

Lean Management in Construction Industry

Morish Kumar.K¹, Logesh kumar.M²

¹PG student, Sona College of Technology, Salem, Tamilnadu.

²Assistant Professor, Sona College of Technology, Salem, Tamilnadu.

Abstract - The construction industry globally faced with challenges of time overrun, frequent deadlines delays, cost overrun, and material wastage. It has been observed many times that the productivity of the construction depleting which leads to rework and produces many wastes such as inventory, unnecessary transportation, over production, workers displacement, defects, over processing, waiting of materials, unused employee creativity, work accidents, etc. In order to address these challenges, the lean construction approach has been adopted in the construction industry. The main aim of Lean construction approach is helping organizations achieving the overall goals in a construction project lifecycle by adding end-to-end value. Lean construction is an innovative ideas for continuous improvement, flattened organization structure, efficient usage of resources, elimination of waste, and cooperative supply chain, filtering of work packages to stabilize work flows, pull flow of teams and materials, and in-process quality control, demands effective and timely flows of information both to and from the workforce. Lean construction is one of the way to minimize wastage of materials, time and effort in order to generate maximum possible amount of value, which in turn to improve the entire construction process delivery with raising the profit level. Hence, this study aims to explore the concept of Lean approach and examines how the approach can impact the construction industry. In this work, the collection of data by questionnaire survey from Project managers, senior Engineer, Site supervisors and Contractors of Construction companies by interviews, e-mail questionnaire and through telephone. Based on the gathered data, analysis was made to identify the factors affecting the industry. After the identification of factors, there is a need to find the root causes of these factors or problems. By identifying the root causes and its extent, we can recommend the best measures to control these problems.

Keywords: lean concept, waste elimination, problem identification, continuous improvement, customer satisfaction.

1. INTRODUCTION

Construction projects are typically high in complexity and to manage such highly complex projects, a new improvement concept has been developed; i.e. lean construction. 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”.

Lean construction is a new production philosophy which has the potential of bringing innovative changes in the construction industry. It believed in preserving value with less work and also improvement in efficiency by improving the workflow. Lean principles have slowly made into the construction industry because of its approach to waste elimination and providing value with less effort and time. Construction process consists of countless activities that add no value to the product and those non value adding activities (e.g. waiting time, double handling, searching for material etc.) are pure waste and should be eliminated completely. This approach tries to manage and improve construction processes with minimum cost and maximum value by considering customer needs. Lean construction is about eliminating the non-value generating activities such as reducing the costs by cutting waste, innovating by engaging people and organizing the work-place to be more efficient, the concept of lean construction has been adapted from manufacturing, from Toyota Production System. Several studies regarding various stages/aspects of construction projects have confirmed that waste in construction can be reduced by improving the project management activities. The removal of waste (Man, Machine, Method, Material and Measurement) and value generation in terms of adding value to the customer are the major contributions of lean construction to sustainable development. The main objectives of this research are: prioritising influential (strong) barriers to successful lean construction, determining the difficulty associated with overcoming each barrier.

2. LITERATURE REVIEW

- **Apoorva Mercy Nama and Asra Fatima (2016)** identifies and analysed to overcome the barrier for successful implementation of lean construction in the Indian construction industries by conduction of questionnaire survey in various construction firms.
- **Aakanksha Ingle and Ashish P Waghmare (2015)** highlights the cost and benefits of potential contribution of lean construction to achieve the

productivity enhancement and waste minimization in construction industry.

- **Mohammed D M Alhalafi and Dr. Parminder Singh Kang (2017)** reveals by conduction of survey by questionnaire that the lean thinking in project management reduces time and cost and achieve overall goal in construction project lifecycle by adding end-to-end value.
- **Piotr Nowotarski et.al., (2016)** analysed by proposing 3 process (i.e., column concreting, storage area management, scaffolding ordering) and reveals improving of these construction processes by using lean management methodologies.
- **Qian Chen (2007)** investigates the concept of Interface management and its benefits to construction management by improving the implementation of lean production and agile project management.

