IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

IDENTIFICATION AND MITIGATION OF CHALLENGES TO IMPLEMENT LAST PLANNER SYSTEM IN INDIAN CONSTRUCTION PROJECTS

[1]Souvik Das, [2]Vaibhav Bawaniya, [3]Dr. Virendra Kumar Paul, [4]Dr. Chaitali Basu

[1]Studnent, [2]Assistant Professor, [3]Professor, [4] Assistant Professor

[1]Department of Building Engineering and Management,

[1]School of Planning and Architecture, New Delhi, India

Abstract: In recent years projects have increasingly used Last Planner System (LPS) in building construction. However project managers still struggle with figuring out how the LPS could be applied on their specific projects. One main reason for this struggle is that explicit instructions for systematically applying LPS are not available. This seminar aims to identify LPS implementation challenges and an indication of how LPS can be applied. This seminar qualitatively aggregates the results of literature study and 8 case examples from India to identify LPS implementation challenges, Critical success factors and qualitative analysis (RII) of those challenges through questionnaire surrey (from professionals who has some experience of working with LPS).

After identification and analysis of challenges and success factor it is observed that challenges can be mitigated indirectly through minimizing of construction waste. A live case example is taken and causes of wastes is identified for mitigation of challenges that might occur during the implementation of LPS. Besides that some implementation techniques of LPS are proposed for 3 weeks.

Main finding of this research are, a) majority of challenges of implementation are due to stubborn attitude, management problem, unskilled labors, non-involvement of stakeholders' etc. b) challenges can be mitigated directly through improving involvement, pushing workers to adopt news system by training, proper management etc. and indirectly by minimizing waste. 3) The major reasons behind wastes are arrives from management related issues and worker related issues.

Index Terms - Lean principle, Lean construction, Last Planner System, Challenges of Implementation of LPS, Mitigation, Success factors, Causes of Waste

I. INTRODUCTION

Lean construction is termed as a "Way to design production systems to minimize waste of materials, time, and effort in order to get the maximum amount of value" (BALLARD, 2000). Lean in its simplest form means eliminating waste from every aspect of the work process while ensuring that value-adding activities are completed in the most efficient and time effective manner. Lean has been successfully applied in all sectors of business, service and project delivery, resulting in improved performance in quality, time, cost and bottom line profit. Lean also helps organizations to develop their people, at the same time creating a culture of continuous improvement. In Indian construction industry, availability of skilled labors is a major problem. Due to the unskilled labour and poor workmanship, sometimes the quality of the project is in question. To avoid such a problem, and to build a quality, construction firms require use of latest innovative technology. One of such a technique used in the study is called lean management. Lean management helps in addressing the problems related to labour and some other problems related to construction quality. The implementation of lean techniques in the construction industry will help in increasing the profit and quality of project in reasonable time. The main prospect of lean management principle is "Drive more value by using less of everything" (Anon., n.d.). But they are many challenges faced for implementing lean concepts in our Indian construction industry.

The construction industry is influenced by a number of issues, which necessity to be explained and addressed. The chronic problems of construction projects poor performance are low productivity, risk, and defective design, inferior. Working conditions, and insufficient quality etc. Unfortunately, these chronic problems have created a large wastes volume, which the owner, in reality, is paying as a part of the project budget. The construction industry is known to be one of the largest environmental polluters, physical waste producers, and energy consumers throughout its lifecycle. Because of these challenges in the built environment, including issues relating to rapidly growing populations and anthropogenic climate changes, there is an important need in proceeding the industry towards sustainable development. Therefore, lean construction approach was transformed from the car manufacturing industry into the construction industry to reduce the waste and optimize the resources. Lean construction is a mixture of operational research and practical development in design and construction with an adjustment of lean manufacturing philosophies and practices to the end-to-end design and construction procedure.

Dissimilar manufacturing industry, the construction industry is a project-based production procedure. Lean construction is worried about the alignment and holistic pursuit of concurrent and continuous enhancements in all measurements of the built and natural environment: design, construction, repairs, retrieving and reprocessing. One of the lean construction tools is Last Planer Concept (LPC), which usually applied to cover the project planning and scheduling procedure. Therefore, this proves to be a perfect method in dealing with waste minimization and efficiency improvement by the analysis of the per cent of planned complete. The important role of the last planner concept is to replace optimistic planning with realistic planning by assessing the performance of workers based on their capability to reliably achieve their promises. The aim of the last planner is to pull the tasks by reverse phase scheduling through team planning that optimize the project resources.

This paper investigates the barriers of implementation of LPS in Indian construction industry and mitigation techniques.

A. Aim

To identify challenges of implementing last planner system in Indian construction projects and proposing mitigation

B. Objectives

1. To understand lean construction principle and last planner system.
2. To identify challenges by observing Last Planner System being practiced in Indian Construction Projects.
3. To identify success factors and propose mitigation for challenges (by minimizing wastes) of implementation of LPS on construction projects.

