JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue

JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)

An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Critical Success Factors and Barriers to Last Planner System Implementation over Traditional Management System in the Indian Construction Industry

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Abstract: Overall advancement in the construction industry has not been spectacular in recent decades. Furthermore, delays in projects have been a very common issue in the construction sector. The Indian construction industry has grown significantly and follows the traditional methodology for the completion of construction projects. As a result, nearly 80–90% of Indian construction projects are hampered by time and cost overruns. The construction industry should adopt new construction management technologies like lean management and agile management for project performance like on-time completion, within budget, and promised quality. Lean construction is a way to design production systems in the construction environment with the aim of reducing time, effort, and material waste. The Last Planner System is one of the most effective lean construction tools to improve the construction management process. A combination of these systems would provide far more benefits than traditional methods of implementation. This study intends to fill that void by developing an LPS adoption framework for the construction sector. This study examines the implementation of the LPS over the traditional management system by analyzing the critical success factors and barriers' impact. Through relevant literature, structured interviews, and an industry survey, a total of 34 critical success factors and 25 barriers for LPS (Last Planner System) were identified. These parameters were then rated on a Likert scale by 66 experienced professionals using a questionnaire survey. This data is validated by industry LPS experts. An online questionnaire survey was carried out to collect data from the project manager, contractors, planning engineers, and site engineers. The frequency analysis method was used to analyze the data. The main results show that the critical success factors for implementing the Last Planner System were top management coordination, improper implementation plan, and defined roles and responsibilities for monitoring and implementation of the Last Planner System. On the other hand, organizational inertia or resistance to change, lack of commitment to Last Planner System implementation, or negative perspective towards new systems, were the main barriers to LPS implementation.

Keywords: **–** Lean Management**,** Last Planner System, Traditional Management System, Critical Success Factors, Barriers

I. INTRODUCTION

Lean thinking was initially (In 1450s) used in Arsenal, Venice. They used Lean conceptfor production of War ships for Venetian Navy. They applied Continuous Flow concept for theproduction of war ship. In this concept, they manufactured the Ship parts at different location and assemble those parts Main Factory. Therefore, because of maintenance of standardization,quality of work was much better than previous works, but Henry Ford first incorporated a complete manufacturing process in Highland Park, MI, in 1914. Ford Company used Continuous Flow system for Mass Production of Ford Cars. They have done huge profitable business for 19 years but because of not flexibility in design; their business has faced tremendous loss. After that, in the late 1930s, German Aircraft Industry used the Takt Time concept to manufacture aircraft according to the variation in the demand of the customer. Takt Time can be said as Required Production Time by Customer demand. Toyota subsequently combined the idea of Takt Time with Ford's ideas on Continuous Flow in the 1950s and implemented critical dimension of flexibility in very short lead time for high-quality project. The lean production concepts in the construction industry were first implemented by koskela later. In manufacturing systems such as TFV (Transformation, Flow and Value Generation), heproduced Triplet perspective and this was the main reason for the emergence of lean construction in the construction industry. Lean construction can be described as; "It is a management technique that can achieve maximum project value due to minimal material wastage, time and effort."

Lean construction is a way to design production systems in the construction environment with the aim of reducing time, effort and material waste. Lean construction ensures a project is completed rapidly and lower construction expenses are incurred. Lean construction also aims to maximize and minimize the cost of the maintenance, layout, planning and activation project during construction. The use of Lean construction worldwide improves the construction industry's productivity. Last Planner system is one of the most effective tool of Lean Construction. Construction projects are complex in nature and require separate planning

levelsperformed by different individuals at different levels throughout the project. In LPS, an individual person or group of person who produces assignment for project progress is called asa "The Last Planner" and uses the PULL scheduling system to fulfil project objectives.In this system, planner consider the lowest level of worker and all possible risks, which can affect the project progress.

There are overall thirty tools of Lean construction, (LPS) is one of the most effective tool of LC which is mostly getting used in construction Industry. PULL scheduling is a main concept of LPS; five types of detail scheduling are done under LPS like Master Schedule, PhaseSchedule, Six Week Look Ahead Plan, Weekly Work Plan, and PPC.