3. OBJECTIVES OF THE PROJECT

The following are the objective of the project:

- To adopt method to improve business and beat the competition.
- Identify the benefits and barriers associated with lean implementation.
- Identify the requirements for improvement of lean implementation.
- To improve the quality of the project and profit by minimizing the waste.

4. SCOPE OF THE PROJECT

Lean is a best and effective concept which is about designing and operating the right process at the right time. If performance is improved, there will be an increase in the quality, energy sources and environment and reduction in waste.

The main objective of this project is to find the major barriers in completion of construction project soon, such as insufficient information about construction field, followance of old techniques, work structuring, external delays. This project presents an exploratory study on the results of questionnaire survey among construction participants to explore the factors.

In this project the causes and their extent on construction are explained. It includes the control measures that can be recommended for the future use. By adopting these measures the benefits like Reduced overhead cost, Elimination of hazard, Increased profitability, Reduced variability, Reduced lead time, Better quality of materials, Reduced rework, Improved work efficiencies, Minimize the chances of future delay, Elimination unnecessary cost can be achieved.

5. NEED FOR RESEARCH

Construction industry is one of the largest industries which support the economy of a country. Since construction can go a long way in helping the economy of the world. The construction industry globally is faced with challenges of time overrun, cost overrun, and material wastage. The building industry has been identified with numerous several challenges that seek to limit its sustainability and efficiency in delivering value for money to clients and end-users. Amongst the challenges confronting the growth and development of the building industry, time overrun, cost overrun, and material waste are very critical as they combine to have negative impacts on the efficiency of firms in the delivery of building projects. In order to improve the efficiency and reduction of waste, the lean construction has been introduced as a new management principle for better implementation. Lean construction is simply known as "It's about continuously delivering better quality from the customer perspective".

5.1 Lean: Lean refers a set of management practices to improve efficiency and effectiveness by eliminating by eliminating waste. The complete concept of the lean is to reduce and eliminate non-value adding activities and waste.

5.2 Lean Principles: The five Lean principles are

- Identify Value:** Define value from the customer's perspective.
- Mapping the Value stream:** Map all the activities (i.e. value added and non-value added) that brings value towards customer's needs.
- Creating flow:** Continuous flow of all activities from beginning to end process.
- Establish pull system:** To produce what the customer wants just in time.
- Pursuing Perfection:** Complete elimination of waste so all activities create value for the customer by continuous improvement.

5.3 Waste: Waste is any action or step in a process or activity that does not add value to the product or service in the perspective view of customer. Waste can be:

- Value added waste:** Any activity that adds value and meets the customer's demand, and the customer is willing to pay for it.
- Essential non-value added waste:** The activity that must be completed to enable the value-adding activity to complete, but it does not add value. For example, Inspection is necessary but customer does not pay for it.

iii. **Non-value added waste:** Any activity that does not add value to the customer's requirement.

5.4 Customer Satisfaction: Customer satisfaction is the measure of how the needs and response are collaborated and delivered to meet the customer's expectation. In other words, it is a part of customer's experience that exposes a supplier's work on customer's expectation.

6. RESEARCH METHODOLOGY

6.1 Methodology Overview: The following methodology shows figure 1 was proposed one to analyse and implement the lean management principles in construction industry.

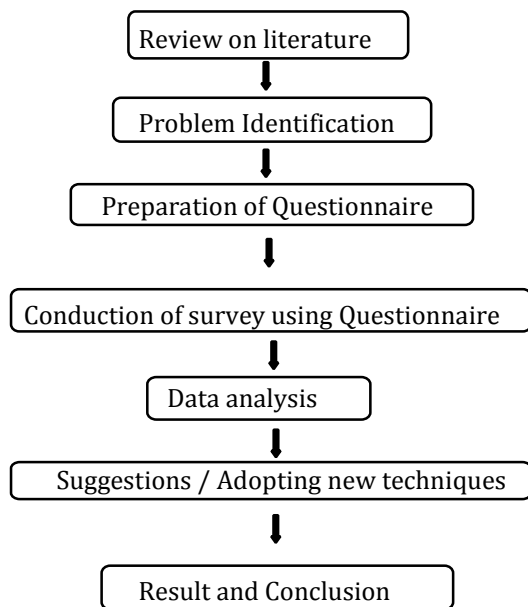


Figure 1: Methodology

6.2 Questionnaire Survey: The Design of the questionnaire consists of 35 questions and its categorized under 5 criteria according to type of waste. Totally 25 companies were surveyed via Personal Interview and E-mail. The design of questionnaire was prepared by using 5-point likert scale.

