



## A STUDY ON EFFECTIVENESS OF LEAN CONSTRUCTION TECHNIQUES

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**Abstract:** In resolving the problems of construction wastes, lean construction (LC) tools are anticipated to be utilized in the construction industry. LC is a sustainable approach that may accomplish the construction wastes efficiently throughout the construction processes. Essential features of lean construction include a transparent set of objectives for the delivery process, geared towards maximizing performance for the customer at the project level, concurrent design, construction, and also the application of project control throughout the life cycle of the project from design to delivery. This paper involves the study of principles, methods, and implementation phases of lean construction showing the waste in construction and how it could be minimized. A field study was conducted to evaluate the effectiveness of some lean construction techniques including last planner, increased visualization, daily huddle meetings and the 5s process. The data collected through direct observations, interviews, questionnaires, and documentary analysis from Indian as well as foreign organizations. Thus, the data obtained is used to develop a framework which will provide an environment for construction organization to survive in any economic condition of our Indian society. A standardized framework enables to combine qualitative evaluation through observation together with quantitative analysis. A categorized evaluation scheme is proposed within the same model, to easily visualize and interpret the rating results. Then LC tools and waste are ranked supported RII, and Spearman's rho is conducted to investigate the connection between construction wastes and LC tools. The findings could assist the industry players in determining the suitable and proper LC tools that are suitable for their organization.

**Index Terms - lean tools and techniques, questionnaire, relative importance index (RII) method**

### I. INTRODUCTION

Lean is a philosophical way of working which emphasizes the removal of waste within a process. Core to the present philosophy involves the principle that expenditure of resources for any goal aside from the creation of value for the end customer is wasteful and so should be a target for elimination. This principle is applied from the attitude of the customer who consumes a product or service. Value is usually defined as any action or process that a customer would be willing to pay for. Put simply, Lean Process actively focuses upon preserving value with less work. The aim, therefore, is to make enhanced efficiencies leading to improved process flow and ultimately increased speed across a process. Lean philosophies achieve this through applying a series of "tools" which assist within the identification and steady elimination of waste. As waste is eliminated, quality improves while production time and costs are also reduced. A Lean process emphasizes getting the right things to the right place at the right time in the right quantity to achieve perfect, sustainable work flow while minimizing waste and being readily adaptable to change.

Lean is a combination of operational research and practical development in design and construction with an adaptation of lean manufacturing principles and practices to the end-to-end design and construction process. Unlike manufacturing, construction is a project-based production process. Lean Construction focus with the alignment and holistic pursuit of concurrent and continuous improvements in all dimensions of the built and natural environment: design, construction, activation, maintenance, salvaging, and recycling. This approach tries to manage and improve construction processes with minimum cost and maximum value by considering customer needs, while it helps to attain and maintain sustainability in construction sector.

## II. DATA COLLECTION

Initially, a questionnaire is prepared. Using this questionnaire, a survey analysis was done in order to find out the constraints and barriers in the construction sector and in order to identify the waste categories. The questionnaire was prepared after thorough study of literature and by understanding the lean construction techniques with its advantages and challenges. All the questions are framed objective type or ticking the answer format so that it can be easily answered and wouldn't take much time. Some of the measure barriers are listed after studying the literature properly and are asked to scale from 1 to 5 in respect of their probability of occurrence. The questionnaire was filled through online platform by sending to professionals including contractors, site engineers, project managers, etc. They were requested to answer the same as per their point of view. The answers are analyzed on the probability of their occurrence and the most probable barriers are listed in the result. The answers to the questionnaire received are compiled so that we could get a clear view of most probable barriers.

## III. LITERATURE REVIEW

**Marhani Mohd Arif, Ahmad Bari Nor Azmi, et.al (2019)** This paper is a preliminary survey, therefore, aim to analyze the perceived effectiveness of LC tools in reducing construction waste for the enhancement of contractor's environmental performance in the Malaysian construction industry. A structured interview was conducted with twenty (20) key personnel from selected G7 contractors in Malaysia, which are registered with the Construction Industry Development Board Malaysia. The results revealed that total quality management and partnering were the significant LC tools in reducing construction wastes. The findings defined in this paper could be necessary for future LC tools framework development that can strengthen the contractor's quality of work. This advancement is in-line towards enhancing the Malaysian construction industry through the fourth industrial revolution.

