved.

Keywords - Last Planner System, Residential building construction, Percent Plan Complete, Design science research.

I. INTRODUCTION

Last Planner System (LPS) is a system of production control that emphasizes the relationship between scheduling and production control to improve flow of resources (Ballard, 2000; Fewings, 2013). The Last Planner is the person for operational planning, that is, the structuring of product design to facilitate improved work flow, and production unit control, that is, the completion of individual assignments at the operational level (Ballard, 2000). People, information, equipment, materials, prior work, safe space and safe working environment are the seven flows required to come together at the workplace to enable construction transformation to flow. The Last Planner System (LPS) manages all seven flows by building relationships, creating conversations, and by securing commitments to action at the right level at right time throughout the process (Mossman 2008).

According to Ballard and Howell (1994), the use of Lean-based tools like Last Planner reduces accident rates. The aim of Last Planner System according to Ballard (1997) is to improve productivity by eliminating barriers to workflow. One of the main advantages is that it replaces optimistic planning with realistic planning by assessing the last planners' performance based on their ability to achieve their commitments (Salem et. al, 2006).

II. LITERATURE REVIEW

Usama Hamed Issa (2013) stated that many construction projects involve different risk factors which have many impacts on time-overrun. This study suggests and applies a new approach for reducing risk factors and its effect on time using lean construction process. Assessing the effect of using the new tool like Percent Expected Time-overrun (PET) and the other is Percent Plan Completed (PPC). The very important risk factors are also identified and evaluated, while PET quantified at the starting stage of the project and during the project execution stage a quantification model used for time-overrun quantification.

Mohd Arif Marhani et al. (2013) proposed that sustainability through Lean Construction Approach. The aim of this research is to give the basic fundamental concept of Lean construction and highlight the main barriers of its implementation process. A wide and extensive literature reviews conducted by retrieving articles related from journals ranging from the year 1992 to June 2012. From the various review of literature search, it identified that Lean construction ability in improving the project performance especially in reducing site waste, construction

stipulated time and overall cost of the construction, improving quality of the projects and environmental as whole.

Ojo et al (2014) established a qualitative approach to analyze barriers in implementing green supply chain management in Nigeria. The results revealed the following barriers: lack of public awareness, lack of knowledge and environmental impact, poor commitment by top management, lack of legal enforcement by government, lack of resources, lack of sustainable practices, lack of market, and lack of information sharing, lack of demand. He stated that the teaching techniques of lean construction and project management training programs conducted for motivating the research scholars and practitioners. It was also concluded that the success of the training Course is reflecting the opportunities for improvement identified between editing and publishing, made possible through the feedback collected from participants.

Raghavan et al. (2014) proposed implementing the Lean Concepts on Indian Construction Sites. Construction industry in India has been on a rapid growth path lately and increasing efficiency and profitability has been a key concern. IIT Madras, an educational institution, had recently taken up a program as a challenge to give training and implementation of Lean construction process in few trial projects through seminar halls and webinar based training course, reporting in technical formats, monitoring and motivating by site visits and carrying out reviews regularly. Construction sites encouraged to adopt the Last Planner System technique and to use other Lean tools in-depth help from the Faculty. It was also concluded that by implementing the lean concept and practices in Indian construction projects; will cut the overall project time and will improve the project planning and scheduling.

III. RESEARCH METHOD

Having reviewed the relevant literature for the research, it is now imperative to demonstrate the philosophical principles behind the research and how it was designed to address its objectives. This describes the methodology used in carrying out this research. It introduces Design Science Research (DSR) methods and further justifies the adoption of this research method employed to meet the objectives of this research. Design science research approach is introduced as an alternative approach to the traditional research methods employed within construction management. It also discusses the data collection and evaluation processes utilized in carrying out this research. DSR in itself is an innovative research method; hence it serves as a contribution to knowledge in whatever fields it is applied. DSR focuses on the development (construction) of a solution and its evaluation (Hevner *et al.*, 2004). It allows for several data collection tools rather than a single method of data collection. Hence, multiple sources of data collection were employed in this research. It included: interview, focus groups, participant and non-participant observation, survey questionnaires and documentary analysis. The data was evaluated based on the utility, quality and efficacy of the information gathered.