II. NEED FOR STUDY

Indian construction industry contributes almost 2586.14 INR Billions (7.90%) to GDP of India but Since last decades, the way in which construction projects are managed has not changed and because of that almost 80% construction projects are either time overrun or cost overrun. Construction industry faces the Last Planner Implementation Barriers, awareness of Modern Management Techniques. This problem can be solved by adoption of tools of Lean construction in Indian construction sector. Last Planner System (LPS) is one of the most efficient tool of lean construction.

III. RESEARCH GAP

Construction sector faces problems such as time and cost overrun, and Lean concepts can solve this (Vishal Porwal, 2010)—Last Planner System Implementation Barriers. Solutions of these problems can be identified with use of lean construction Methodology. Time overrun and Cost Overrun are the wastes for the construction Industry. Lean construction is easy to identify such waste (Mohamed Saad Bajjou, 2017) Therefore, Application of Lean construction methodology further required to be explored; researcher opines that if Construction Industry use Lean construction as a Management method (For construction industry, last planner is Most effective Lean tool) thenit may provide an integrated approach to provide possible solutions for problems aforementioned above.

IV. PROBLEM STATEMENT

Indian construction industry is 10th most emerging industry in worldwide though Indianconstruction projects are suffered from the cost overrun and time overrun. This problem can beresolved with use of applying Lean Construction concept to actual practice in construction Industry.

So now it needed to find out that "what are the key changes required in traditional organizational structure which is used by construction firms and subsequently to determine, what are the Critical Success Factors & Barriers to Implement Last Planner System? How can Lean Construction be accomplished by applying the Last Planner System in the construction industry? What is the Impact of Critical Success Factors & Barriers on Implementation of Last Planner System? "

V. RESEARCH OBJECTIVES

The objective of this research to study and identify critical success factors and barriers to the applicability of the Last Planner System in Construction Project.to rank and prioritize identified parameters.

VI. SCOPE OF WORK

The quantitative empirical study was conducted. Scope of Study efforts limited to identifying Critical Success Factors for Implementation LPS and user Barriers from Top Management to Lower Management. Data responses of Questionnaire survey is restricted to Ahmedabad Construction Industry. Understanding of parameters and defining them with the help of industry experts and literature reviews will be carried out. Data analysis based on identified parameters to provide weightage and carry out rankings based on the importance of the viability parameters.

VII. LIMITATIONS OF STUDY

The inferences derived from the feedback analysis have the limitation of being based on limited responses from participants and scope of study data restricted to Ahmedabad.

Abbreviations

LPS : Last Planner System
LC : Lean Construction
PPC : Percentage Planned Completion
SOP : Standard Operating Procedure