**Mohd Arif Marhani, Aini Jaapar, et.al (2012)** This paper provided the fundamental knowledge of LC and highlighted its implementation in the construction industry. It was discovered that the knowledge of stakeholders are reasonably significant as the principles of LC is widely implemented in the work field. However, the stakeholders are indifferent in their understanding on the basic terminologies of LC hence unable to reap its full potential. It was proven that by implementing LC, the construction industry benefits by maximizing value and improved sustainability.

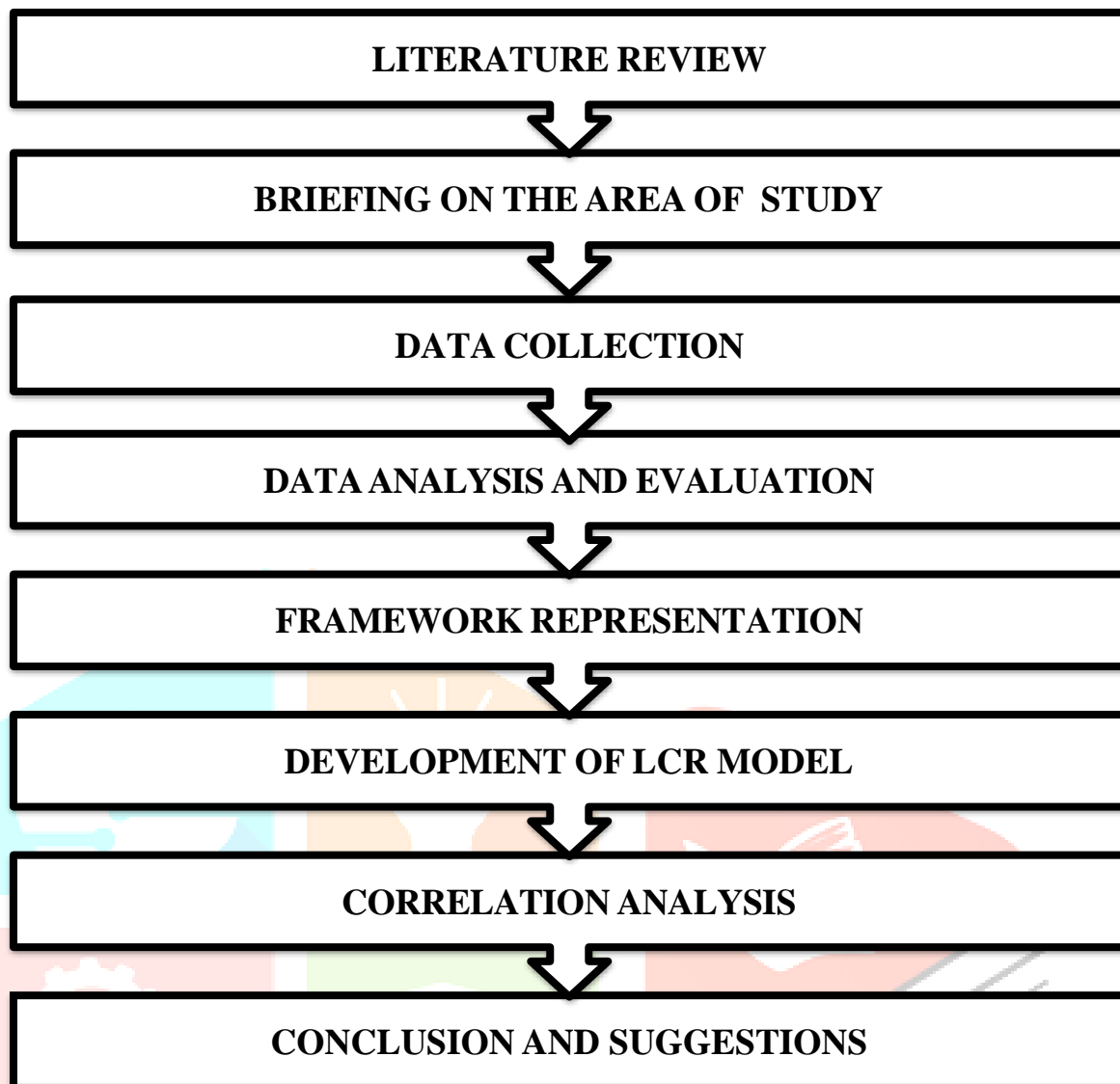
**Mohd Arif Marhani, Nor Azmi Ahmad Bari, et.al (2018)** This paper conducted a study to investigate the availability of LC tools and its implications towards the quality of a construction product via the survey questionnaire. The questionnaire was sent to the contractors that register with the Construction Industry Development Board Malaysia (CIDB) under class G7 categories in Malaysia. Based on the findings, the most LC tools implemented in the Malaysian construction industry are teamwork, daily hurdles meetings, and 5S. The implementation of LC tools can give a positive impact on the quality of the construction project. The findings outlined in this paper could be essential for the future framework of LC tools that can enhance the contractor's quality of a product towards sustainable low carbon emission development.