IV. LPS IMPLEMENTATION

A. Case background

The case study was carried out in an on-going construction project at Gachibowli located at the outskirts of Hyderabad city. The project is for the construction of proposed Amazon Development Centre India Private Limited at Hyderabad with all facilities. It is located at about 20 km away from Secunderabad, the site is opposite to Wave rock building which serves as a landmark to the site, and it is 5 km away from the Outer Ring Road at Gachibowli Exit.

The data for the research work was gathered in three phases which consisted of:

- Pre-implementation
- Implementation, and
- Post-implementation phase.

B. Pre-implementation phase

The data collected from the contractor during the observation and interview session in this section is discussed. The researcher started with the non-participant observation, followed by the interview, which served as a validation of the findings obtained from the observation process. These findings from the contractor are discussed below.

TABLE I. Phases of data collection process

Phase 1	Pre-Implementation	<ul style="list-style-type: none"> • Non-Participant Observations • Interviews
Phase 2	Implementation	<ul style="list-style-type: none"> • Participant Observations • Documentary Analysis
Phase 3	Post-Implementation	<ul style="list-style-type: none"> • Questionnaires

TABLE II. Findings with the non-participant observations with the Contractor

Site Activities	Contractor – Shapoorji pallonji & Co Pvt. Ltd.
Planning practice in terms of labor and material schedules.	Labor and Materials were properly coordinated in an arranged manner as per the site map.
Frequency of Site Meetings.	Daily and regular site meetings.
Site Coordination.	Work is properly structured but partly properly coordinated.
Communication and Relationships.	Good communication channel with modern communication gadgets as well as a good coordinational relationship between the projects participants.

TABLE III. Findings from the Interview of the Contractor

Site Activities	Contractor – Shapoorji pallonji & Co Pvt. Ltd.
Current Planning - Frequency of Site Meetings	Meetings are held daily
Control - Site Manager	Site Engineers coordinate different sections of the site
Communication Gadgets	Communication Gadgets like Walkie-Talkies were used.
Project Management Systems in Place	Critical Path Methods (CPM)
Lean Awareness	Aware of Lean Construction but have never practiced it in work.

C.Implementationphase

The researcher introduced the concepts of Lean Construction and the Last Planner System to the contractor carrying out the construction of the Amazon IT services, Hyderabad. The contractor (Shapoorji Pallonji & Co Pvt. Ltd.) was keen on improving the way they previously coordinated, planned and controlled site activities. The implementation commenced with a brief seminar on the concepts of Lean construction and the Last Planner System. The workshop was held on the 15th April, 2016, and the employees of Shapoorji Pallonji & Co Pvt. Ltd. ensured that all the project participants including its subcontractors were a part of this seminar.

From Table-IV and Figure-1, the average PPC is 48.72 % which is a very low PPC. The reasons for the incomplete assignments that led to a low PPC is shown in figure-2.

TABLE IV. Comparison of 4 weeks of PPC (20/04/2016 – 17/05/2016)

Weeks	No. Of Completed Tasks	No. Of Incomplete Tasks	Total Tasks	PPC
20/04/2016 - 26/04/2016	6	5	11	54.55 %
27/04/2016 - 03/05/2016	5	4	9	55.56%
04/05/2016 - 10/05/2016	4	6	10	40.00 %
11/05/2016 - 17/05/2016	4	5	9	44.44%
	19	20	39	48.72 %

