

# An Analysis of Lean Construction Practices in Tamilnadu Construction Industry

Shaik Md Sami Pasha<sup>1</sup>, B.Harish Naik<sup>2</sup>P.G. Student, Dept. of Civil Engineering, Shri Shirdi Sai Institute of Science and Engineering, Ananthapuram, India<sup>1</sup>Assistant Professor, HOD, Dept. of CE, Shri Shirdi Sai Institute of Science and Engineering, Ananthapuram, India<sup>2</sup>

**ABSTRACT:** the construction industry plays a significant role in economic growth, both directly through its activities, and indirectly through the provision of buildings and infrastructures for the smooth functioning of businesses. However, the construction industry is highly challenged as 3D's industry – dirty, dangerous and demanding. Lean Construction is a new production philosophy which would bring in revolutionary changes in the construction industry. It is a way to design production systems to minimize waste of materials, money, time and effort in order to generate the maximum possible amount of value. Lean significantly contributes to the efficiency of the construction industry. Lean philosophy is all about designing and operating the right resources at the right time with right systems. Two very important construction tools are added under lean construction are the production control and structuring of the work. Lean Construction is also about gaining the control through coordination between stakeholders and the team members to improve the performance, delivery and value for everyone involved in the project. Thus, the construction in “Lean Construction” refers to the entire industry which includes owners, architects, designers, engineers, contractors, sub-contractors and suppliers. In current technological trend, lean construction has gained its importance significantly. An analysis of lean construction practices in Tamil Nadu construction industry has been made by certain methodologies. A questionnaire survey is used to collect information and data from the construction companies about the practice of lean construction techniques in the major districts of Tamil Nadu. It also includes the drawbacks, problems faced during implementation and wastes generated during operational process. Methodologies have been formulated to rank all the above criteria and arrive at the required conclusions. Collected data has been analyzed in two categories, one by manual consisting of three approaches and the other by software. Solutions & Suggestions for the major problems have been proposed to minimize the ranked wastes from the analyzed data and overcome the barriers in implementing lean construction techniques.

**KEYWORDS:** Lean Construction Practices

## I. INTRODUCTION

The construction industry plays a significant role in economic growth, both directly through its activities, and indirectly through the provision of buildings and infrastructures for the smooth functioning of businesses. However, the construction industry is highly challenged as a 3D's industry – dirty, dangerous and demanding. The construction industry lags 10 years behind the manufacturing industry because of the several reasons. The primary reason being its fragmented approach rather than an integrated approach. The second important reason is that the construction industry is far more complex than the manufacturing and thus the technical innovations are required to be more developed to be significantly implemented. Lean construction is a new production philosophy which would bring in revolutionary changes in the construction industry. To survive in today's competitive market, it has become imperative for construction companies to improve the quality of their work, increase work effectiveness, reduce waste and costs, and increase profit. This is particularly more pressing under the current financial crisis and economic recession. Consequently, the combination of project speed, high quality, and low cost has become a key engineering and managerial effort in facing the growing competition in the construction business. Most construction managers agree that the industry is susceptible to multiple wastes, overruns, delays, errors, and inefficiency. As a result, construction projects seldom finish on time, within budget, and at a quality level accepted by the customer. Thus, several project management approaches have emerged to improve construction performance including lean construction, lean project management, and value-engineering. Lean principles have slowly made inroads into the construction industry because of its approach to waste elimination and providing value with less effort and time.

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## LEAN CONSTRUCTION

**Definition:** Lean construction, as defined by the Lean Construction Institute (LCI), is a production management-based project delivery system emphasizing the reliable and speedy delivery of value. It is a new way to design and build capital facilities. Lean has already caused a major change in manufacturing industry and when applied to the construction industry, lean changes the way of working throughout the delivery process. Lean construction has successfully resulted into maximizing the value and minimizing the waste in the construction process.

### LEAN APPROACH

Lean production focuses on eliminating waste and maximizing productivity through the pull system, employee involvement, continuous improvement, etc. Much has been discussed about the waste elimination and productivity improvement that can be achieved by applying the lean concept. However, as the consideration of the environment is becoming an increasingly important part of the construction culture, there is a need to investigate the applicability of the lean concept to achieve environmental sustainability, which is often used interchangeably with the term “green”.