C. Research Methodology

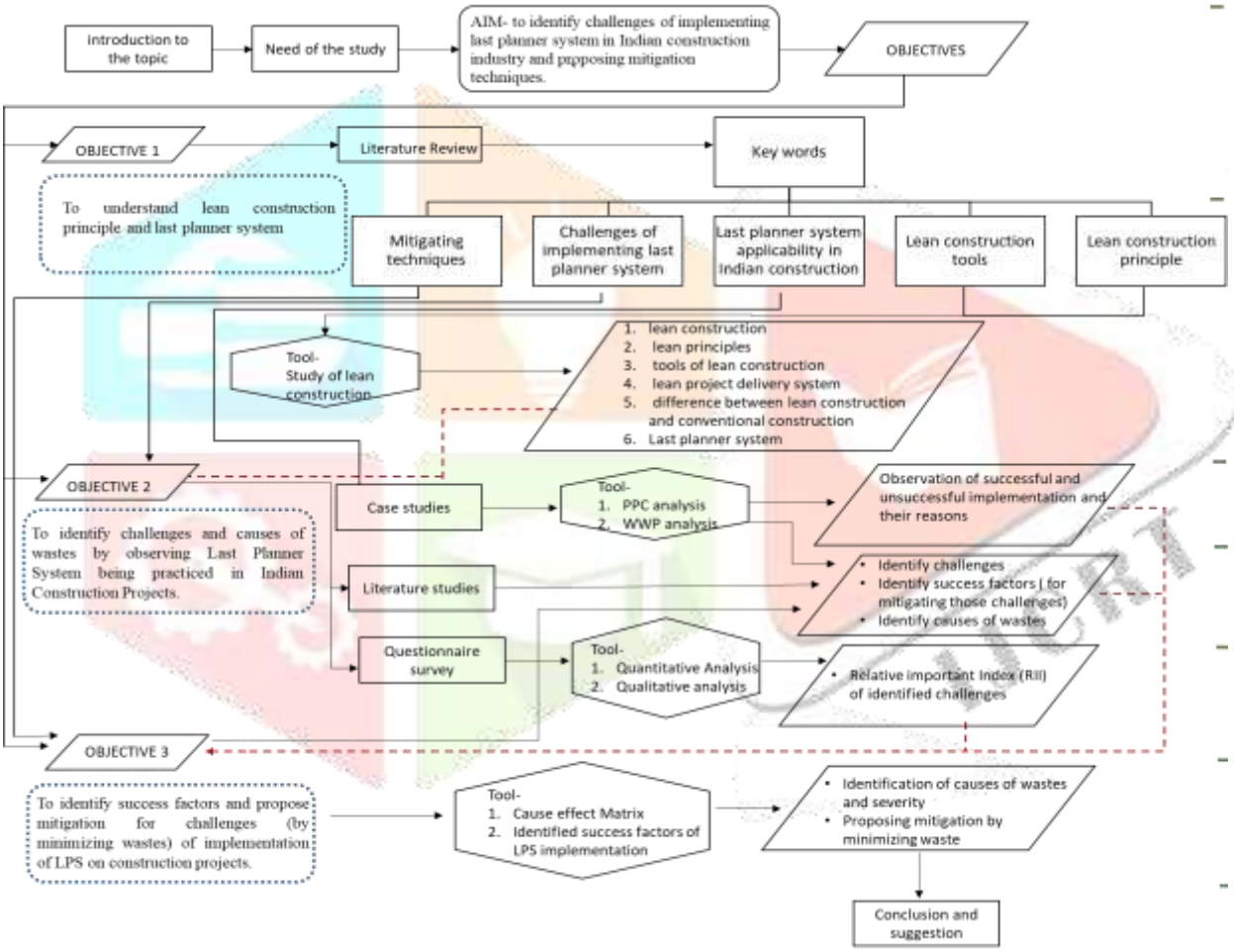


Figure I.1 research methodology flow chart

II. Literature Review

The credit for the development of lean principles goes to the Toyota Car Company of Japan which has revolutionized the way of manufacturing of automobiles. From the mass production theory which was being followed by Henry Ford in US, the manufacturing industry today has certainly come a long way. But before elaborating on the contributions of Toyota in the development of lean principles, it is important to understand the reasons behind the need of a new manufacturing technique when Ford was going great guns in delivering the consumer a cheap and yet an efficient product.

A. Last Planner System

Developed by Prof. Glenn Ballard of the University of California at Berkeley (2000), it aims to reduce / remove the uncertainties plaguing the construction project processes. In CCPM there is strict adherence to the master schedule even when great obstacles lie in its path. Supervisors keep on pressurizing the subordinates to produce despite obstacles. Many a time these obstacles result in poor quality output which remain in the project supply chain throughout.

Last Planner System (LPS) aims to shift the focus of control from the workers to the flow of work that links them together. The two main objectives of LPS are to make better assignments to direct workers through continuous learning and corrective action and to cause the work to flow across production units in the best achievable sequence.

Planning for the project cannot be performed in detail much before the events being planned. Consequently, deciding what and how much work is to be done by a design squad or a construction crew is rarely a matter of simply following a master schedule established at the beginning of the project. Hence it is imperative that LPS focuses on making a 6 -8 weeks look ahead schedule with detailed weekly plans in discussion with the last planners (persons who actually execute the work) based on the current situations. The activities from the master schedule are broken down to great details. Assignments are prepared for the workers to work upon. Ballard (BALLARD, 2000)suggested that assignments should satisfy the following criteria before being allocated to the workers:

1. Work should be clearly defined.
2. Work should be sequenced properly.
3. All pre requisites for the work should be obtained and the constraints should be removed.
4. Work should be sized based on the availability of the crew.

The assignments satisfying the above criteria enter the workable backlog. All the other assignments are postponed till the time they satisfy the above mentioned criteria. In this way

The workers are never overloaded, they only do what they promised and this helps to keep a track of the productivity. Failure to keep commitments is investigated so that they do not occur again. This is done by a factor known as PPC (percent planned complete). Ideally this should be 100% as everyone is expected to keep his commitments but generally a value of 80% is considered to be good. All the above lean construction tools are used in the last planner system. As the Last Planner System involves the pull approach to form a workable backlog, it utilizes the just in time tool, since all the persons involved in the project sit together to form the look ahead schedule, wherein continuous improvement is built into the process. Thus the Last Planner System serves to successfully remove the uncertainties in the construction process.

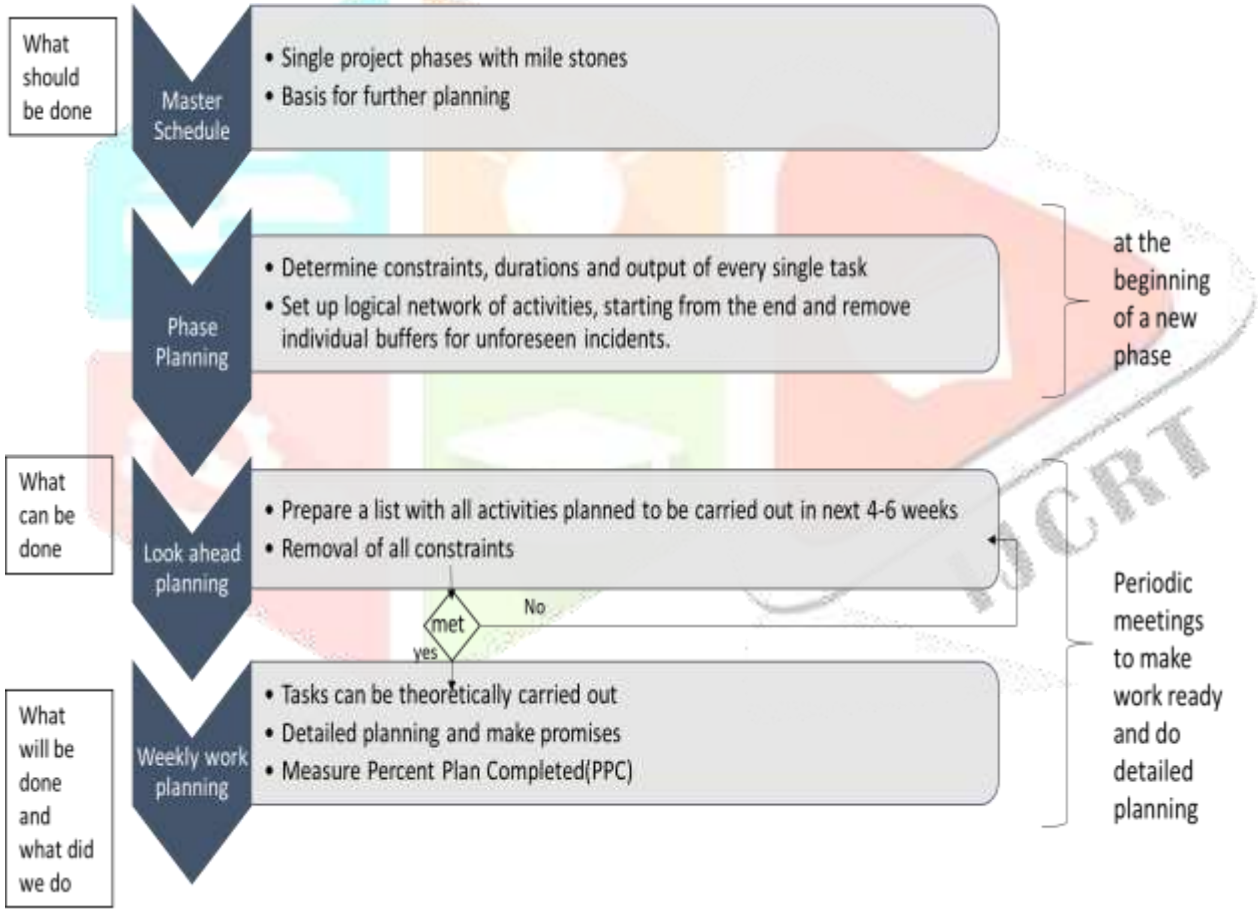


Figure II.1 Phases of last planner system

B. Challenges of Implementation-

Challenges Faced during the Implementation and Use of LPS The introduction of the LPS to a site, into a company or into a country is not an easy and uncomplicated task (Koskenvesa and Koskela 2005). In addition to certain benefits, academicians and practitioners have reported the challenges faced by AEC professionals during the implementation of using LPS. AEC professionals face challenges at two stages. First is the implementation stage, when the project team is introduced to LPS and pilot projects are in progress. These are organizational challenges faced by senior and mid-level management in the initial stages. During the second stage, LPS is used by an experienced team and technical challenges associated with skill building and human capital needed for using LPS are introduced.