**P.SelvaPrasanth M.E., S.Ranjitha (2018)** The goal of our project is to apply the lean techniques in small scale construction projects such as residential buildings. This project deals with the various lean tools which include Last planner system, Increased visualization, Total Quality management, 5S process and Just in time. These tools helped them to improve the short term scheduling effort and communication. The essence of lean construction is increased by the elimination of non value adding activities from the construction. For that they had mainly visited 4 construction companies named Kishore Construction, AG construction, Panimalar builders, and Aalaya construction. They graphically plotted the waste related issues in the construction site, resource related works, management related works and information related works. The required lean tool is implemented. They also depicted in detail about the work plan for construction of a residential building.

**Amitha P & Dr. T. Shanmuga Priya (2017)** This paper intends to provide the fundamental knowledge of lean principles and highlight the waste elimination strategies thereby improving overall performance and quality. Nowadays waste in construction industry suffer lot of problems which results in low productivity and poor performance. There are lot of waste in construction process which are left unnoticed. As an attempt to improve the performance waste elimination can be used as one of the most effective ways to increase the profitability. To eliminate waste, it is important to understand exactly what waste is and where it exists and how to make it lean. Lean construction is excellent in managing the construction process and achieving the project's goal by eliminating waste.

## IV. RESEARCH METHODOLOGY

The research method used to achieve the objectives of this study is based on the following steps as shown



**Figure 4.1 Methodology flowchart of Project**

#### **V OBJECTIVES OF THE STUDY**

1. To study the principle, methods and implementation of lean construction showing construction waste and how it could be minimized.
2. To find out the barriers in construction sector for the implementation of lean concept by questionnaire survey
3. To develop a framework which will provide an environment for construction organization to survive in any economic condition

#### **VI. SCOPE OF THE STUDY**

4. To implement the method of lean construction for larger as well as smaller projects
5. To eradicate wastes completely during construction and to increase profit.
6. To improve the value creation accordingly as the client demands

#### **VII.RESULTS AND DISCUSSION**

##### **QUESTIONNAIRE SURVEY ANALYSIS**

The questionnaire was prepared after thorough study of literature and by understanding the lean construction techniques with its advantages and challenges. All the questions are framed in yes/no type format or tick type format so that it can be easily answered and wouldn't take much time. Some often measure barrier and the necessity are listed after studying the literature properly and are asked to scale from 1 to 5 in respect their probability of occurrence. The answers are analyzed based on the probability of occurrence and are listed in result. The answers to the questionnaire received are compiled to get a clear view of the result. Most of the consultants are not aware of lean but they think it would be a good initiative for Indian construction industry to minimize the waste and time factor.