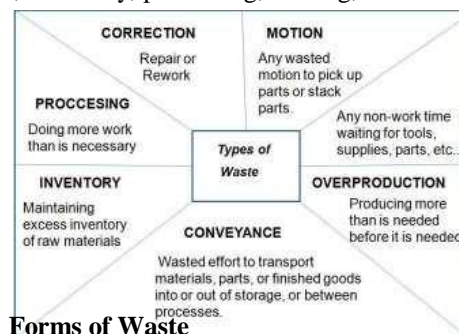
### LEAN PRINCIPLES

The lean principles include:

- Establishing good terms within the team comprising of owners, architects, contractors, subcontractors and suppliers.
- Emphasizing on the process design, and thus combining project design.
- Stopping production rather than spoiling the construction process.
- Enhancing participation of all the team members in a project, thus decentralizing decision making.

### WASTES GENERATED IN CONSTRUCTION INDUSTRY

Reduction and removal of waste is an important part of lean and green construction. Using the material resources efficiently can lead to sustainable waste management. Waste is hardly ever recognised by the project managers which is the major cause of loss of efficiency and productivity (Koskela 1992). Figure 3 identifies the seven forms of waste which are over production, conveyance, inventory, processing, waiting, correction and motion.



**Forms of Waste**

We can reduce the level of waste production in the construction industry by designing such a way that minimum waste is generated, by increasing the efficiency of the production process, by using the just-in-time tool to prevent the wastage of unused material, by recycling materials wherever possible and by educating the staff about waste reduction and material recycling. Formoso et al. classified construction wastes into two types: unavoidable (or natural) waste in which case the cost of prevention of the waste is higher than the production cost; and avoidable waste, in this case the cost of waste is higher than the cost of prevention. Construction wastes can be categorized according to its source or stage in which the root causes of the waste occur. It is classified construction waste causes into six sources: design, procurement, materials handling, operation, residual and others. Garas et al. grouped construction wastes into two: time wastes which include waiting periods, stoppages, clarifications, variation in information, rework,

ineffective work, interaction between various specialists, delays in plan activities and abnormal wear of equipment. The other type is material waste which comprises over ordering, overproduction, wrong handling, wrong storage, manufacturing defects and thefts or vandalism.

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**NEED FOR STUDY** India's rapid economic growth over the past few decades has placed a tremendous stress on its limited infrastructure. Construction industry is one of the largest industries which support the economy of a country. Since construction has a major and direct influence on many other industries reducing waste in construction can go a long way in helping the economy of the world.

## OBJECTIVES AND SCOPE OF THE PROJECT

The objectives and scope of the research are as follows:

- To analyze the extent of lean development in Tamil Nadu (TN) construction industry.
- To analyze the current lean practices at all the levels of construction projects in TN construction companies.
- To investigate all the barriers in implementing Lean Construction techniques.
- To rank the construction wastes generated in TN construction industry.
- To propose better solutions to overcome the barriers in implementing lean construction techniques.
- To recommend the solutions and suggestions for the major problems to minimize the top 10 prioritized wastes in TN construction industry.
- To develop a practical framework for adopting lean construction techniques and measuring lean performance.

## II. STUDY OF LITERATURE

**GENERAL** A literature review is an account of what has been published on a topic by accredited scholars and researchers. It is a text of a scholarly paper, which includes the current knowledge including substantive findings as well as the theoretical and methodological contributions to a particular topic.

### LITERATURE REVIEW

Salem et al, (2006) studied the theory part of lean construction to implementation. The author compares the techniques developed for lean construction with those developed for lean manufacturing. Lean manufacturing and lean construction techniques share many common elements despite the obvious differences in their assembly environments and processes. Manufacturing plants and construction sites are different in many ways that might explain why lean production theories and practices do not fully fit the construction industry. Additionally, this paper presents a study of a construction project in which specific lean construction elements were tested. Each technique was evaluated in terms of its impact on the performance of the project. Based on the findings of the study, a new "lean assessment tool" is proposed to quantify the results of lean implementations. The assessment tool evaluates six lean construction elements: last planner, increased visualization, huddle meetings, first-run studies, fiveS's, and fail safe for quality. This paper provides a simple and comprehensive approach that is transferable to any construction project.