VIII. RESEARCH METHODOLOGY

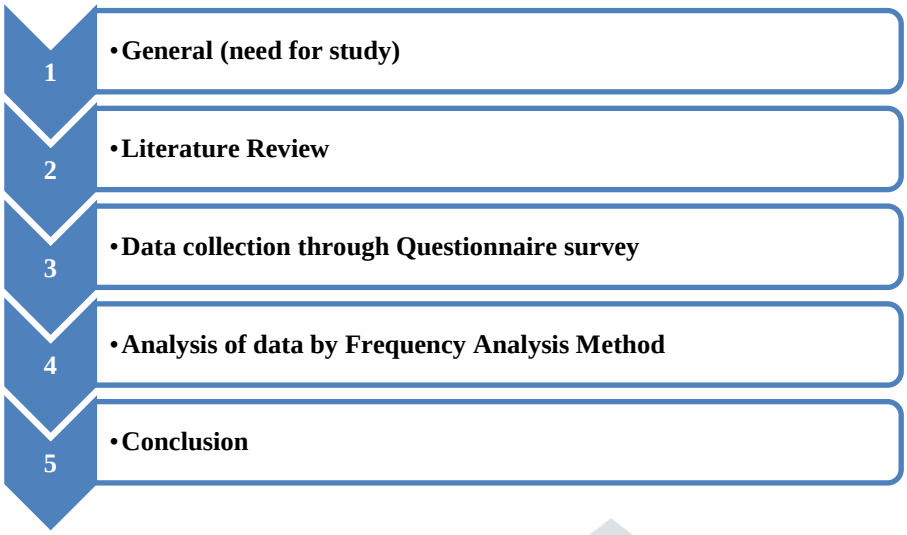


Figure 1 Research Methodology Flowchart

IX. LITERATURE REVIEW

Through literature review it was found that (Hedaoo, 2017) explained use of last planner system to overcome the limitations of traditional construction work. . Identified the barriers to apply lean principles in Indian construction industry (Devaki M. P, 2014). , The main factors for applying the Last Planner Concept are strong correlations with sub - contractor and top management commitment. The most significant barriers are a lack of skill, training, and experience (Bassam A. Tayeh1, 2018). to improve project management by reducing waste, increasing productivity, and maximizing value. Obtaining The value of consistency ratio and the assessment of Pairwise comparison between criteria are critical success factors for LPS. Analysis of the highest priority weightage of stakeholder support and top management support using AHP (Analytical Hierarchy Process) weightage (Andrean Mandala, 2022).

3.1Population and Sample Size

To calculate sample size of method developed by Hogg & Tanis (2015) was used for Infinite Population,

Statistical formula:

$$\text{Sample Size} = \frac{Z^2 \times P \times (1 - P)}{C^2}$$

Here,
Z = Confidence level which is 95 % , for Z value is 1.96
P = Population Size which is 0.5 (Consider Infinite Population Size)
C = Correction Error is 12 %

The results of above values = $\frac{(1.96)^2 \text{ x } 0.5 \text{ x } (0.5)}{(0.12)^2} = 66.69 = 67$

Therefore, Sample Size is 67.

I. DATA COLLECTION & DATA ANALYSIS :

3.2 Questionnaire design & Contents

Critical Success factors & Challenges are selected from the relatable literature, industry Experts & informal interview. Total 34 Critical Success factors & 25 barriers were identified from Literatures and informal Interviews.Questionnaire Contains study purpose & confidentiality for encourage the high responses. Question Pattern format is on the basis of level of Implementation and level of Importance.The parameters are measured on a scale suggesting criticality of that factor. A score of 1 indicates the parameter has a high degree of importance, while the score of 5 indicates the least degree of importance. The respondents rate these factors in an online survey through Google form. The mediums of contacts were Email, LinkedIn and WhatsApp. I have received 66 responses from the project manager, contractors, planning engineers, and site engineers.

1	2	3	4	5
Very Important	Important	Moderately Important	Slightly Important	Not Important

Parameters Identified from Literature and informal Interviews:

Code	Critical Success Factors (CSFs)	Level of Implementation				
		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
C1	Coordination with Top Management					
C2	Last Planner System trained Staff					
C3	Involvement stakeholders in Last Planner System planning process					
C4	Eagerness to learn and train for Last Planner System					
C5	Enforce the employees to Traditional to Last Planner System					
C6	Co-ordination and cooperation between Sub-contractors					
C7	Manage resistance to change					
C8	Involvement of Project manager/Project Coordinator					
C9	Magnified support and Real time monitoring					
C10	Failure to daily updates & weekly meetings					
C11	Defined roles and responsibilities for monitoring and implementation of Last Planner System					
C12	Greater commitment by management					
C13	Effective integration of subcontractors					
C14	Additional time and cost for training of staff					
C15	Labour and material management skills					
C16	Material Supplier issues					
C17	Poor weekly meeting performance					
C18	Contracting and Procurement issues					
C19	Commercial issues and unsolved problem					
C20	Difficulties in solving root causes of delays of failures					
C21	Unforeseen Risks					
C22	Changes in Architectural or Structural design					
C23	Improper implementation plan					
C24	Time to implement Last Planer System					
C25	Change in master schedule					
C26	Improper Inventory management					
C27	Uneven cash flow management					
C28	Improper material store management					
C29	Change in SOP (Standard Operating Procedures)					
	Tech driven Last Planner System adoption (on ERP based)					
C30	- Cost of Maintenance and development of Last Planner System on ERP					
C31	- Training for software application					
C32	- Regularly updating of activity progress in software					
C33	- Fear of data security					