the barriers during the implementation of LPC discussed in construction projects are: "(1) Lengthy approval procedure from client and top management, (2) Involvement of so many parties joined the project, especially subcontractors and suppliers, (3) Low understanding of the process planner to the concepts of last planner, (4) Weak communication and transparency among participants of the production process, (5) Lack of integration of the production chain between client, consultant, contractor and supplier, (6) Inadequate administration of the necessary information to generate a "learning cycle" and to take corrective actions, (7) Low implementation of advanced technology in

construction, (8) Language and cultural issues when performing a project, (9) Shortage of the training course for the directors when planning and controlling a project, and (10) Over-commitment to the work which can be done in a look ahead plan.

In this paper 26 cases in worldwide and 8 cases from India is observed and the challenges faced by those projects are being classified into 6 categories, (1) workers related (2) management related (3)legal reason (4) stakeholders related (5) administration related and (6) others. A caparison of the barriers /challenges faced between India and worldwide construction projects is made

Table II-1 Barriers of implementation of LPS

	challenges	Ballard (2000)	Garza and Leong (2000)	Alarcón et al. (2001)	Alarcón et al. (2002)	Fiallo and Revelo (2002)	Kim and Jang (2005)	Koskenvesa and Koskela (2005)	Salem et al. (2005)	Arbulu and Soto (2006)	Ansell et al. (2007)	Ballard et al. (2007)	Jang et al. (2007)	Kemmer et al. (2007)	Kim et al. (2007)	Sterzi et al. (2007)	Alarcón et al. (2008)	AlSehaimi et al. (2009)	Hamzeh (2009)	Jara et al. (2009)	Liu and Ballard (2009)
1	Organizational inertia or Resistance to change or "This is how I always done it" attitude		✔		✔	✔		✔	✔		✔	✔	✔			✔		✔			
2	Lack of commitment to LPS implementation or Attitude towards new systems	✔	✔	✔					✔	✔		✔	✔					✔			✔
3	Lack of human capital - Lack of understanding of new system or difficulty to make quality assignments or Lack of skills and experience	✔					✔			✔			✔	✔	✔				✔	✔	✔
4	Lack of training	✔			✔							✔							✔	✔	
5	Lack of leadership or Failure of management commitment or Organizational climate	✔	✔	✔	✔					✔		✔									✔
6	Lack of stakeholder support	✔	✔						✔					✔							
7	Partial or late implementation of LPS			✔	✔													✔			✔
8	Poor use of information generated during implementation of LPS	✔											✔				✔				
9	Lack of empowerment of field management or Lengthy approval												✔					✔			✔

	procedure from client and top management																			
10	Extra resources or More paper work or Extra staff or More meetings or Additional time				✔				✔	✔										
11	Lack of physical integration of all the stakeholders									✔										✔
12	Short term vision				✔												✔			
13	Inadequate administration				✔												✔			
14	Misinterpretation of PPC indicator		✔		✔															
15	Contracting and legal issues or Contractual structure	✔	✔																	
16	Bad team chemistry or Lack of collaboration										✔									
17	Bad work ethics and cultural issues																✔			
18	Parallel implementation with other improvement programs				✔															

Table II-2 summarized characteristics of case examples from India

Case	Location	year	Reference	Project	Type of Project	LPS Implementation Phae		Avg PPC(Before using LPS)	Avg PPC(after using LPS)
						Construction	Design		
CS1	India, Guwahati	2009	Ankit Bhstia,may 2010, IIT Guwahati	IIT Guwahati, Academic Block	institutional	x		30	60
CS2	India, Tamilnadu	2017	C. Vignesh, 2018, Manipal University	Bishop Heber college campus	institutional	x		37.5	85
CS3	India, Chandigarh	2017	Banpreet Walia, PEC University of Technology	Residential Block in Chandigarh	Residential	x		46	75
CS4	India, Dwarka		U Vimal Kumar, SRM University	MTNL Dwarka	Office Building	x		67	85
CS5	India, Chennai	2013	K. Bardhan, CBRE	Ramanujan IT City, Chennai	Office Building	x		39	64
CS6	India, ahmedabad	2016	R.S. Prasad, STUP	Sardar Ballav Bhai Patel Cricket Stadium	Stadium	x		65	82
CS7	India, Assam	2017	Ankit Bhatla, IIT Guwahati, 2018	G+3, Office Building	Office Building	x		34	67
CS8	India, Mumbai	2010	Vishal Porwal,Principal at InteloBuild Project Solutions	17 storey Residential Building	Residential	x		42	62

Table II-3 challenges faced by case examples

Category	Sl no	Challenges	cases form live examples construction stage
WORKERS	1	lack of understanding of new system or difficulty to make quality assignments	CS1, CS2, CS 3, CS 5, CS7, CS8
	2	Lack of commitment to LPS implementation or Attitude towards new systems	CS1,CS2, CS6
	3	lack of labour	CS1, CS3, CS4, CS6, CS8
	4	Bad work ethics and cultural issues	CS5,CS7,CS8,CS6
MANAGEMENT	5	Lack of leadership or failure of management commitment or organizational climate	CS2, CS5, CS6,CS7,CS8
	6	Organizational inertia or resistance to change or "This is how I always done it" attitude	CS1, CS3, CS5, CS8
	7	Bad team chemistry or lack of collaboration	CS3, CS5, CS6, CS7, CS8
LEGAL	8	Contracting and legal issues or contractual structure	CS8
STAKEHOLDER	9	Lack of stakeholder support	CS4, CS5, CS7
ADMINSTRATION	10	Inadequate administration	CS1,CS3,CS6,CS7,CS8
OTHERS	11	Extra resources or more paper work or extra staff or more meetings or Additional time	CS 2,CS5,CS8
	12	Misinterpretation of PPC indicator	CS7
	13	Parallel implementation with other programme.	CS7,CS8

Most of the challenges during implementation of last planner system are common for case examples from India and case examples from Literature study. Mainly the problems related to workers and management are common for both cases. Only some problems like misinterpretation of PPC, parallel implementation of last planner system with other programmes are observed in literature study but not found in live case examples in India

C. Mitigation of Challenges (success factors of LPS)

There is a substantial body of literature concerning the use of LPS for various construction projects. The majority of this literature is in the form of case studies from academic and industrial backgrounds. Case studies report the use of LPS in different project settings (building construction, heavy civil construction, etc.), in different parts of the world, and for different project phases (definition, design, pre-design, and construction). In particular, some of them discussed the CSFs for LPC implementation. Table shows a summarized list of the key factors supporting the implementation of LPS in the construction industry from previous studies: The critical factors for successful implementation LPC are the commitment to planning and coordination between the project parties. The collected factors showed that the LPC achieve more successful planning and control than the traditional approach through the involvement of all stakeholders e.g. sub-contractors and suppliers.