The survey concludes that following are the major barriers for implementing the lean in Indian construction industry as shown in figure

Lack of lean awareness and understanding

Management is not interested in implementing Lean techniques

Lack of proper training for employees

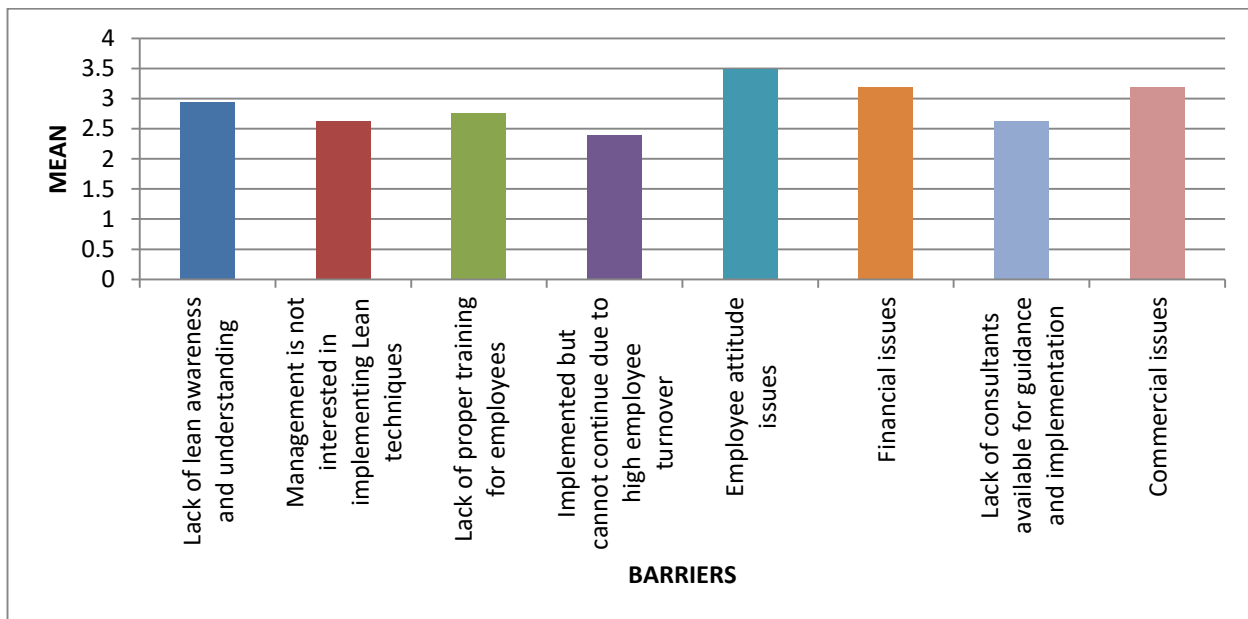
Implemented but cannot continue due to high employee turnover

Employee attitude issues

Commercial issues

Financial issues

Lack of consultants available for guidance and implementation



**Figure 7.1 Implementation challenges of lean technology**

From the study, it can be concluded that, majority of the respondents are not aware about lean techniques and tools and along with it most of the companies are facing employee attitude issues like no interest from employee's side, some employees are not ready to change to new practices and some slip back to old method whenever management tries to implement new methods. There are issues financially and commercially which cause delay in actual project duration due to changes carried out in issue orders by the owner and discrepancy in delivering documents.