C34	- Client conviction to use ERP for site data management					

Code	Barriers to Implement Last Planner System	Level of Importance				
		Very High	High	Medium	Low	Very Low
B1	Organizational inertia or resistance to change					
B2	Lack of commitment to Last Planner System implementation or negative prospective towards new systems.					
B3	Lack of Last Planner System Knowledgeable Staff					
B4	Difficulty in creating quality assignments, or lack of skills, training, and experience.					
B5	Lack of leadership or failure of management commitment.					
B6	Lack of stakeholder support.					
B7	Lack of empowerment of site management or lengthy approval procedure from client and top management.					
B8	Effectiveness to use information generated during implementation of Last Planner System					
B9	Contracting and legal issues or structure.					
B10	Partial or Poor implementation of Last Planner System					
B11	Bad team Communication or lack of collaboration.					
B12	Bad work ethics and cultural issues.					
B13	Short-term vision.					
B14	Mis-interpretation of PPC (Percentage Plan Completion) indicator.					
B15	Extra resources & more paper work					
B16	Maintaining Daily White-board (White-board Method)					
B17	Parallel implementation with other improvement programs.					
B18	Lack of detailed long range planning and tracking					
B19	Appropriate knowledge of planning and scheduling					
B20	Lack of exposure on the need for Last Planner System					
B21	Difficulty in tracking and monitoring the progress					
B22	Technological barriers					
B23	Lack of high facilitator					
B24	Lack of Motivation Initiative towards LPS					
B25	Lack of visualizing techniques					

3.3 Data Analysis

3.3.1 Reliability test of Questionnaire Survey:

SPSS software is used for the reliability test of the respondents. In this study 66 responses collected from google form.

Reliability:

Case Processing Summary

		N	%
Cases	Valid	66	100.0
	Excluded[a]	0	.0
	Total	66	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.957	59

As per Cronbach's Alfa Value is > 0.9 which is Excellent and survey is reliable, Consistent & Valid.

3.3.1 Frequency Analysis Method

Critical Success Factors to Implement Last Planner System over Traditional Management System:
The parameters are measured on a scale:

Level of Implementation				
Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1	**2**	**3**	**4**	**5**