Sunil Desale and Deodhar (2013) described the application of lean and six sigma principle for constructional process improvement in Indian organizations. This paper highlights the real issues contrasting construction organizations and explores the potential of Lean and Six Sigma construction concepts in construction industry in India. Lean Construction and Six Sigma or related concepts have been successful acceptance in the Automobile sector in many countries. But still the same has yet to be used in construction rigorously. This research is focused on this emerging concept called –

"Lean Construction" based on the basic Principles of management and special tools and techniques to achieve those desired goals of better productivity and better profit margins. The author has concluded that the construction organization needs positive thinking and top management (i.e. Owner) supposes to start on the Lean & Six Sigma implementation journey. They have to make fundamental changes in their strategic of production, quality improvement and adaptation of new technology. To unlock the huge potential, leading institutes and researchers has to work hard to percolate this technology to bottom of society.

Rajprasad et al, (2014) studied the application of lean construction techniques using last planner concept in residential building. This study intends to provide a better understanding of the Last Planner System (LPS) which is a Lean Construction concept by analyzing the various schedule systems involved in the concept. The LPS is a production control system for managing projects. It supplements or replaces a typical management system based on activities and a defined schedule produced by a project manager. The LPS produces predictable workflow and rapid learning. This produces maximum value to the owner by eliminating waste caused by unpredictable workflow. Its use has enabled contractors to reduce the delivery time of a project and at the same time allowed specialty contractors to improve utilization of their resources. This paper focuses on implementing Last Planner System in residential construction by comparing the present scheduling techniques used in the industry. The results indicated that the respondents are not

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familiar with the LPS concept. It was concluded that with effective training in the concepts of LPS, the builders can overcome schedule delay and can improve the standards of the project.

### III. RESEARCH METHODOLOGY

The project methodology has been shown in the Figure 3.1. The main tool for the collection of data includes questionnaire survey. The target population for the data collection includes project managers of TN construction companies.

#### STUDY ALL THE POSSIBILITY OF WASTES IN CONSTRUCTION INDUSTRY

The wastes generated in construction industry has been identified and categorized by site survey and literature review. The site survey includes various projects such as residential, institutional, commercial buildings and the wastes are identified by the various data collected from the site and literature review. The categorized wastes are as follows:

**Table List of Wastes occurring in Construction Industry**

S.NO	LIST OF WASTES OCCURRING IN CONSTRUCTION INDUSTRY
1	Waste due to Improper Planning of Construction
2	Waste due to Worker's Mistakes
3	Waste due to delay in material supply
4	Waste due to irregular Cash Flow
5	Waiting due to crews interference
6	Waiting due to Inspection
7	Waste due to Stock Problem
8	Waste while waiting for instruction
9	Waste in waiting due to equipment's installation
10	Waste due to theft or Vandalism (theft)
11	Waste produced due to over-ordering & over production
12	Waste due to wrong handling and wrong storage
13	Waste occurred due to manufacturing defects
14	Waste due to ordering of materials that do not meet the project requirements defined on design documents
15	Waste due to re-work
16	Waste due to in-effective work (errors)

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## IV. STRUCTURE OF QUESTIONNAIRE

The questionnaire has been structured based on the six main divisions. This includes barriers in implementing lean construction, techniques used in lean construction, wastes generated in construction industry, stages at which wastes are produced, statistical analysis of various parameters for the assessment of company's growth, measurement of lean conformance. The questionnaire has also uploaded to Google drive in the form of Google docs so that the survey details can be collected online also. The survey has been conducted both in direct (Personal Interview) as well as through online. The form for direct interview is enclosed in Appendix 1. This online form has seven sections. The section details are:

**Table Questionnaire Section and its Details**

SECTION NO.	CONTENT OF THE SECTION
1	General Introduction about Lean Construction
2	Details of Respondent
3	Barriers in implementing Lean Construction and Techniques used in Lean Construction
4	Techniques used in Lean Construction
5	Ranking – Wastes Generated in Construction Industry
6	Stages at which wastes are generated
7	Statistical Analysis of various parameters for the assessment of Company's Growth
8	Measuring Lean Conformance

