

Effective Utilization of Lean Management to Achieve Economy in Residential Construction

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Abstract- in complex rapid construction projects, it is not possible to manage the project through the conventional ways which based on work breakdown structure, critical path method and earn value management. It has been observed many times projects are not delivered on time and within a budget by using traditional construction method. Faulty work practices leads to rework and produces many wastages such as over production, inventory, unnecessary transportation, non-value added workers displacements, over-processing, defects in member, waiting of materials (cement, steel etc.), unused employee creativity, work accident, addition and alterations in drawings etc. This has been ultimately resulted unable to handling present challenges of projects therefore practical innovative ideas and techniques need to be used in construction that will help projects teams to deal with wastages in construction with use of optimum resources and this can be achieved by using lean construction. This paper aims to, find out the different wastages in residential construction across the pune region and analyze the impact of waste on cost, quality and time through questionnaire survey.

Keywords— Lean construction, Lean principle & Benefits, Waste analysis, top 10 waste & its main causes.

1. INTRODUCTION

Projects have been considered as temporary based production systems which need to be designed, planned, produced and delivered within a specified time. Fast track projects with long, complicated supply chains subject to multiple, extensive process design changes have complex flow management that has failed miserably. As a result, the industry is characterized by delays and often has suffered cost and time overruns. In general, a very high level of wastes/non-value added activities is confirmed to exist in the construction industry. Several studies from various countries have confirmed that, wastes in construction industry represent a relatively large percentage of production cost[2] The existences of significant number of wastes 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. It has been contended by the Lean Construction Institute (2014) that about 57% of productive time waste can be found in the construction industry [2]

In the United States, meticulous studies have been carried out by CII (Construction Industry Institute), which estimate that between 25% and 50% of the cost of construction corresponds to waste due to the inefficiency of the traditional management system. According to LCI, The construction industry is characterized by a ratio production/waste higher than that of the manufacturing industry.[1] Nevertheless, lean manufacturing principles and techniques provide the foundations for minimization or total elimination of the waste faced by the industry. Lean construction has change the traditional view of labor flow and work flow reliability and gives the value added construction.

1.1 Objective of Study:

To study the different types of waste found in residential construction project through questionnaire survey and analyze the impact of wastes on Cost, Quality and Time.

2. Present scenario of construction:

Infrastructure is the second largest sector after agriculture in India and is the integral part of country's development. It includes hospitals, townships, schools, offices, houses and other buildings and urban infrastructure. Construction is the basic input for socio economic development. In the past years many researchers stated there are number of waste can occur at any stage of the construction project. Since construction has directly or indirectly impact on many other industries so reducing the waste in the construction industry and saves the great cost of owner. Waste can be classified as natural waste which is unavoidable and avoidable waste. And the main root cause of waste comes from construction processes such as Planning, Design, Material procurement, Material handling, Material supply and Material manufacturing as well as construction stages, lack of work knowledge in labours, casual approach towards work, improper concrete mix design, faulty shuttering. Accidents due to negligence, choice of wrong construction process, cement/ mortar, timber, blocks, steel as the major material wasted on construction projects. It has become crucial to seek innovative and creative solutions/alternatives that ensure better and more optimized management techniques that could minimize the sources of wastes and increase the performance of the construction process. The construction industry facing various problems as a result of the uncertainties of the global economic climate, environmental

hazards, including labor delayed projects and zero margin contract bids, greenhouse gas emissions etc. So there is need for waste minimization and enhancement of productivity in construction activity. Productivity is critical determinant of cost efficiency. The conventional system of construction is not sustainable. In one of the research it is estimated that

current system of construction had around 50% of non-value added efforts or waste[4] Most of The present construction practices run with traditional work flow methods and uses conceptual models of construction management because there are some barriers to adopt lean management in present construction practices those are mentioned further.

3. Lean construction:

Basically lean means that to make work as much as easy to understand, perform, and Manage and main idea underlying this concept is about reducing waste in processes and focusing on things that add value to the customer with pursuing quality perfection in the execution of the project work.

3.1 The Lean five principles:

- I. **Value specification:** Precisely specify what creates value from the client's perspective
- II. **Value stream identification:** Clearly identify all the steps in the processes (value stream) that deliver exactly what the customer values and remove everything that do not add value to the customer.
- III. **Flow:** Take actions that ensure continuous flow in the value stream,
- IV. **Pull:** This means to produce only what the customer wants just in time; and
- V. **Perfection:** Always strive for perfection by delivering what the customer wants and expects through a continuous removal of waste. Through process improvement to deal with the challenges in the construction.

3.2 The benefits of Lean Principles:

- Precisely specify value from the perspective of the ultimate customer.
- Clearly identify the process that delivers what the customer values.
- Delivering projects on time or in some cases ahead of schedule and eliminates all non-value adding steps.
- Crating a smooth workflow and eliminates the waste.
- Improving relations with vendors and improving customer satisfaction.