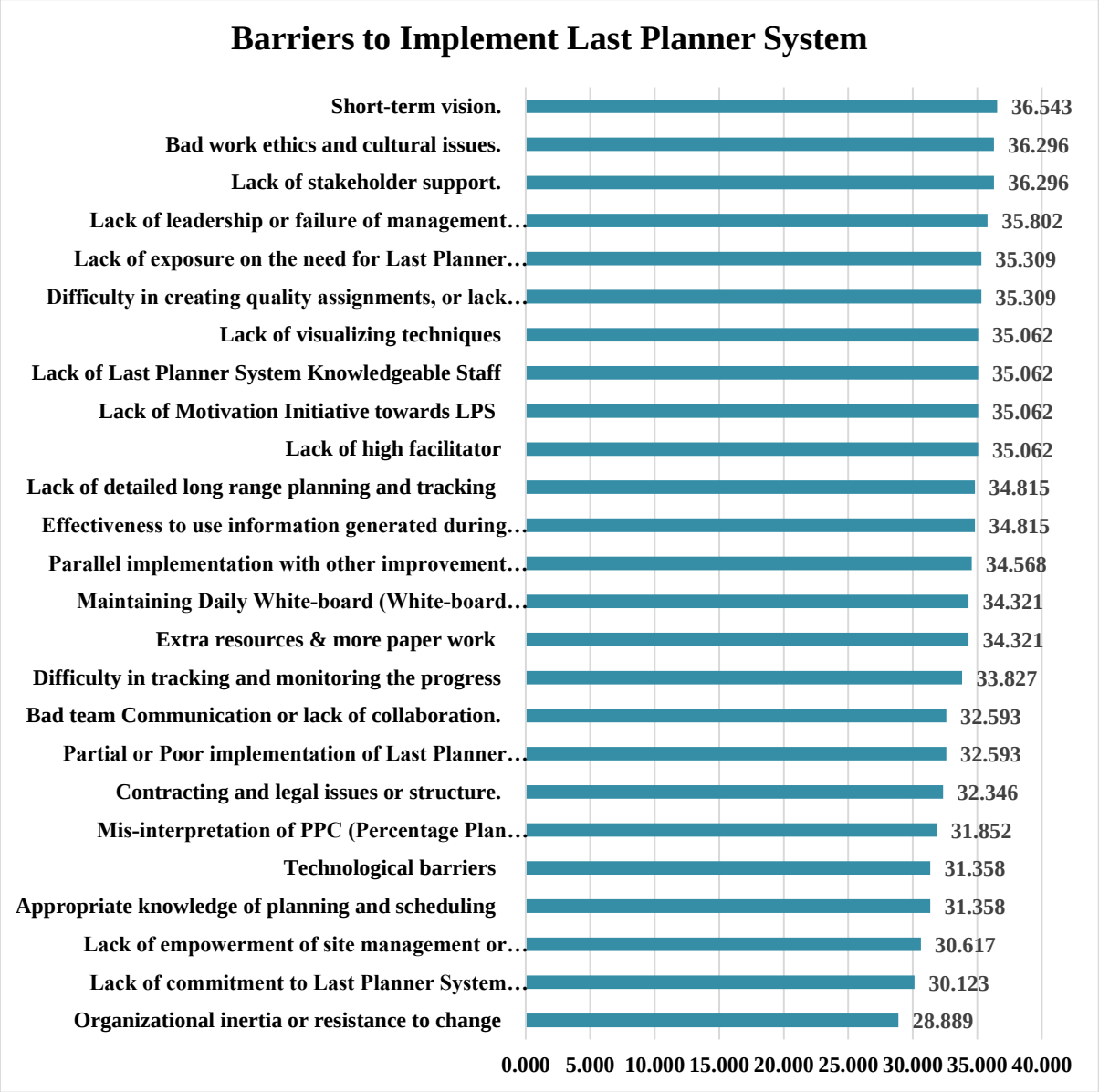
Code	Critical Success Factors (CSFs)	Frequency	Rank
C1	Coordination with Top Management	28.89	1
C23	Improper implementation plan	30.12	2
C11	Defined roles and responsibilities for monitoring and implementation of Last Planner System	30.62	3
C6	Coordination and cooperation between Sub-contractors	31.11	4
C17	Poor weekly meeting performance	31.36	5
C9	Magnified support and Real time monitoring	31.36	6
C2	Last Planner System trained Staff	31.85	7
C29	Change in SOP (Standard Operating Procedures)	32.10	8
C10	Failure to daily updates & weekly meetings	32.35	9
C21	Unforeseen Risks	32.59	10
C30	Cost of Maintenance and development of Last Planner System on ERP	32.59	10
C20	Difficulties in solving root causes of delays of failures	32.84	12
C27	Uneven cash flow management	32.84	12
C5	Enforce the employees to Traditional to Last Planner System	33.83	14
C34	Client conviction to use ERP for site data management	34.07	15
C19	Commercial issues and unsolved problem	34.32	16
C31	Training for software application	34.32	16
C32	Regularly updating of activity progress in software	34.32	16
C25	Change in Master schedule	34.57	19
C3	Involvement of stakeholders in the Last Planner System planning process	34.81	20

C8	Involvement of Project manager/Project Coordinator	34.81	20
C14	Additional time and cost for training of staff	35.06	22
C33	Fear of data security	35.06	22
C18	Contracting and Procurement issues	35.06	24
C15	Labour and material management skills	35.31	25
C4	Eagerness to learn and train for Last Planner System	36.30	26
C12	Greater commitment by management	36.30	26
C28	Improper material store management	36.54	28
C7	Manage resistance to change	36.79	29
C24	Time to implement Last Planer System	37.04	30
C13	Effective integration of subcontractors	37.78	31
C22	Changes in Architectural or Structural design	38.02	32
C26	Improper Inventory management	38.02	32
C16	Material Supplier issues	39.75	34

Barriers to Implement Last Planner System over Traditional Management System:
The parameters are measured on a scale:

Level of Importance				
Very High	**High**	**Medium**	**Low**	**Very Low**
1	**2**	**3**	**4**	**5**