Table 1: Likert Scale

Grading
Never
Once
Sometimes
Frequently
Most Frequently

The prepared questionnaires were given to the various project participants are Project Manager, Design Engineers, Site Engineers, Supervisors and Labourers.

6.3 Means of Survey: The data of questionnaire has been collected through two ways.

- Through direct site visit.
- Through Google forms.

7. DATA ANALYSIS AND RESULT

The data collected from all the construction sites (project manager, site supervisor, contractors) were analyzed by using Microsoft Excel and each waste were differentiated by the percentages of various companies.

7.1 Ms Excel: Microsoft Excel is a software program produced by Microsoft that allows users to organize, format and calculate data with formulae using a spreadsheet system. It uses a grid of cells arranged in numbered rows and letter-named columns to organize data manipulations like arithmetic operations.

7.2 Count if: The COUNTIF function is used for counting cells within a specified range that meet a certain condition.

Formula: =COUNTIF (range, criteria)

For Example: You can write a COUNTIF formula to find out how many cells in a worksheet contain a number greater than or less than the number you specify.

7.3 Sum if: The SUMIF function is a worksheet function that adds all numbers in a range of cells based on one criteria.

7.4 Count a: The COUNTA function counts the number of cells that are not empty as well as the number of value arguments provided. It can be entered as a part of formula in a cell of a worksheet function.

Formula: COUNTA (value 1, value 2, ..., value n)

7.5 Count blank: The COUNTBLANK function counts the number of empty cells in a range of values. The COUNTBLANK function can be entered as a part of formula in a cell of a worksheet function.

Formula: =COUNTBLANK (range)

7.6 Wastes in Construction:

A very high level of waste /non-value added activities is confirmed to exist in the construction industry. In general, Construction Project has a production systems which need to be designed, planned, produced, and delivered within a specific time with effective cost. In fast track project there could be long, complicated supply chains involving many resources (materials, equipments, labours and employees) and subject to multiple, extensive design process and changes and have complex flow management that might be failed. As a result, the industry is characterized by delays and often has suffered cost and time overruns.

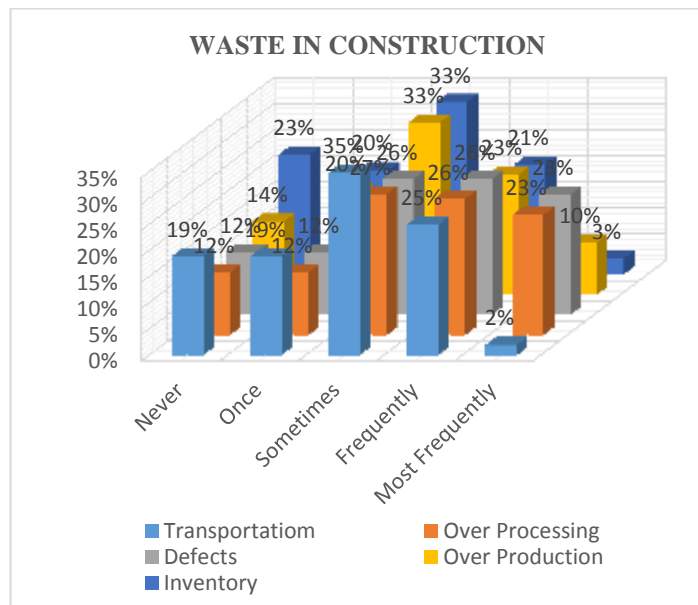


Figure 2: Various percentage of waste in construction industry

A. Transportation Waste: The Transportation waste is the major problems in the construction sites. This waste occurs between process steps and workstations rather than within them. Transportation like motion is a highly visible type of waste. The transportation waste in materials can be easy to observe and identify like breakage while moved with the forklift or truck, manual by labours carrying materials/goods between worksites. Unnecessary transportation often occurs because poor facility layout and poor logistics. Here the bar chart shows that the 62% of respondents were agreed that the resources are wasting in everyday.