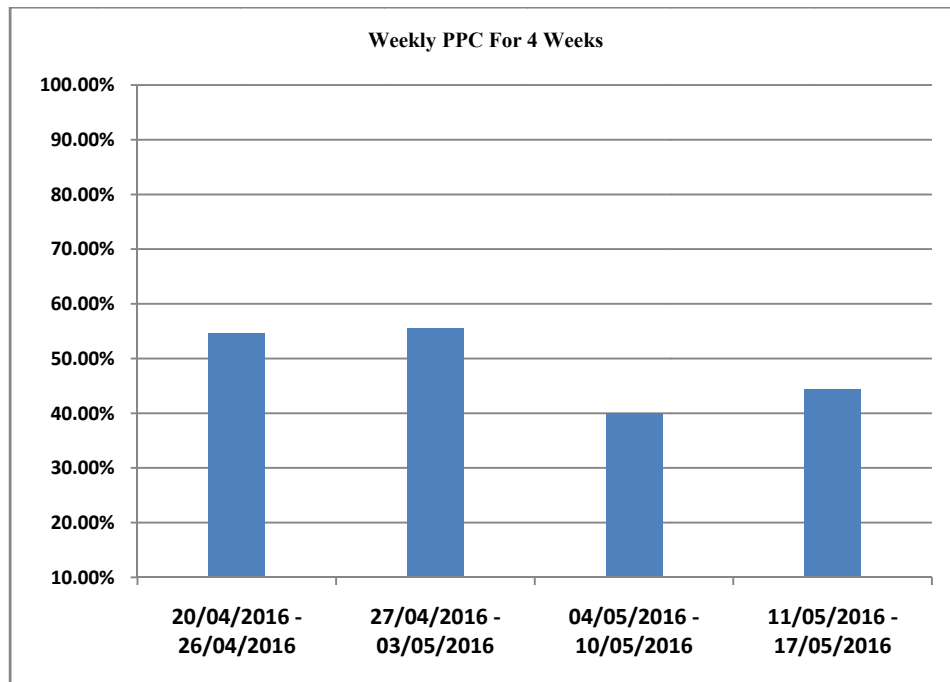


Fig.1. Weekly PPC for Four Weeks (20/04/2016 – 17/05/2016)

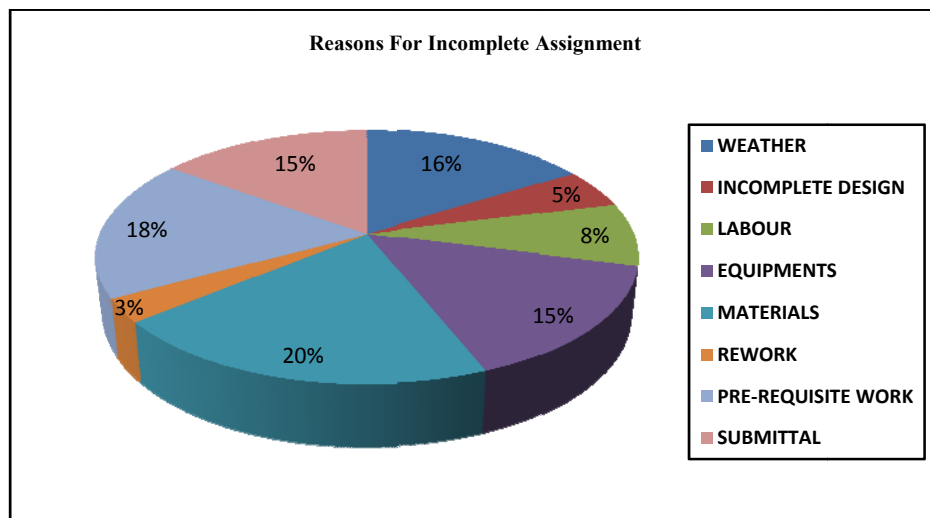


Fig.2. Reasons for incomplete assignment for first look-ahead schedule (20/04/2016 – 17/05/2016)

TABLE V. Comparison of 4 weeks of PPC (18/05/2016 – 14/06/2016)

Weeks	No. Of Completed Tasks	No. Of Incomplete Tasks	Total Tasks	PPC
18/05/2016 - 24/05/2016	7	5	13	58.33 %
25/05/2016 - 31/05/2016	6	6	12	50.00 %
01/06/2016 - 07/06/2016	9	5	16	64.29%
08/06/2016 - 14/06/2016	6	6	12	50.00 %
	28	22	50	56%