From all literature study it is identified that most of challenges of implementation of Last Planner system can be mitigated, mainly through 2 ways. (Walia, 2017)

- Directly using Critical success Factors
- Indirectly Minimizing waste using cause effect matrix

Table II-4 Success factor Identified by Case examples (Indian)

	DIRECT Success factors	INDIRECT Success factors	Ref.
workers related	Push employees to accept new tool and techniques	Identify and minimize Wastes (caused by Workers)	CS1,CS5
	providing proper training		CS1,CS8
	make workers committed to their works		CS3
Management Related	Top management support	Identify and minimize Wastes (caused by Management)	CS5,CS8
	Communication between parties to achieve team work		CS2
	Robust relationship with suppliers		CS6
	Coordination and cooperation between parties		CS2,CS7
	Involvement of project manager		CS5,CS7
	meet the program daily		CS5
	Increased support and monitoring of management and Sub directorate		CS2
	Integration of Sub-Contractors		CS6,CS2

Legal	minimize delays ,regarding approval and other legal works	x	CS8
stakeholder	Involve more Stake Holder and Make them realize the importance of LPS	x	CS4,CS5
Administration	involve administration	x	CS1,CS3,CS4,CS5,CS8

D. Causes of Waste-

Waste is a product or material that is unwanted. Waste is also can be defined as any materials by product of human and industrial activity that has no residual value. Construction waste can be clustered into two groups namely the physical and non-physical waste.

1. Physical waste-

Physical construction waste can be defined as a mixture of inert and non-inert materials arising from construction, excavation, renovation, demolition, roadwork and other construction-related activities. Similarly defined by Shen et al. and Kofoworola and Gheewala construction and demolition waste is generally defined as waste which arises from construction, renovation and demolition activities including land excavation or formation, civil and building construction, site clearance, demolition activities, roadwork, and building renovation. But some defined as solid waste and consists of concrete debris, different types of bricks and blocks, various kinds of tiles, steel reinforcement, wood, plastic materials and paper, as well as gravel and soil. Research has also interpreted in physical construction waste as waste origins and can be found in. (Raja, 2019)

2. Non-physical waste-

On the other hands, waste can be defined as non-value adding works. The term non value-adding activity is used to differentiate between physical construction waste found on-site and other waste which occurs during the construction process. This type of waste also mentions by other researcher as intangible waste, in-directs waste or non-physical waste. Womack and Jones describe waste as any human activity that absorbs resources but creates no value, such as mistakes that require rectification, production of items no one wants, process steps that are not needed, unnecessary movement of employees, and people waiting for the conclusion of upstream activities. Furthermore, Koskela also describe waste as any inefficiency that results in the use of equipment, materials, labour or capital in larger quantities. In other words, waste in construction is not only focused on the quantity of waste of materials on-site, but also related to several activities such as overproduction, waiting time, material handling, processing, inventories and movement of workers .Similarly, researcher from Indonesia defined waste is not only associated with waste of materials in the construction process, but also other activities that do not add value such as repair, waiting time and delays. (Raja, 2019)

Table II-5 Cause effect matrix of waste (identified by case examples)

		DEFECTS		OVERPRODUCTION		WAITING		UNUSED TALENT		TRANSPORT		INVENTORY		MOTION		OVER-PROCESSING	
		Literature	Case example	Literature	Case example	Literature	Case example	Literature	Case example	Literature	Case example	Literature	Case example	Literature	Case example	Literature	Case example
HANDLING	Wrong material storage					3,6,7,8,14,16,19,20	2,4,5,7			3,4,5,11,14,15,17,18	3,5,6,7			17,18,19,20	1,2,5,7		
	Poor material handling	17,18,21,22	3,6														
	Damage during transportation		2														
	Equipment failure/tools not suitable	8,11,14															
	Delay during delivery					2,4,5,6,11,14,17,20					5,6,7,8						
WORKERS	Poor attitudes of workers	6,7,8,10	4,8	5,6,8,13,11,16,21	2,4,5,6,7												
	Damage caused by workers		3,4,6													17,18,11,14,9,21	2,4,5,7
	Insufficient training for workers	19,20,22		7,11,16	2,6		2,7,8										
	Lack of experience	7,10,18,19	2,3,4,6,8	6.7.9.10,12,13,14,15,17,19,21	1,3,4,5,7,8	4,5,6,8,11,18				2,4,7,9,11,14,19,20,21	1,3,6,7						
	Shortage of skilled workers	8,9	1,2,3,4,7,8														
	Poor workmanship	19,21	3,4,6,11,15,18,19,21	19,20,4,6,7,8,9,15	2,5,7,8												
MANAGEMENT	Poor planning		2,7,8	2,4,5,7,8,9,10,11,12,14,17,19,20,21	3.4.5.7.8	5,6,8,13,11,16,21	2,4,5,6,7	2,4,5,7,8,9,10,11,12,17,19,20,21	1,3,6,7	3,4,6,11,15,18,19,21	1,3,4,5,7,8	9.10,12,13,14,15,17,19,21	1,2,3,5,7,8	2,4,5,7,8,9,10,11,12,17,19,20,21	1,3,6,7	1,2,3,6,7,11,14,17,18,21	1,2,4,7,8
	Poor site management		6	2,5,7	2,5	2,4,9,13,17	1,3,4,5,7,8	11,12,18,19,21	5,8	3,7,8,9,20	1,7,8	6.7.9.10,12,13,14,15,17,19,21	2,7,8	3,9,20	3,4,6	17,18,21,22	1,3,6,7
	Poor controlling		2,5	11,14,15,19	1,3,4,5,7,8	6,7,8,10	3,4,6			6,7,8,10						5,6,8,13,11,16,21	2,3,4,6,8
	Poor supervision			2,4,9,13,17		19,20,4,6,7,8,9,15					3,4,6		3,4,6		1,3,4,5,7,8		2,4,5,7
	Inappropriate construction methods	3,4,18,21,22		11,12,18,19,21													
	Lack of coordination among parties		8,9	3,7,8,9,20								6,7,8,10		19,20,4,6,7,8,9,15			
	Poor information quality			1,3,4,6,7					1,3,4,5,7,8		8,9						
	Late information flow among parties			19,21													
	Outdated equipment	2,5,6,9,11,15															
	Non availability of equipment			2,5,7,8			2,5										
SITE CONDITION	Leftover materials on site					3,19,21											
	Poor site condition									7,11,16	2,6						
	Waste resulting from packaging									6.7.9.10,12,13,14,15,17,19,21	1,3,4,5,7,8						
	Congestion of the site					17,18,11,14,9,21	2,4,5,7										
	Lighting problem					17,18,11,14,9,21	2,4,5,7										
	Crews interference						1,5,8										
EXTERNAL	Effect of weather		4,6,7														
	Accidents	7,8,15,19,21	1,2,6,8			2,5,6,9,11,15											
	Pilferage																
	Vandalism						3,6,8										
	damages caused by third parties		2,7,8			8,13,17,18											
	Festivities		4				4,7										
	Unpredictable local conditions					6,8,11,12,19	2,4,5										
	Lack of legatitive enforcement					2,3,9,11,221											

III. QUESTIONNAIRE AND SITE SURVEY METHODOLOGY-

Lean construction is established to work as a systematic approach to identify and eliminate waste through continuous improvement. The prime objective of lean is to add value to the project and maximize productivity on site. Hence, an overview of the work methods and practices on Indian construction sites is developed, which helps assess how lean can help overcome these shortcomings and work on Indian sites. Challenges during implementation of Last Planner System is identified through Literature and Case Examples. With challenges, some critical success factors of Implementation of Last Planner System and Causes of Wastes in construction is also identified. A survey is conducted for finding the Relative Important Index (RII) of Challenges. A live construction site is undertaken to identify and analyze Causes of Wastes and proposing mitigation for challenges. Some suggestive measures to implement Last Planner System is also given.