**Table 7.1 Summary of analysis of lean tools**

CATEGORY	OBSERVED QUESTIONS	MEAN	RANK
5S Techniques	s, equipments and materials are arranged according to usage and importance,	2.54	3
Increased visualization	Safety signs are inserted in all required and critical spots at site, The warning about equipments and accidents are provided	2.76	2
Last planner	planning gives more preferred results than complete future planning	3.06	1
Huddle meeting	ings with site-in-charge at start of work on daily basis will sustain the work flow	2.4	4

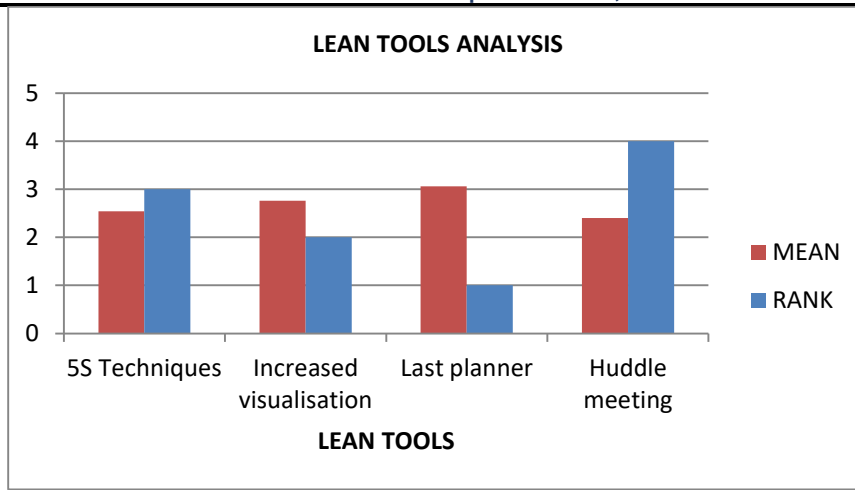


Figure 7.2 Bar chart analysis of Lean tools

**NEED FOR FRAMEWORK OF LEAN TECHNIQUES**

Based on the analysis carried out, the actual need for lean technique in the analyzed area is derived