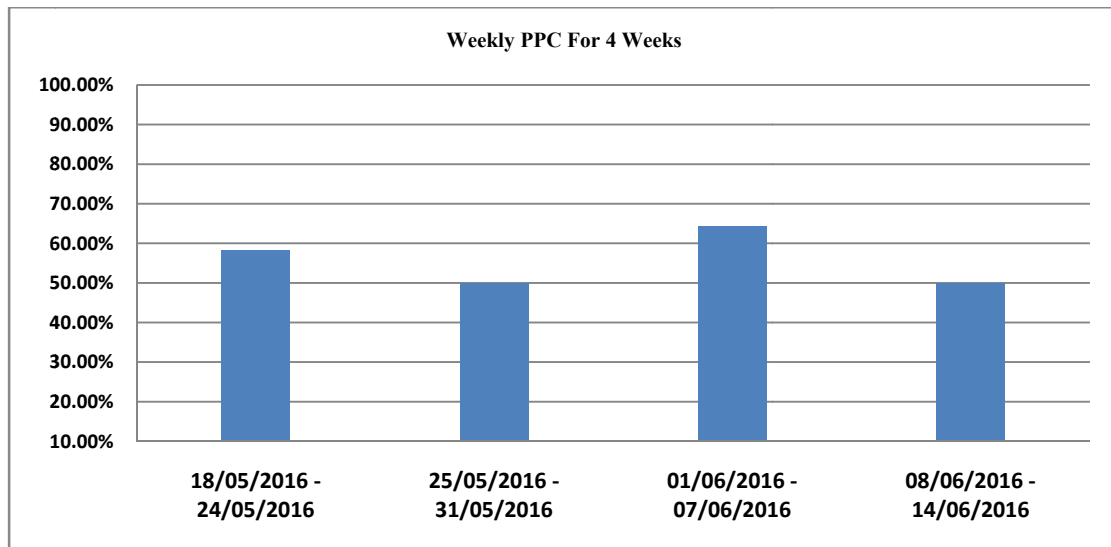


Fig.3.Weekly PPC for Four Weeks (18/05/2016 – 14/06/2016)

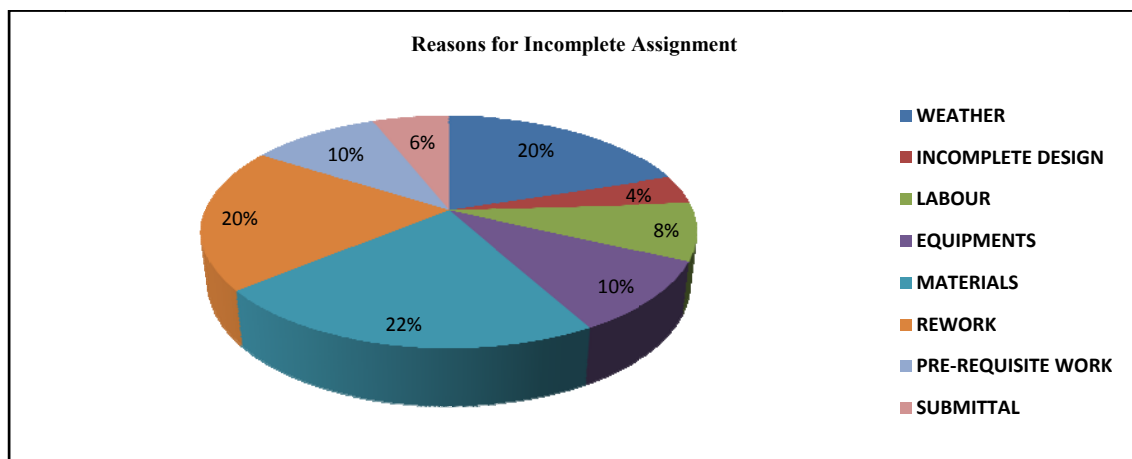


Fig.4.Reasons for incomplete assignment for second look-ahead schedule (18/05/2016 – 14/06/2016)

Furthermore, table 5 indicates the PPC's recorded within the second look-ahead schedule (second month) of the implementation. The average PPC recorded in this (i.e. second) month was 56%. This was higher than the average PPC (48.72%) recorded in the first month of the observations. An improvement in the average PPC's was observed as each team saw the importance of keeping reliable promises.

The PPC's for the third look-ahead schedule is presented in table 6 and figure 5 shows a noticeable improvement on the PPC's and the average PPC recorded within these four weeks is 66.04%.

TABLE VI. Comparison of 4 Weeks of PPC (15/06/2016 – 12/07/2016)

Weeks	No. of Completed Tasks	No. of Incomplete Tasks	Total Tasks	PPC
15/06/2016 - 21/06/2016	10	2	12	83.33 %
22/06/2016 - 28/06/2016	9	7	16	56.25 %
29/06/2016 - 05/07/2016	8	6	14	57.14 %
06/07/2016 - 12/07/2016	8	3	11	72.73 %
	35	18	53	66.04 %