A. Questionnaire Design and Content-

After making a review of all studies that focus on LPS especially in the construction industry, the questionnaire was prepared to satisfy the research objectives. The questionnaire contained a cover that explains the study purpose, the way of filling the questionnaire, the study goal and the confidentiality of the information for encouraging high response.

The questionnaire was containing 3 parts, 1-regarding the general information of respondents, 2-Evaluating the challenges (RII) 3- opinions of respondents regarding the benefits of using LPS.

The Relative Importance Index (RII) method has been extensively applied in construction management studies for determining attitudes with regards to surveyed factors (S M Abdul Mannan Hussain, n.d.). Numerous studies have used the RII in their analysis. The participants were requested to assess the identified interface problems on a five-point Likert scale between "1" for the strongly disagree and "5" for the strongly agree. Based on the survey response, RII was calculated using the following equation:

$$\text{Relative Importance Index} = \frac{\sum w}{AN} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5N}$$

Figure III.1 formula for RII (relative important index)

Where, W is the weighting specified to every factor by the participant between 1 and 5, n1 = number of participants for strongly disagree, n2 = number of participants for disagree, n3 = number of participants for neutral, n4 = number of participants for agree, n5 = number of participants for strongly agree, A is the highest weight (5 in this study) and N is the total number of samples.

B. Survey, to identify causes of waste for a live project-

The site for construction of this experiment is 120 bed ASIAN FIDELIS HOSPITAL, with 1 basement, Group housing colony, Sector-88, Faridabad. Total site area 5058.57 Sq., Total Build up area 8268 sq.
Client- M/S, RPS Infrastructure Ltd. Associated with Pristine Infracon Pvt. Ltd.
(Tayeh, 2018) (Raja, 2019)As it is identified that, critical success factors for mitigation of challenges of implementation of Last planner System are basically 2 types. 1-direct application of success factor; 2- Indirectly minimizing waste. For this project site a cause effect matrix along with severity of causes of wastes identified would help to mitigate challenges that might occur during implementation of Last Planner System.
To identify the construction wastes on site, a virtual online meeting was held with the site manager (architect's representative on site), project manager and site engineer. Once these were identified, a cause effect matrix was subject to them, to identify the most important sources for critical wastes. The responses to cause effect matrix were collected from 5(A-E) site personnel, and based on their response frequency of each caused were made to identify the most important sources for critical wastes.

IV.RESULTS AND DISCUSSION-

A. Questionnaire Survey-

A questionnaire survey was conducted to assess the challenges faced by professionals in LPS implementation stage. This survey was designed based on challenges reported in previous test case projects .The online survey questionnaire was available from 07/04/2020 to 20/04/2020. Survey link was sent to 30 respondents. A total of 22 responses were analyzed using descriptive statistics and results were compared with the literature survey results .The survey was answered by architects, engineers, general contractors, subcontractors, and management professional who have some working experiences in LPS implementation.

1. Respondents' general information-

Figure IV.1 respondents' profession and years of experience

It is shown in these above figures that maximum percentage of respondents are Project manager, construction manager and architects and currently they are working as Site manager, dept. manager, project manager etc. In this above figure it is clearly show that maximum respondents are with 5-10 years, 10-2o years, more than 20 years of experience.

2. Evaluation of Challenges-

All category of challenges of implementation of LPS, further grouped into 5 categories.
The majority of the respondents believe that they can invest better in construction process itself instead of training the staff. These outcomes agreed with who highlighted that any company needed training programs for staffs and highlight the importance of skill development and human capital in using LPC. Also according to, it is shown that "Management related challenges" have maximum avg RII 65.8 and workers related challenges have RII of 67.9%. And another higher RII factor is of Administration.

Table IV-1 the statistical results of key challenges (RII)

CHALLENGES	SCORE	OUT OF
C01: Lack of human capital - lack of understanding and difficulties in adopting new system		
S01: In my organization people are not skilled at using LPS	86	110
S02: In my organization people do not have enough knowledge in using LPS for planning and control purposes	80	110
S03: In my organization people do not have enough experience in using LPS for planning and control purposes.	92	110
S04: In my organization people find it hard to use the LPS	77	110
C02: Lack of commitment to LPS implementation or Attitude towards new systems		110
S01: In my organization people refuse to assume commitments themselves	53	110
C03: Lack of commitment of workers towards new systems	87	110
C04:lack of labor	75	110
C05: Lack of leadership or failure of management commitment or organizational climate		
S01: There is no strong leadership in my organization for implementing LPS	82	110
S02: Management in my organization is not committed to the implementation and use of LPS	90	110
S03: My organization does not provide a positive climate for implementing LPS	95	110
S04: My organization does not offer incentives to last planners (example: foreman, supervisor, project engineer) who support implementing and using LPS	80	110
S05: My organization faces internal conflicts (example: resistance to change, lack of training) in implementing and using LPS	58	110
C06: Organizational inertia or resistance to change or "This is how I always done it" attitude		110
S01: In my organization people are reluctant to implement and use LPS for planning and control purposes	78	110
S02: In my organization people are unwilling to change, when new systems are introduced	82	110
S03: Standard procedures of my organization make it difficult to implement and use a new system such as LPS.	75	110
C07: Bad team chemistry or lack of collaboration		110
S01: In my organization people find it difficult to collaborate with the teams from other organizations during the weekly-work-plan meetings organizations during the weekly-work-plan meetings	58	110
C08: Contracting and legal issues or contractual structure		110
S01: My organization faces contractual issues when implementing and using LPS	62	110
S02: My organization faces legal issues when implementing and using LPS	50	110
C09: Lack of stakeholder support		110
S01: My organization faces external conflicts (example: lack of client support or subcontractor support) and challenges in implementing and using LPS	56	110
S02: My organization does not get good support from the owner (client) for using lean principles and techniques such as LPS	60	110
S03: My organization does not get encouragement from the owner (client) for using lean principles and techniques such as LPS	61	110
S04: In my organization people refuse to include subcontractors in planning	65	110
C10: Inadequate administration	67	110

The majority of respondents believes that maximum challenges are arrived from management, administration and worker related issue.

Table IV-2 relative important index of challenges

Category	Challenges	score	No of qn	Out of	Score in Percentage (RII)	Ranking	Avg Score
workers related	C01: Lack of human capital - lack of understanding and difficulties in adopting new system	335	4	440	76.14	2	67.90
	C02: Lack of commitment of workers towards new systems	53	1	110	48.18	10	
	C03:lack of labour	87	1	110	79.09	1	
	C04:Bad work ethics and cultural issue	75	1	110	68.18	5	
Management Related	C05: Lack of leadership or failure of management commitment or organizational climate	405	5	550	73.64	3	65.86
	C06: Organizational inertia or resistance to change or "This is how I always done it" attitude	235	3	330	71.21	4	
	C07: Bad team chemistry or lack of collaboration	58	1	110	52.73	8	
Legal	C08: Contracting and legal issues or contractual structure	112	2	220	50.91	9	50.91
stakeholder	C09: Lack of stakeholder support	242	4	440	55.00	7	55.00
Administration	C10: Inadequate administration	67	1	110	60.91	6	60.91

B. Site Survey-

The site, sitting in the city of greater Faridabad, is a public sector project, for RPS Infrastructure Pvt. Ltd. While the commencement of the project was rapid, delays, wastes, re-work and bureaucracy were found to disrupt the schedule and overall budget of the project.