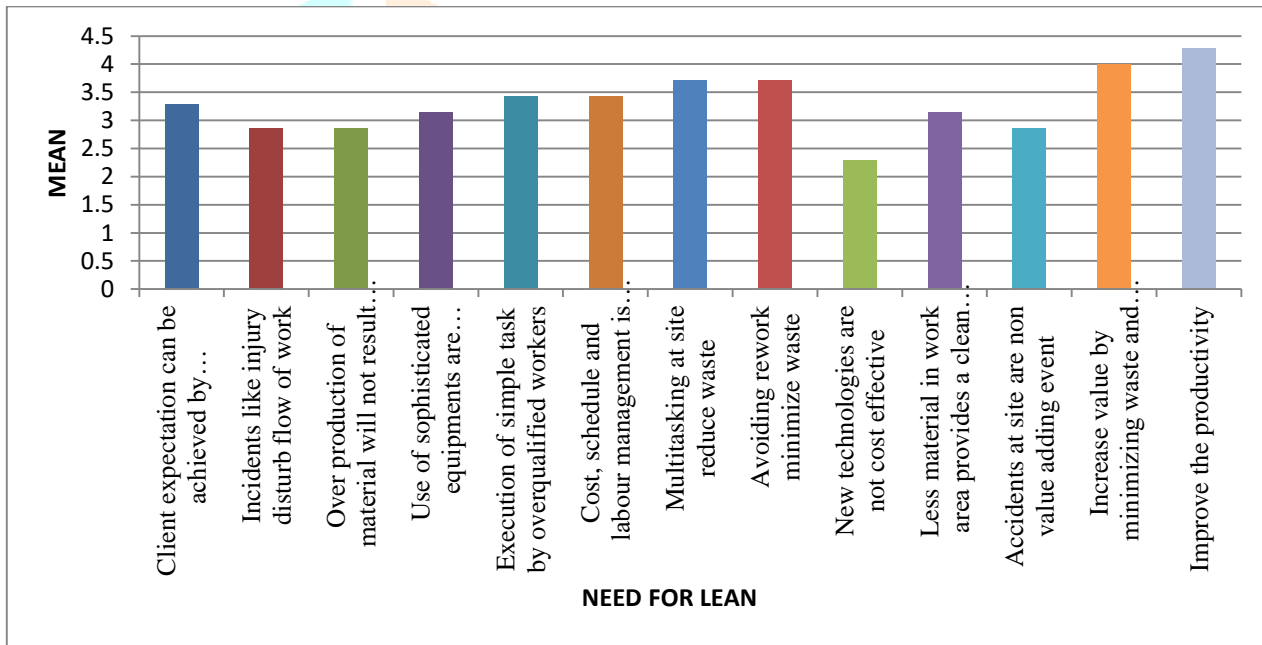


Figure 7.3 Need for lean technique

**CORRELATION ANALYSIS BETWEEN WASTES AND LC TOOLS**

The non-parametric technique used in this survey was a Spearman’s rho. This Spearman’s rho or Spearman’s rank correlation coefficient was assessing the strength of the relationship between two ranked data variables. The value of the correlation coefficient determined the strength of a relationship, which is ranging from -1.00 to 1.00. There are guidelines on how to interpret the values. The guidelines are: -

- Small  $r = .10$  to  $.29$
- Medium  $r = .30$  to  $.49$
- Large  $r = .50$  to  $1.0$

The negative sign of the values refers only to the direction of the relationship, not the strength of it. Hence, in this research, the Spearman’s rho was conducted to analyze the relationship between Construction wastes and LC tools. For the analysis five most rated categories of wastes was taken which are defects, material wasted, unnecessary material handling, delays and extra processing and four LC tools that are used for correlation analysis are 5S technique, Least planner technique, increased

visualization, and daily huddle meeting. The result is tabulated in the following Table 7.2

There was a strong and negative correlation between wastes formed due to extra processing and 5S technique,  $r = -0.568$ . When wastes formed due to defects and material wasted are correlated with the LC tools, it showed a moderate and negative correlation with daily huddle meeting, with  $r = -0.397$  and  $-0.316$  respectively. Also, wastes formed due to delay also showed a moderate and negative correlation with the last planner technique, with  $r = -0.373$ .

Table 7.2 construction wastes correlation between LC tools

	W1	W2	W3	W4	W5	LC1	LC2	LC3	LC4
W1	1	0.762	0.329	0.123	0.283	0.397	0.283*	-0.397	0.287
W2		1	0.316	0.322**	0.123**	-0.316	-0.409	-0.316	0.141*
W3			1	-0.027	0.172	0.317*	0.166*	0.339**	0.114
W4				1	0.299	-0.373	0.11	0.155	0.085
W5					1	0.141**	0.2	0.395*	-0.568
LC1						1	0.013	-0.075	0.556
LC2							1	0.32	0.457
LC3								1	0.578**
LC4									1

\*\*Correlation is significant at 0.01 level(2-tailed). \*Correlation is significant at 0.05 level(2-tailed).

W1-Defects,W2-Material wasted,W3-Unnecessary material handling,W4-Delays,W5-Extra processing  
LC1- Last planner, LC2-Increased visualization, -Daily huddle meeting,LC4-5S

## VIII CONCLUSION

From the questionnaire survey analysis, it is concluded that about 75% of the respondents are not aware about lean tools and techniques, and more than 80% of the companies are facing commercial and financial pressure which cause delay in actual project duration. Change in customers' expectations, changes carried out in discrepancies by the owner, are further other issues Lean construction comprises of many techniques but this study focused on four main techniques that is increased visualization, last planner technique, 5S technique and daily huddle meeting and a framework is developed to avoid confusion, delays, wait and loss in productivity in Indian construction production department and can be enhanced to suit any type of construction project. This study also analyzed the most significant LC tools in reducing the construction wastes. A Spearman's correlation analysis was conducted between five most rated wastes in construction which are defects, material wasted, unnecessary material handling, delays and extra processing and four LC tools last planner, increased visualization, 5S and daily huddle meeting. It was found that daily huddle meeting and 5S technique were significant LC tools in reducing construction wastes. There was a strong and negative correlation between wastes formed due to extra processing and 5S technique,  $r = -0.568$ . The findings could assist the industry players in determining the appropriate and proper LC tools that are suitable for their organization. The LC tools framework is potentially to be a stepping stone to the organization in achieving a better construction product.

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