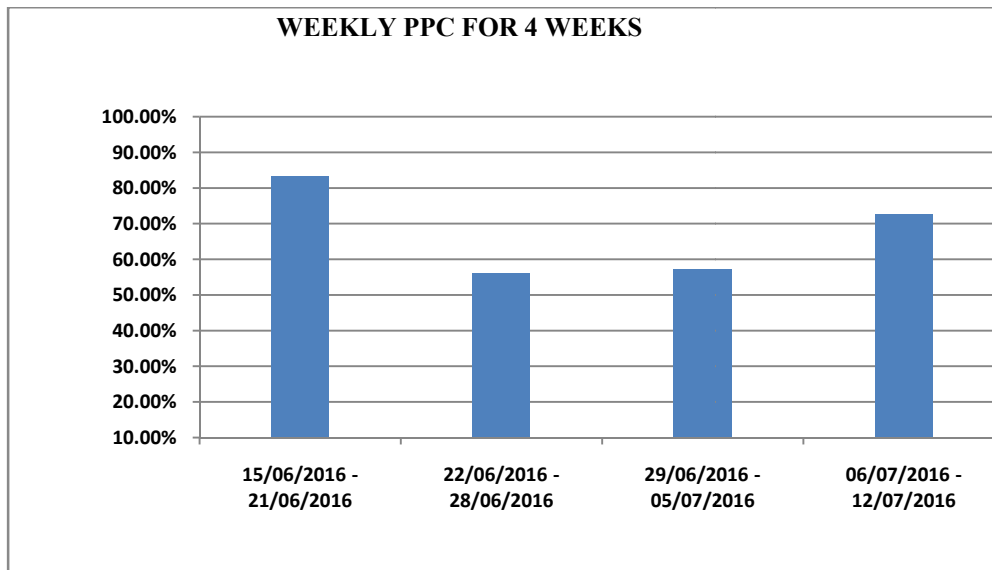


Fig.5. Weekly PPC for 4 Weeks (15/06/2016 – 12/07/2016)

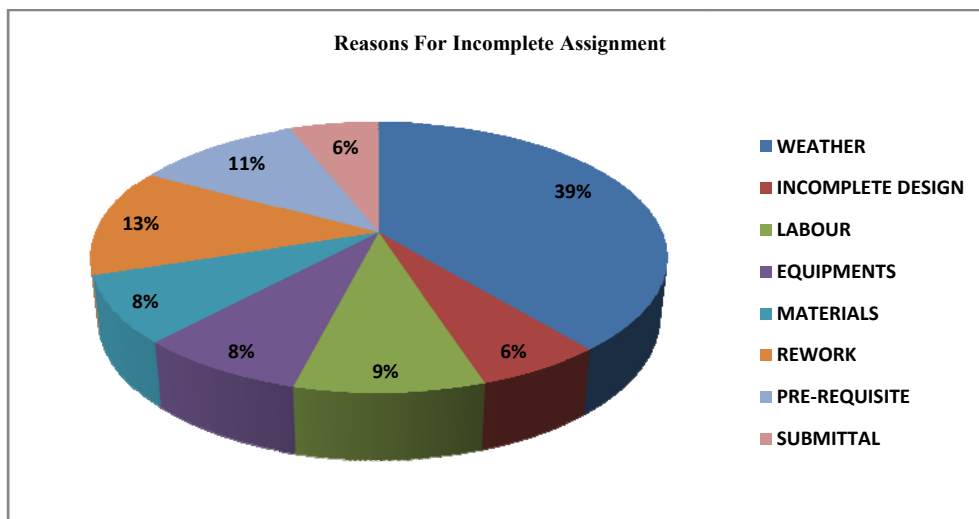


Figure.6.Reasons for incomplete assignment for third look-ahead schedule (15/06/2016 – 12/07/2016)

4.4. Post Implementation Process

A. Questionnaire Surveys Questionnaire surveys were administered to the project participants to evaluate the Last Planner System implementation process. The questionnaire was classified into four sections (section A - D). The first section (i.e. Section A) focused on getting an overview of the outcome of the implementation. Whereas, the second section (i.e. Section B) focused primarily on the barriers of the implementation process. The third section (i.e. Section C) gave attention to the critical success factors of the implementation process. Furthermore, the last section (i.e. Section D) dwelt on the benefits perceived on implementing Last Planner System on the case project. The respondents for the questionnaire comprised of the contractor's team, the employer's and the suppliers. A percentage breakdown of the respondents is shown below in Table 7 and the details of the questionnaires and their corresponding responses are discussed below.