Excavation work for basement was completed, basement raft casting was completed but both those activities faced rapid delays, wastes, re work etc. Slab casting of phase 1 is completed and Shuttering of Phase 2 basement slab was ongoing, 23/3/2020 work has been suspended due to Covid-19.

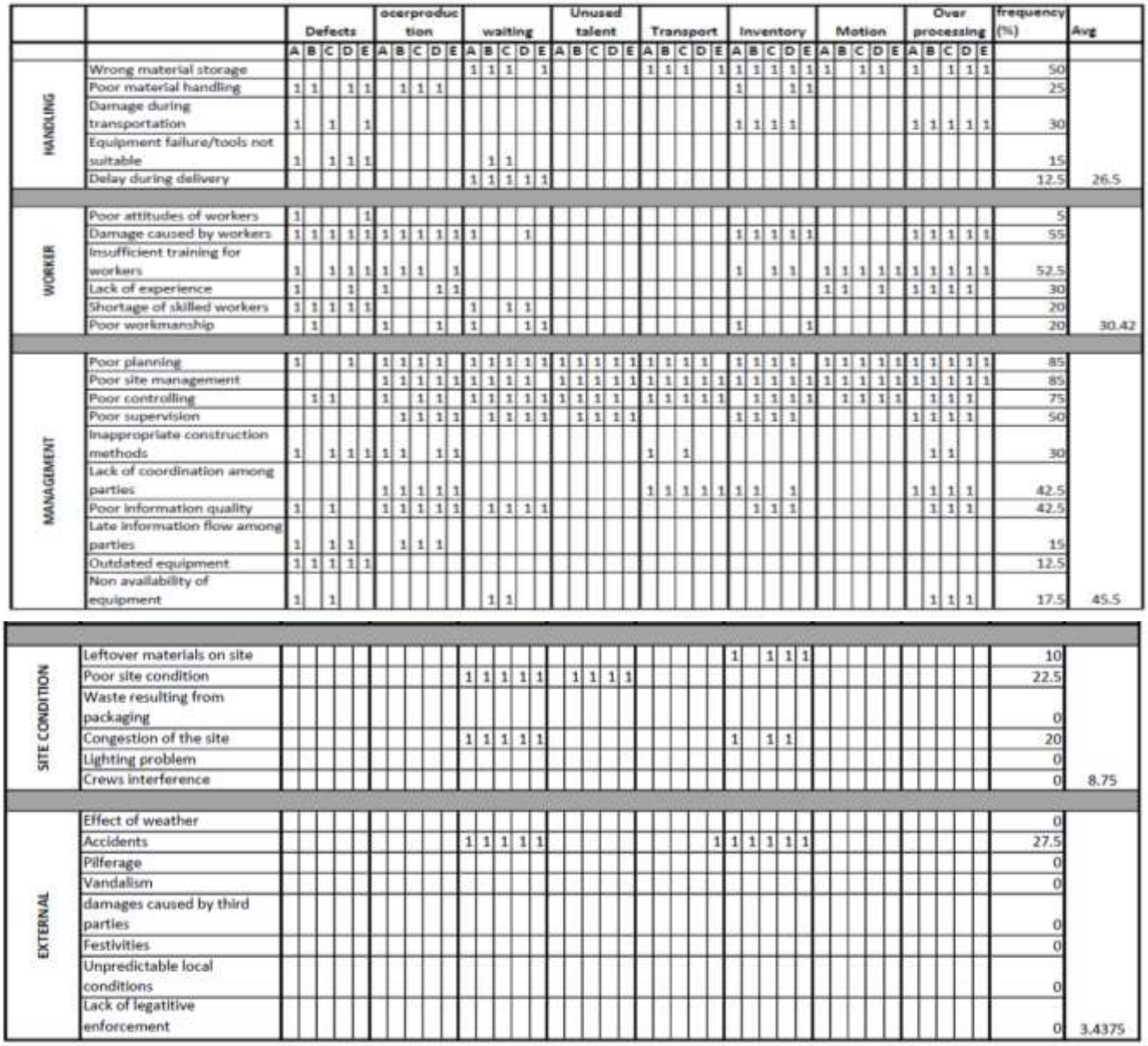
Hence, the activity for slab casting of phase 2 was selected, to identify wastes generated in context to the specified activity, and the reasons behind the same. This activity of slab casting has been selected to be scheduled for 3 weeks under the Look-Ahead Schedule, and detailed for Weekly Work Plans for these 3 weeks.

1. Cause effect matric of waste-

To identify the construction wastes on site, a virtual online meeting was held with the site manager (architect's representative on site), project manager and site engineer. Once these were identified, a cause effect matrix was subject to them, to identify the most important sources for critical wastes.

The responses to cause effect matrix were collected from 5(A-E) site personnel, and based on their response frequency of each caused were made to identify the most important sources for critical wastes.

Table IV-3 Cause effect matrix of waste



		Defects					overproduction					waiting					Unused talent					Transport					Inventory					Motion					Over processing					frequency (%)	Avg
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E		
HANDLING	Wrong material storage											1	1	1		1						1	1	1		1	1	1	1	1	1	1		1				1		1	1	1	50	
	Poor material handling	1	1		1	1		1	1	1																	1			1	1											25	
	Damage during transportation	1		1		1																					1	1	1	1							1	1	1	1	1	30	
	Equipment failure/tools not suitable	1		1	1	1							1	1																											15	
	Delay during delivery											1	1	1	1	1																											12.5	26.5
WORKER	Poor attitudes of workers	1				1																																			5	
	Damage caused by workers	1	1	1	1	1	1	1	1	1	1	1			1												1	1	1	1	1							1	1	1	1	1	55	
	Insufficient training for workers	1		1	1	1	1	1	1		1																1		1	1		1	1	1	1	1	1	1	1	1	1	52.5	
	Lack of experience	1			1		1			1	1																					1	1		1		1	1	1	1		30	
	Shortage of skilled workers	1	1	1	1	1						1		1	1																											20	
	Poor workmanship		1				1			1		1			1	1											1				1												20	30.42
MANAGEMENT	Poor planning	1			1		1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1		1	1	1	1	1	1	1	1	1	1	85	
	Poor site management						1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	85	
	Poor controlling		1	1			1		1	1		1	1	1	1	1	1	1	1	1		1	1	1	1	1		1	1	1	1		1	1	1			1	1	1		75	
	Poor supervision							1	1	1	1		1	1	1	1		1	1	1	1						1	1	1	1							1	1	1	1		50	
	Inappropriate construction methods	1		1	1	1	1	1		1	1							1		1																		1	1			30	
	Lack of coordination among parties						1	1	1	1	1						1	1	1	1	1	1	1		1												1	1	1	1		42.5	
	Poor information quality	1		1			1	1	1	1	1		1	1	1	1							1	1	1												1	1	1		42.5	
	Late information flow among parties	1		1	1			1	1	1																															15	
	Outdated equipment	1	1	1	1	1																																			12.5	
	Non availability of equipment	1		1									1	1																								1	1	1		17.5	45.5
SITE CONDITION	Leftover materials on site																										1		1	1	1											10	
	Poor site condition											1	1	1	1	1		1	1	1	1																					22.5	
	Waste resulting from packaging																																									0	
	Congestion of the site											1	1	1	1	1											1		1	1												20	
	Lighting problem																																									0	
	Crews interference																																									0	8.75
EXTERNAL	Effect of weather																																									0	
	Accidents											1	1	1	1	1										1	1	1	1	1	1											27.5	
	Pilferage																																									0	
	Vandalism																																									0	
	damages caused by third parties																																									0	
	Festivities																																									0	
	Unpredictable local conditions																																									0	
	Lack of legatitive enforcement																																									0	3.4375