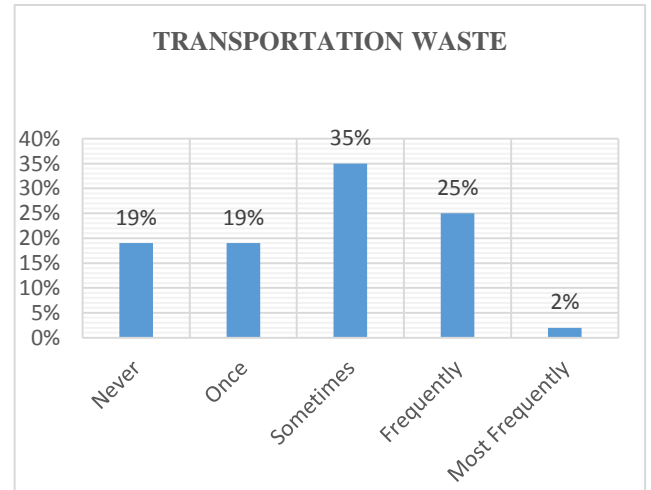


Figure 3: Level of Transportation waste

B. Over processing Waste: Over processing is probably the most difficult waste to see and understand. Over processing waste is caused by having unclear standards and specifications, Rework to meet quality requirements, multiple conformations, delivering high precise dimensional component and including more material than necessary to meet specifications. Another issue is the one of non-standardized working practices, unless you have standardized working then you will have difference in methods between different shifts and different people. Many operators will try to do the best job possible and will not always be aware of what truly adds value. Here the bar chart presents the survey result that 76% of respondents felt that excess effort and delay of project happens frequently by above mentioned over processing waste.

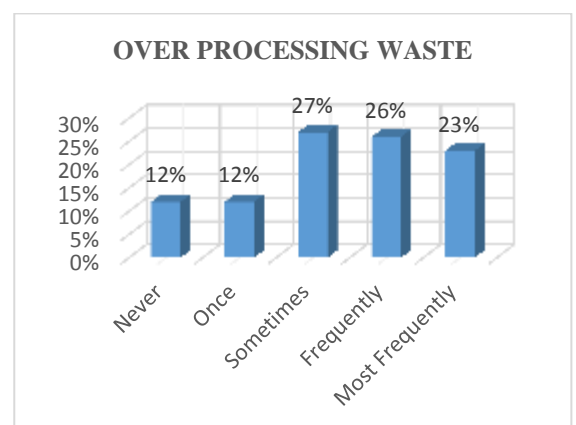


Figure 4: Level of Over Processing waste

C. Defects Waste: Defects waste mainly happen due to lack of quality checkup, lack of using safety measures, lack of inspections, unconscious of labours at workplace, incorrect information, misunderstand of plans. This bar chart shows that 75% of respondents thought that the waste happens due to above

mentioned defects related problems. Defects leads to rework and resulting in additional costs, delays, and possible safety issues.



Figure 5: Level of defects waste

D. Overproduction Waste: Overproduction waste can happen when materials, plans, labours are produced which are not needed, but also when items are produced before they are needed. Long setup times, unreliable process, unstable schedules is the major problems to get more cost and time. The below bar chart shows that the 66% of respondents are agreed that the overproduction wastage are happening in every construction sites.

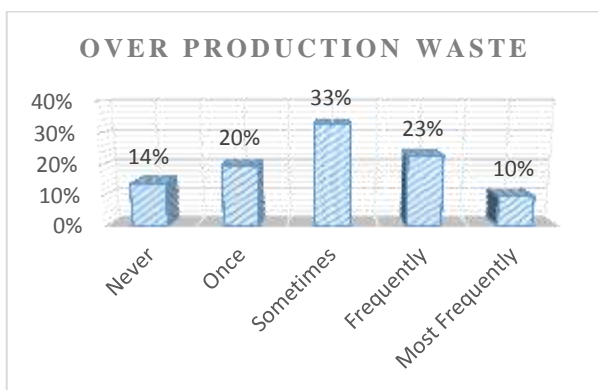


Figure 6: Level of Over Production waste

E. Inventory Waste: Inventory wastes takes place when the supply exceeds the real customer demand. Major causes of inventory waste is because of buffer exceeds need, lack of proper monitoring systems, production speed not aligned to demand, suppliers are not reliable, long set-up times. The below bar chart shows that the 57% of respondents are agreed that the overproduction wastage are happening in every construction sites.