Out of the 22 employees involved in the survey 24 (96%) provided responses accordingly. Out of the respondent, 13 (54.17%), 4 (16.67%), 4 (16.67%) and 3 (12.50%) are respectively contractor's team, client's team, sub-contractor's team and the supplier's team.

TABLE.VII. Respondents of the questionnaire for Case Study

Respondents Total	22	100%
Contractor's Team	13	59.09%
Consultant Team	2	9.09%
Subcontractor's Team	4	18.18%
Supplier's Team	3	13.63%

1)Section-A

The question that whether Last Planner System is effective within the project or not, was examined by the 22 respondents under the 5 Point Likert Scale. The percentage of those accepting the effectiveness of Last Planner System within the project is 100%.

Furthermore, it was identified that 100% of the respondents agreed to the statement that as compared to their previous projects, the results were quiet satisfactory this time as shown in Table 8. In the same way, the question that whether the weekly work plans or PPC's were useful to the implementation was carefully examined, 91% respondents agreed on the usefulness of weekly plans and PPC while the remaining 9% respondents were indifferent or disagreed.

Additionally, from the survey results of the respondents felt that the process of implementing Last Planner System was not at all difficult and they felt it was easy to carry out the implementation of Last Planner System

TABLE VIII. Overview of the Implementation (Section A)

Sr.No.	Reasons	Weighting Frequency (F)										
		1	2	3	4	5	$\sum f$	\bar{x}	RII	Rank	Rating	% Rating
01.	LPS was very effective within this project.	0	0	0	15	7	22	4.32	0.86	3	Very High rating	100
02.	The results obtained from the implementation were satisfactory as compared to the previous projects.	0	0	0	4	18	22	4.81	0.96	1	Very High rating	100
03.	The weekly work plans and PPC were very useful.	0	2	0	4	16	22	4.36	0.87	2	Very high rating	91
04.	Difficulty to carry out the implementation.	8	10	4	0	0	22	1.81	0.36	4	Low rating	0

2) Section-B:

The questions in this section are primarily focussed on the barriers that were faced during the implementation of Last Planner System. The questions were formatted using a 5-Point Likert Scale for each attribute attached to the question. The attributes were divided into 6 options identifying possible barriers to the Last Planner System implementation.

From table 9, it was observed that 64% agreed to the option that supervision/quality control was a barrier to the implementation, while 32% were of the opinion that fluctuations and variations were barriers during the implementation. Furthermore, 59% indicated that employer's involvement was a barrier faced by the company during the implementation.

In the same vein, 82% agreed that resistance to change was a major barrier. While another 100% were of the opinion that cultural issues was a barrier. Finally, 86% agreed that lengthy approval procedure by the client was a barrier to the implementation process.

TABLE IX. Barriers during the Implementation (Section B)

Sr. No.	Barriers	Weighting Frequency (F)										
		1	2	3	4	5	ΣF	\bar{x}	RII	Rank	Rating	% Rating
01.	Poor Supervision & Quality Control	0	2	6	13	1	22	3.59	0.72	5	High rating	64
02.	Fluctuations & Variations	0	5	10	6	1	22	3.16	0.63	6	High rating	32
03.	Employer's Involvement	0	3	6	9	4	22	3.63	0.73	4	High rating	59
04.	Resistance to Change	0	0	4	14	4	22	4	0.8	3	Very High rating	82
05.	Cultural Issues	0	0	0	16	6	22	4.27	0.85	2	Very High rating	100
06.	Length approval issues by Client	0	0	3	9	10	22	4.31	0.86	1	Very High rating	86

3) Section-C:

This section evaluates the critical success factors of implementing Last Planner System within this case study. The attributes for the question raised in this section, were possible success factors derived from the literature reviews and from the site observations during the implementation. Table 10 shows the views of the respondents. Here, 100% respondents agreed that training and empowering last planners were a critical success factor (CSF) to the implementation. In the same vein, 91% respondents agreed that involvement of all stakeholders (i.e. team work) was a major CSF to the implementation. Similarly, 100% were of the opinion that motivating people was a CSF to the process, while 100% affirmed that top managements support was one of the critical success factors. On the other hand, 82% indicated that managing resistance to change was a CSF. Similarly, 95% agreed that having a close relationship with suppliers was a CSF for the implementation. Conversely, 73% of the respondents were of the opinion that having appropriate human capital was a CSF, while the remaining 27% respondents were either indifferent or disagreed that having appropriate human capital was CSF.