2. **Severity of causes of waste-**

	CAUSES	RESPONDENTS					RII (%)
		A	B	C	D	E	
HANDLING	Wrong material storage	3	4	2	5	5	76
	Poor material handling	4	4	5	3	5	84
	Damage during transportation	1	1	1	3	2	32
	Equipment failure/tools not suitable	1	2	1	1	1	24
	Delay during delivery	1	2	1	1	1	24
WORKER	Poor attitudes of workers	2	3	3	4	4	64
	Damage caused by workers	5	5	4	3	4	84
	Insufficient training for workers	5	5	3	4	5	88
	Lack of experience	4	3	3	3	4	68
	Shortage of skilled workers	5	4	4	3	3	76
	Poor workmanship	3	3	4	3	4	68
MANAGEMENT	Poor planning	4	3	5	4	4	80
	Poor site management	5	3	3	4	3	72
	Poor controlling	3	3	2	4	5	68
	Poor supervision	1	2	2	3	2	40
	Inappropriate construction methods	1	1	2	1	2	28

	Lack of coordination among parties	4	4	3	5	4	80
	Poor information quality	1	1	3	2	1	32
	Late information flow among parties	2	1	2	2	2	36
	Outdated equipment	1	2	2	1	1	28
	Non availability of equipment	1	1	1	1	1	20
SITE CONDITION	Leftover materials on site	3	2	4	3	3	60
	Poor site condition	5	4	4	5	5	92
	Waste resulting from packaging	0	0	0	0	0	0
	Congestion of the site	2	4	4	5	4	76
	Lighting problem	0	0	0	0	0	0
	Crews interference	0	0	0	0	0	0
EXTERNAL	Effect of weather	2	1	2	2	1	32
	Accidents	3	4	3	3	4	68
	Pilferage	0	0	0	0	0	0
	Vandalism	0	0	0	0	0	0
	damages caused by third parties	0	0	0	0	0	0
	Festivities	0	0	0	0	0	0
	Unpredictable local conditions	0	0	0	0	0	0
	Lack of legatitive enforcement	0	0	0	0	0	0

The cause effect matrix for the project brings out some of the important sources that lead to wastes on site, which eventually lead to delays and cost overruns, along with inadequate performance and productivity on site.

- Major Sources of Waste, as can be observed in the matrix, are – Excessive bureaucracy, Poor Planning, Late Information, and Defective/ Unclear Information. This can be correlated to complaints by site personnel, where obtaining approvals and addition/substitution of items was one of the most challenging tasks. Poor Planning and unsatisfactory Construction Logistics on site resulted in inappropriate selection of materials, without realizing the shortage of space to complete the item of work. The same problems were faced due to unclear.
- Besides that other important source of waste comes from worker related issues. Like damaged caused by workers, insufficient knowledge of workers, lack of skilled labour. Labour related issues are mainly causing overproduction, over processing, waiting time those kind of wastes.
- The matrix also helps identify which wastes were the most critical, and that the sources of these wastes needed to be rectified in order to eliminate or minimize these wastes. For instance, it is important to have adequate planning and management on site, along with appropriate scheduling, that would accommodate previous lags caused due to change in waterproofing material and approvals, without hindering works scheduled for current phase
- The matrix also helps realize the incapacity of the project personnel to deal with bureaucracy at government levels. This can be understood as an 'out of scope' activity for the project manager, since such instances are unavoidable and un-rectifiable.

V. PROPOSAL-

The Last Planner planning cycle comprises of (i) a master schedule covering an entire project, (ii) a detailed phase schedule emerging from collaborative planning, (iii) a look-ahead plan with constraints analysis, and (iv) a weekly work plan with measured percent plan complete.

The master schedule initiates a strategic plan, where major milestone dates are identified and the Critical Path Method logic is incorporated to determine overall project duration.

Phase scheduling generates a detailed schedule that evolves during the project by magnifying the master schedule into more detailed project components.

A look ahead plan produces a list of work packages or activities that need to be worked on in the upcoming 6-8 weeks. The plan is updated weekly, where constraints that obstruct reliable workflow are observed and resolved.

The Weekly Work Plan, the most detailed plan in the system, directly drives the production process. At this level, making quality work packages as assignments for workers ensures reliable planning, so that the production unit is not affected by upstream uncertainty.

A. Look ahead planning-

The look ahead schedule was prepared for three weeks, where procurement of material, labour and equipment was ensured one day (working day) before commencement of works for that week. Each phase was aimed to be completed in one week, for which the soldier piling would be laid first, and waterproofing works follow. Similarly, raft laying was scheduled to follow after completion of waterproofing works. The detailed Look Ahead Schedule is as follows.

Table V-1Look ahead Planning

LOOK AHEAD PLANNING																				
Sl No	Task Description	Responsible Agency	WEEK 1						WEEK 2						WEEK 3						NOTES
1	Procurement Of Materials		M	T	W	T	F	S	M	T	W	T	F	S	M	T	W	T	F	S	
1.1	Material for Shuttering	Contractor	✗																		to be confirmed before commencement of work
1.2	Materials for Reinforcement	Contractor	✗																		to be confirmed before commencement of work
1.3	Materials for Concreteing	Contractor																	✗		to be confirmed on the day of commencement of work
1.4	Material for Masonry work	Contractor		✗																	to be confirmed before commencement of work
2	Procurement of Labours																				
2.1	Labours for Shuttering	Contractor		✗																	to be confirmed on the day of commence of work
2.2	Labours for Reinforcement	Contractor		✗																	to be confirmed on the day of commence of work
2.3	labours for concreting	Contractor																	✗		to be confirmed on the day of commence of work
2.4	Labours for Masonry work	Contractor			✗																to be confirmed on the day of commence of work
3	Tasks																				
3.1	Cleaning and Preparation	Contractor	✗																		Procurement of labour and materials to be confirmed before commence of work
3.2	Shuttering of Part B slab	Contractor		✗	✗	✗	✗	✗	✗	✗	✗	✗	✗								
3.3	Reinforcement of Part B slab	Contractor		✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗			
3.4	Concreting of Part B slab	Contractor																	✗	✗	
3.5	Masonry work for basement	Contractor			✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	

B. Weekly work plan-

As an integral part of Last Planner System, Weekly Work Plans help detail activities down to hourly basis for each day of the week, with each gang of workers being assigned an activity, which is expected to be completed within the given time frame.

One phase of work was assigned to one week, and any shortcomings/ lag in work/ leftover work were planned for the next week after the actual work done was recorded until the last day of the week.