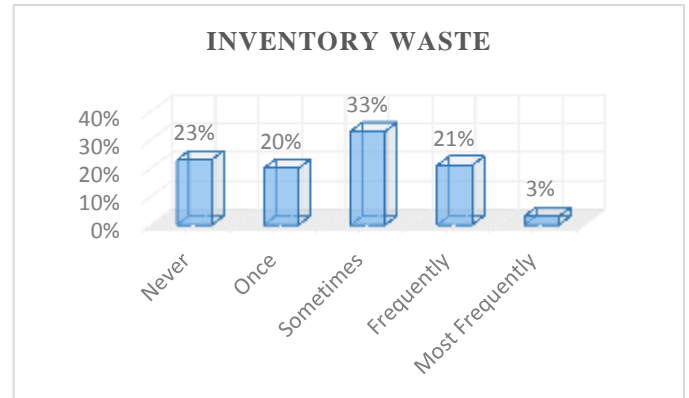


Figure 7: Level of Inventory waste

8. RECOMMENDATIONS AND SUGGESTIONS

The existence of various number of waste in the construction have depleted overall performance and productivity of the industry, and certain serious measures have to be taken to rectify the current situation i.e., Lean Construction. Lean construction is concerned with the alignment and complete chasing of concurrent and continuous improvements in all dimensions of the built and natural environment such as design, construction, maintenance etc. This method manage and improve construction processes with minimum cost and maximum value by considering customer needs which helps to achieve and maintain sustainability.

8.1 Lean Transportation Practices

Followance of 8 Rights (8R) to eliminate wastes while transportation takes place and to achieve lean in transportation are:

- Right Materials
- Right Quantity
- Right Time
- Right Place
- Right Source
- Right Price
- Right Quality
- Right Service

8.2 Lean Overproduction Practices

- Wide demand visibility - To adjust your production system (track orders, inventory, demand trends and other variables).
- Reduced cycle times.
- Understanding Market Realities.
- Focus on "pull" rather than "push" production - you let customer demand, not your own

production capacity, establish the rate and quantity of production.

8.3 Lean Defects Practices

- To help eliminate defects and rework from your daily routine, make sure you have a full understanding of all work requirements and customer needs before starting the task. Simple work such as checklist, inspections, standardized work plans, automation smart technology can make a big difference as well.
- Implement SOP (Standard Operations Procedures) and training to ensure that the correct methods are undertaken and standards achieved.
- Use techniques like autonomation/jidoka (Machines with human intelligence) that are able to detect when a non-standard event has occurred.

8.4 Lean Over Processing Practices

- Have a clear schedule and work plan.
- Establish clear quality standards and stick to them.
- Establish the “Final Critic” and move on.
- Use smart factory analytics with customized dashboards for each role to reduce excess processing waste.
- Remember to get signed change orders for any changes.

8.5 Lean Inventory Practices

To control the inventory wastes:

- Setting up of various stock levels.
- Preparations of inventory budgets.
- Maintaining perpetual inventory system.
- Establishing proper purchase procedures.
- Inventory turnover ratios.

9. CONCLUSIONS

Eliminating wasteful activities is one of the most essential to improve the overall performance of successful project completion.

Lean construction is a way of improving the construction industries that it impacts in waste. Lean Management is a new form of production management to construction industry. It seeks to ensure that work gets done quicker and at a lower cost for the entire project. The essential features of lean construction

include a clear set of objectives for the delivery process (time, cost and effort), aimed at minimizing wastes and maximizing value for the customer at the project level, optimizing resources, concurrent design of process. This is done by implementing new limitations on design, planning, activation and maintenance. The application of such production control throughout the lifecycle of the construction project from design to delivery to improve construction industry.

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