Code	Barriers to Implement Last Planner System	Frequency	Rank
B1	Organizational inertia or resistance to change	28.889	1
B2	Lack of commitment to Last Planner System implementation or negative prospective towards new systems.	30.123	2
B7	Lack of empowerment of site management or lengthy approval procedure from client and top management.	30.617	3
B19	Appropriate knowledge of planning and scheduling	31.358	4
B22	Technological barriers	31.358	5
B14	Mis-interpretation of PPC (Percentage Plan Completion) indicator.	31.852	6
B9	Contracting and legal issues or structure.	32.346	7
B10	Partial or Poor implementation of Last Planner System	32.593	8
B11	Bad team Communication or lack of collaboration.	32.593	8
B21	Difficulty in tracking and monitoring the progress	33.827	10
B15	Extra resources & more paper work	34.321	11
B16	Maintaining Daily White-board (White-board Method)	34.321	11
B17	Parallel implementation with other improvement programs.	34.568	13
B8	Effectiveness to use information generated during implementation of Last Planner System	34.815	14
B18	Lack of detailed long range planning and tracking	34.815	14
B23	Lack of high facilitator	35.062	16
B24	Lack of Motivation Initiative towards LPS	35.062	16
B3	Lack of Last Planner System Knowledgeable Staff	35.062	18
B25	Lack of visualizing techniques	35.062	18
B4	Difficulty in creating quality assignments, or lack of skills, training, and experience.	35.309	20
B20	Lack of exposure on the need for Last Planner System	35.309	20
B5	Lack of leadership or failure of management commitment.	35.802	22
B6	Lack of stakeholder support.	36.296	23
B12	Bad work ethics and cultural issues.	36.296	23
B13	Short-term vision.	36.543	25



Here, lower the value of Frequency Value, greater the importance of that factor which is viability parameter in current research.

IV. RESULTS AND DISCUSSION :

Data analysis were carried out using Frequency Analysis method to identify the most important viability parameters impact the implementing Last Planner System over Traditional Management system.

Here, Out of 34 Critical Success Factors and 25 Barriers parameters, the top 10 parameters according to their Frequency Value are ranked and it's shown in the table below.

Top Most Critical Success Factors:

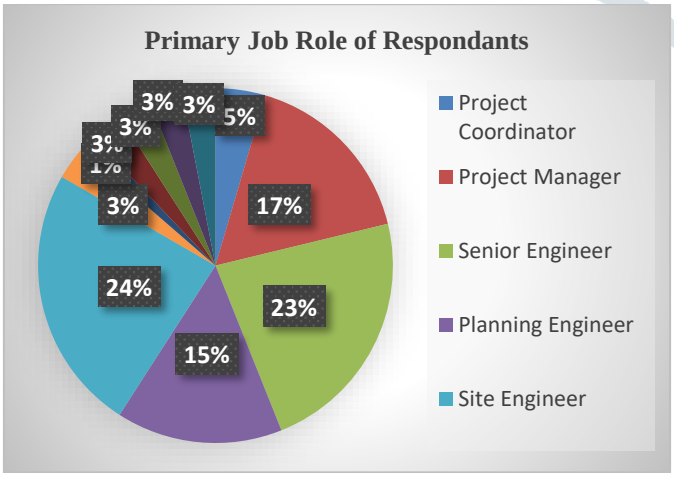
Code	Critical Success Factors (CSFs)	Frequency	Rank
C1	Coordination with Top Management	28.889	1
C23	Improper implementation plan	30.123	2
C11	Defined roles and responsibilities for monitoring and implementation of Last Planner System	30.617	3
C6	Coordination and cooperation between Sub-contractors	31.111	4
C17	Poor weekly meeting performance	31.358	5
C9	Magnified support and Real time monitoring	31.358	5
C2	Last Planner System trained Staff	31.852	6
C29	Change in SOP (Standard Operating Procedures)	32.099	7
C10	Failure to daily updates & weekly meetings	32.346	8
C21	Unforeseen Risks	32.593	9
C30	Cost of Maintenance and development of Last Planner System on ERP	32.593	10

Top Most affecting Barriers:

Code	Barriers to Implement Last Planner System	Frequency	Rank
B1	Organizational inertia or resistance to change	28.889	1
B2	Lack of commitment to Last Planner System implementation or negative prospective towards new systems.	30.123	2
B7	Lack of empowerment of site management or lengthy approval procedure from client and top management.	30.617	3
B19	Appropriate knowledge of planning and scheduling	31.358	4
B22	Technological barriers	31.358	5
B14	Mis-interpretation of PPC (Percentage Plan Completion) indicator.	31.852	6
B9	Contracting and legal issues or structure.	32.346	7
B10	Partial or Poor implementation of Last Planner System	32.593	8
B11	Bad team Communication or lack of collaboration.	32.593	8
B21	Difficulty in tracking and monitoring the progress	33.827	10

Respondents Information:

General Information		Frequency	Percentage
Respondent Primary Job Role	**Project Coordinator**	3	3.70
	Project Manager	11	13.58
	Senior Engineer	15	18.52
	Planning Engineer	10	12.35
	Site Engineer	16	19.75
	Site Supervisor	2	2.47
	BIM Modeler	1	1.23
	Executive Engineer	2	2.47
	Director	2	2.47
	Structure Engineer	2	2.47
	Other	2	2.47
Work Experience	**less than 5 years**	40	49.38
	5 to 10 Years	18	22.22
	More than 10 Years	9	11.11



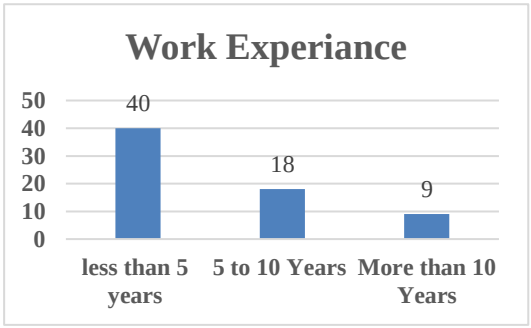


Figure 2

From the above Table, results shows that 13.5% respondents are Project Manager, 18.52% are Senior Engineer, 12.35% are Planning Engineer, and 19.75 % are Site Engineer. From this results Project Manager, Senior Engineer, Planning Engineer & Site Engineer most person who knows the Site Situation very well and they most time available on site. So that respondents opinion on Implementation Factors is near to achieve our objective.

So, from the Frequency Analysis Method, the top most critical success factors found are "Coordination with Top Management", "Improper implementation plan" and "defined roles and responsibilities for monitoring and implementation of the Last Planner System."

I. CONCLUSION

The research work concludes with many new observations analysed through data collection and data analysis. It intends to fill that void by developing an LPS adoption framework for the construction sector. This study examined the implementation of the LPS over the traditional management system by analysing the critical success factors and barriers' impact. This research aimed to identify such critical success factors and barrier parameters by conducting a quantitative study by involving various industry experts and literature reviews.

A total of 34 Critical Success Factors and 25 Barriers parameters were identified based on the reviewed literature and interviews. These parameters were then rated on a Likert scale by 66 experienced professionals using a questionnaire survey. The Frequency analysis method was used to analyse the responses.

The main results show that the critical success factors for implementing the Last Planner System are top management coordination, improper implementation plan, defined roles and responsibilities for monitoring and implementation of the Last Planner System, coordination and cooperation between sub-contractors, Poor weekly meeting performance; Magnified support and real-time monitoring; Last Planner System trained staff; Change in SOP (Standard Operating Procedures); Failure to conduct daily updates and weekly meetings; Unforeseen Risks; and Cost of Last Planner System Maintenance and Development on ERP. On the other hand, organisational inertia or resistance to change, lack of commitment to Last Planner System implementation or negative perspective towards new systems, lack of empowerment of site management or lengthy approval procedures from client and top management, appropriate knowledge of planning and scheduling, Technological barriers, misinterpretation of the PPC (Percentage Plan Completion) indicator, contracting and legal issues or structure. Partial or poor implementation of the Last Planner System Bad team communication or lack of collaboration Difficulty in tracking and monitoring the progress were the main barriers to LPS implementation. These significant parameters can be used during the implementation of the Last Planner System in construction organizations.

II. ACKNOWLEDGMENT

I want to thank my thesis guide Professor Ankit Patel (P.G. Coordinator) and Professor Jayraj Solanki (P.G. Head) for helping me with my dissertation and for always inspiring, guiding and motivating me to achieve the end goal. Without their help this research work wouldn't have been possible.

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