## WASTES GENERATED IN CONSTRUCTION INDUSTRY

Raid Al-Aomar (2012) investigated and categorized the different types of wastes in the construction industry and to develop a lean construction framework with Six Sigma rating that can be used to quantify and assess the quality, cost, and schedule implication of lean construction practices. The categorized wastes are as follows:

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**Table 4.4 Wastes Occurring in Construction Industry**

S.NO	LIST OF WASTES GENERATED IN CONSTRUCTION INDUSTRY
1	Waste due to Improper Planning of Construction
2	Waste due to Worker's Mistakes
3	Waste due to delay in material supply
4	Waste due to irregular Cash Flow
5	Waiting due to crews interference
6	Waiting due to Inspection
7	Waste due to Stock Problem
8	Waste while waiting for instruction

### STAGES AT WHICH WASTES ARE GENERATED

The stages at which wastes are generated in construction industry are tabulated as follows:

**Table 4.5 Stages at which Wastes are generated**

S.NO	STAGES OF CONSTRUCTION
1	Contract Bidding Stage
2	Design Stage
3	Materials Procuring & Handling Stage
4	Operational Stage
5	Others,

### STATISTICAL ANALYSIS

The statistical analysis has been done to assess the company's growth in terms of various parameters. The parameters includes performance assessment, schedule performance, production rate, quality performance, duration of completing the project, cost performance, labour workforce, labour support and safety measures. The statistical analyses has done by calculating the incremental or decremental percentage for the above mentioned parameters by comparing it with the



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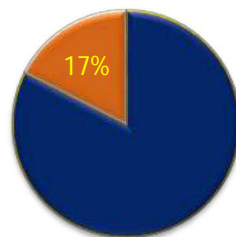
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previous year performance for non-lean firms. For lean firms, the percentage are calculated by comparing the performances of parameters before and after the implementation of lean techniques and concepts.

## V. RESULTS

From the above analyzed data, the following results are obtained:

- The analysis showed that about 82.5 % of the surveyed companies have a clear idea about lean construction. It has been shown in the figure.



■ YES ■ NO **Figure 7.1 Frequency Chart for idea about Lean Construction**

It is found that about 52.42 % of the surveyed companies have incorporated the lean construction techniques in the projects and about 47.57 % of the surveyed companies have not incorporated it.

## VI. SOLUTIONS, SUGGESTIONS AND RECOMMENDATIONS

From the above results, some of the suggestions and solutions are recommended to minimize the wastes in construction industry. It is also recommended to overcome the barriers in implementing lean construction techniques and concepts in the construction projects to minimize the wastes.

### SOLUTIONS TO OVERCOME THE BARRIERS IN IMPLEMENTING LEAN CONSTRUCTION TECHNIQUES

- Lack of exposure on the need to adopt lean construction can be overcome by communicating the benefits of Lean construction through seminars and conferences to the construction practitioners. Also the government should enact policies which appreciate the effort by firms which adopt Lean principles.
- Recommendation is to take company-wide initiative to apply Lean principles and it is not enough to send a few managers or personnel for workshops and seminars. This way of working should eventually percolate to the lower levels.
- The sub-contractors and suppliers should also be made to attend the lean workshops and take initiatives to implement Lean management principles.
- Barriers in uncertainty in the supply chain can be overcome by choosing proper suppliers who not quote less price, but deliver good quality and who also have a proven track record.

## VII. CONCLUSIONS

Lean significantly contributes to the efficiency of the construction industry. The application of lean in the construction process has resulted into structuring of the work throughout the process and the improvement of performance of the project. Lean construction assures to deliver reliable work between specialists in design, supply and assembly, thus delivering Value to the customers and reducing the waste. The project tries to bring out the need for the implementation of lean philosophy in the construction industry. The project has also found out all the barriers in implementing Lean Construction and ranked according to the respondents' weightage. It has also found out all the wastes generated in construction industry and it is ranked according to the respondents' preference. It has been concluded by insisting that the Lean philosophies offer the conceptual basis, and lean construction methods and tools have great possibilities for sustainable construction. It is thus mandatory for the acceptance on lean tools to bring out the developmental change in the field of construction to achieve the substantial flow of work. Thus, solutions and suggestions are recommended to overcome the barriers in implementing lean construction and the

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project is extended to give solutions to minimize the wastes generated in construction industry. Thus, it satisfies the objectives of the project.

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