Table V-2 weekly work plan

Weekly Work Plan - PHASE 1						PLANNED							ACTUAL		
Sl no	Activity	Responsible Agency	Unit	Quantity	Time Required Per unit	MON	TUE	WED	THU	FRI	SAT	Labour Required	Quantity	Duration	Reasons
1	Cleaning and Preparation	Contractor	x	x	x	✓	✗	✗	✗	✗	✗	10-12 Unskilled labour			
2	Centering and Shuttering of Basement slab part-B	Contractor	Sqm	1000	1sqm/ 0.04 Hour	✗	200	200	200	200	200	18 gangs, 1 gang=(1 fitter,2 bedar)			
3	Reinforcement of Basement slab part-B	Contractor	kg	10560	1kg/0.004 hour	✗	2112	2112	2112	2112	2112	22 gangs,1 gang=(1 blakcsmith, 1 beldar)			
4	Masonary Work for Basement	Contractor	Cum		1cum/ 1hour	✗	✗	8	8	8	8	3 gangs, 1 gang=(1st class mason, 1 2nd class mason, 4 coolie)			

Weekly Work Plan - PHASE 2						PLANNED							ACTUAL		
Sl no	Activity	Responsible Agency	Unit	Quantity	Time Required Per unit	MON	TUE	WED	THU	FRI	SAT	Labour Required	Quantity	Duration	Reasons
1	Centering and Shuttering of Basement slab part-B	Contractor	Sqm	1000	1sqm/ 0.04 Hour	200	200	200	200	200	✗	18 gangs, 1 gang=(1 fitter,2 bedar)			
2	Reinforcement of Basement slab part-B	Contractor	kg	12672	1kg/0.004 hour	2112	2112	2112	2112	2112	2112	22 gangs,1 gang=(1 blakcsmith, 1 beldar)			
3	Masonary Work for Basement	Contractor	Cum	48	1cum/ 1hour	8	8	8	8	8	8	3 gangs, 1 gang=(1st class mason, 1 2nd class mason, 4 coolie)			

Weekly Work Plan - PHASE 3						PLANNED							ACTUAL		
Sl no	Activity	Responsible Agency	Unit	Quantity	Time Required Per unit	MON	TUE	WED	THU	FRI	SAT	Labour Required	Quantity	Duration	Reasons
1	Concreting of Basement slab part-B	Contractor	Sqm	352	1sqm/ 0.04 Hour	✗	✗	✗	✗	176	176	2 gangs, 1 gang=(1 mason, 1 needle vibrator, 6 beldar)			
2	Reinforcement of Basement slab part-B	Contractor	kg	8448	1kg/0.004 hour	2112	2112	2112	2112	✗	✗	22 gangs,1 gang=(1 blakcsmith, 1 beldar)			
3	Masonary Work for Basement	Contractor	Cum	48	1cum/ 1hour	8	8	8	8	8	8	3 gangs, 1 gang=(1st class mason, 1 2nd class mason, 4 coolie)			

- The experiment is an attempt to reduce wastes and improve site productivity
- The experiment does not suggest any changes at the bureaucracy level, due to resource and time limitations.
- Only 3 weeks of look-ahead planning and weekly work planning would be suggested in the experiment for a particular package of work (slab casting), so as to get an insight on the applicability of detailed LPS implementation. However, due to shortage of time and resources in the duration of the paper, the LPS programme could not be extended beyond 3 weeks.
- Only the suggestive measure would be given and observation during implementation is not possible due to the suspension of site activities (due to COVID-19)

VI. CONCLUSION-

LPS is one of the lean construction approaches. In this research, a questionnaire survey was implemented to identify the key factors supporting the applicability LPS and to determine its challenges in the Indian construction industry. The main results of the study show that: Close relationship with subcontractors, top management support and coordination and cooperation between staffs to achieve teamwork were the key factors of LPS implementation. The high cooperation and robust relationship between the subcontractors, staffs and the top management should be exerted to enhance and develop the LPS implementation. On the other hand, lack of skills, training, and experience, lack of the training program for the managers, lengthy approval procedure from the client and top management, and misuse of information generated during implementation of LPS were the main challenges /barriers of LPS implementation. The intensive training for all parties is necessary in order to enhance and develop the LPS implementation.

As it is observed from literature study and case examples for india that the indirect success factor for mitigating challenges of implementation of last planner system is Minimizing waste as well, different types of waste and their reason are identified from literature study and case examples from india. Then for a live case examples, Aisan Fidelis Hospital, faridabad is observed to find out wastes and their causes through a cause effect matrix. A relative important index of causes is also made through a questionnaire survey on site to find the severity of causes. Form the severity list it is observed that, most sever causes of wastes are worker and management related. So by minimizing those causes the challenges of implementation of Last Planner System can be mitigated indirectly. And based on the cause effect matrix and severity list some LPS implementation measure have also been suggested.

VII. REFERENCES-

[1] BALLARD, H. G., 2000. *THE LAST PLANNER SYSTEM OF PRODUCTION CONTROL,* s.l.: The University of Birmingham.

[2] Bardhan, K., 2020. *Implemantation of LPS on Office Building.* [Interview] 2020.

[3] Bhatla, A., 2010. *Implementation of Lean Construction in IIT Guwahati,* Guwahati: IIT Guwahati, Civil engineering Dept..

[4] Bhatla, A., 2017. A Case Study of Implementing LPS on Assam. I(IIT Guwahati), p. 14.

[5] Kumar, U. V., 2012. *Implementation of LPS in MTNL DWARKA,* Dwarka: MTNL Dwarka.

[6] Prasad, R., 2020. *Implementation Lean Principles* [Interview] 2020.

[7] S M Abdul Mannan Hussain, D. S. S., n.d. *IMPLEMENTATION OF LPS FOR IMPROVING THE CONSTRUCTION PROCESS,* Hyderabad: GITAM University.

[8] Vignesh, C., 2018. *A CASE STUDY OF IMPLEMENTING LAST,* Tamilnadu: Manipal University.

[9] Vimal Kumar, G. R., 2007. *CRITICAL STUDY OF VARIOUS LEAN TECHNIQUES IN PRACTICE AND DEVELOPING A FRAMEWORK FOR DIFFERENT CONSTRUCTION BUILDING PROJECTS,* Chennai: SRM University.

[10] Walia, B., 2017. *IMPLEMENTATION OF LAST PLANNER SYSTEM AND CHALLENGES ENCOUNTERED IN AN INDIAN RESIDENTIAL CONSTRUCTION PROJECT,* 1(International Journal of Civil Engineering and Technology (IJCIET)), p. 10.

[11] P Zhang, Z. Z. H., 2011. BIM- and 4D-based integrated solution of analysis and management for conflicts and structural safety problems during construction. Automation in Construction, 20(2), pp. 155-166.

[12] Jarkko Erikshammar, E. A. W. L., 2014. Parametric Value Stream Mapping Framework. Oslo, International Group for Lean Construction.

[13] Kalyan Vaidyanathan, S. M., 2016. Application of Lean Principles to Managing Construction of an IT Commercial Facility. Boston, IGLC.

[14] Ltd., S. E. C. S. P., 2012. Alliance Approach in Ramanujan IT City Chennai. s.l.:Sterling Engineering Consultancy Services Pvt. Ltd..

[15] Luis F Alarcon, S. D. O. R. R. C., 2008. Assessing the impacts of implementing lean construction. Revista Ingenieria de Construccion, 23(1), pp. 26-33.

[16] Madanlal, D. S., 2018. www.portfolio.cept.ac.in. [Online] Available at: https://portfolio.cept.ac.in/2018/S/ft/construction-execution-monitoring-and-control-5734-spring-2018/motera-stadium-spring-2018-pt100917 [Accessed 30 March 2019].

[17] N Raghavan, S. K. A. M. K. V. A. A., 2014. Implementing Lean Concepts on Indian Construction SItes: Organisational Aspects and Lessons Learned. Oslo, IGLC.

[18] P Tzortzopoloulos, C. T. F., 1999. Considerations of Application of Lean Construction Principles to Design Management. Berkeley, International Group for Lean Construction.

[19] P.R. Surendhra Babu, N. H. B., 2018. Using technology to Achieve Lean Objectives. Chennai, International Group for Lean Construction.

[20] Patel, B., 2018. www.portfolio.cept.ac.in. [Online] Available at: https://portfolio.cept.ac.in/ft/project-5164-monsoon-2018/planning-and-scheduling-sardar-patel-stadium-motera-monsoon-2018-uc3114 [Accessed 30 March 2019].