Table X. Critical Success factors to the Implementation (Section C)

Sr.No.	Factors	Weighting Frequency (F)										
		1	2	3	4	5	ΣF	\bar{x}	RII	Rank	Rating	% Rating
01.	Training & Empowering Last Planners.	0	0	0	18	4	22	4.18	0.83	3	Very High rating	100
02.	Involvement of all Stake Holders (Team Work).	0	0	2	18	2	22	4	0.8	6	Very High rating	91
03.	Motivating People to make changes.	0	0	0	10	12	22	4.54	0.9	1	Very High rating	100
04.	Having the appropriate Human Capital.	0	2	4	12	4	22	3.81	0.76	7	High rating	73
05.	Top Management Support.	0	0	0	12	10	22	4.45	0.89	2	Very High rating	100
06.	Manage Resistance to Change.	0	2	2	10	8	22	4.09	0.82	5	Very High rating	82
07.	Close Relations with Suppliers.	0	0	1	18	3	22	4.09	0.82	4	Very High rating	95

4) Section-D:

This section focused on the benefits of implementing Last Planner System in construction. Ten benefits were suggested as possible benefits of implementing Last Planner System and respondents were expected to express their views by indicating their levels of agreement in a 5-point Likert scale. Table 11 shows the responses gathered from this section, and the frequency of influence the perceived benefits had on the project.

It was observed that 96% of the respondents agreed that LPS identifies and addresses potential problems before they become obstacles. In the same vein, 86% agreed that LPS reduces the incidence of bad news and completes project on schedule. However, only 32% of the respondents accepted to the benefits that LPS develops supervisory skills, reducing the load on management. Similarly, 50% accepted that LPS creates a more predictable and reliable production program, with the remaining 50% disagreed.

59% agreed on Last Planner System's ability to deliver the project more safely faster and at a reduced cost. Similarly, 68% admitted that it stabilizes projects and support other lean actions, while 82% identified that Last Planner System had the potential to improve construction logistics on projects.

Additionally, 45% respondents indicated that Last Planner System has the benefit of improving predictions of labour required within any project. However, 50% agrees that it is able to reduce the risk of catastrophic loss while 50% disagreed on this opinion. And finally 100% of the respondents agreed on its ability to complete project on schedule.

TABLE XI: Benefits of the Implementation (Section D)

Sr.No.	Benefits	Weighting Frequency (F)										
		1	2	3	4	5	ΣF	\bar{x}	RII	Rank	Rating	% Rating
01.	Solve Problems on time.	0	0	1	12	9	22	4.36	0.87	1	Very High rating	96
02.	Reducing the incidence of bad news & to get what bad news there is early.	0	0	3	12	7	22	4.18	0.84	3	High rating	86
03.	Developing Supervisory skills & reducing the load on Management.	0	5	10	6	1	22	3.14	0.63	10	High rating	32
04.	Creating a more predictable & reliable production program.	0	2	9	6	5	22	3.63	0.73	7	High rating	50
05.	Delivering projects more safely, faster & at reduced costs.	0	3	6	9	4	22	3.63	0.73	6	High rating	59
06.	Stabilize projects & support other lean actions.	0	0	8	10	4	22	3.81	0.76	5	High rating	68
07.	Improving Construction Logistics on Projects.	1	0	3	12	6	22	4	0.8	4	Very High rating	82
08.	Improving Predictions of Labour Required.	1	2	9	7	3	22	3.4	0.68	9	High rating	45
09.	Reduces the risk of Catastrophic Loss.	0	4	7	6	5	22	3.54	0.71	8	High rating	50
10.	Completes projects on Schedule.	0	0	0	15	7	22	4.32	0.86	2	Very High rating	100

V. CONCLUSION

It was observed that Contractor produced substantial results in terms of time, cost and quality performances. The contractor completed the construction project two months before than the actual completion date allocated to the project. The contractor had a better allocation of resources, an organized flow and access of materials and this reduced interference amongst working teams by making all the team members aware of what to do and when to do each assignment.

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.

Thus implementation of Last Planner System helped the project team to receive information regularly of the project success and failures during weekly meetings. It also analyzed the findings from the survey questionnaire to assess participants' views of the process. On the whole, they agreed that LPS had a significant and positive impact on the whole project management.

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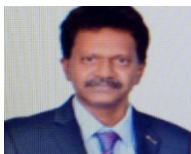
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