- Let the customer pull – don't make anything until it is needed,
- Increases profit and market share.
- Pursue perfection by continuous improvement.

Improving the project cost, quality and time

4. Overview of Past Studies:

Mohammed Fadhil Dulaimi and Caroline Tanamas [2008] had stated that, lean construction is a new way to design and build capital facilities. It advocates the simultaneous consideration of product and process development using simultaneous engineering. From the research findings, it is found that only certain techniques of lean construction have been implemented locally. The biggest barrier is the cultural resistance to change.

Remon Fayek Aziz, Sherif Mohamed Hafez [2013] Researcher stated that 30% Construction is Rework, 40% to 60% of potential labour efficiency, Accident accounts for 3% to 6% of total and 10% of material waste (in UK). And the cost of rework is 35% of total project cost and 50% of total project overrun cost (in Australia). So it should be remove by using lean philosophy in construction.

Richard Hannis Ansah, Shahryar Sorooshian and Shariman Bin Mustafa [2016] Author stated that the conceptual models of construction management and the tools like work breakdown structure, critical path method, and earned value management have deficient in handling the present challenges of projects. As a result, the industry is characterized by a number of wastes, therefore the need for practical and robust models and techniques that will help projects teams deal with the issues of wastes in projects. This can be achieved through the adoption of lean production systems in the construction industry,

Mohamed Saad Bajjou, Anas Chafi, and Abdelali En-nadi [2017] A rigorous comparative study was carried out to show the contribution of the lean construction tools in the promotion of traditional construction especially at the level of the following factors: Creating value and eliminating waste; Planning and mutual coordination; Site organization. (LPS), (VSM), last planner system, Just-in-Time philosophy, (VM) and 5S have shown a great ability to improve the traditional production system through waste reduction, encouraging people involvement, ensuring a pull flow production, and promotion of a continuous improvement philosophy.

5. Methodology:

The study includes the observation of different types of waste found in residential construction project in order to accomplish the desire objectives a deep study by past researchers leads to several types of waste which are

synchronized and for precise result a questionnaire survey has been done. The questionnaire survey includes various types of waste and analyze its impact on cost, quality and time. The questionnaire survey analysis has been carried out by relative importance index method rank the RII accordingly.

5.1 Preparation of questionnaire:

The questionnaire has been developed in to two sections, section one includes various types of wastes and section two includes impact of types of waste on cost, quality and time. Which is elaborated below:

SECTION-1 Following are the various types of waste probably found on construction site

A) Due to management or Administration:

1. Over-allocated/unnecessary equipment on site
2. Over-allocated/unnecessary materials on site
3. Over-allocated/unnecessary workers on site
4. Unnecessary working procedures and protocols
5. Materials reworks/repaired works/defective works

B)Due to Execution / Performance :

1. Waiting for others to complete their works before the proceeding works can be carried out.
2. Waiting for materials to be delivered on site
3. Time for workers rest construction
4. Work Interruptions

C) Waste due to People cause:

1. Materials lost/stolen from site during construction periods
2. Materials deteriorated/damaged during construction periods
3. Mishandling or error in construction applications/installation
4. Accidents on site
5. Waiting for equipment to be delivered on site
6. Waiting for skilled workers to be provided on site

7. Waiting for the clarification and confirmation by client and consultants

8. Time for reworks/repaired works/defective works

9. Time for supervising and inspecting the construction works

10. Time for instructions and communication between engineers and workers

D) Material:

1. Time for transporting workers, equipment and

2. Materials Equipment Breakdown

3. Improper Inventory

4. Material Waste (Steel, Cement, Shuttering etc.)

SECTION-2

Impact of types of waste on Cost, quality and Time as categories in to four cause/waste

1) Management or Administration

2)Execution/performance

3)People

4)Material

5.2 data collection:

Total 150 questionnaire has been prepared and distributed to various construction experts having 5 years to 30 years of experience it includes Engineers, contractor, owner, consultant etc. and around 120 respondents have been positively obtained. The questionnaire has been developed in to two sections, section one includes various types of wastes and section two includes impact of types of waste on cost, quality and time.

5.3 Data Analysis:

The collected data was analyzed by using 4-point Likert scale from 1 to 4 ratings representing as Always, Frequent, Rare and None respectively. Data analysis was done calculating Relative Importance Index (RII) by following formula, adopted from Memon et al. 2012 as RII is best suitable method to do the ranking analysis.

$$RII = \frac{\sum_{i=1}^4 w \times x}{A \times N}$$

Where,

- RII = Relative importance index

- W = Weighting given to each factor by respondents and its ranges from 1-4
- X = Frequency of its response given for each factor
- A = Highest weight (i.e. 4 in case)

N = Total no. of respondents

5.3.1 Waste Analysis:

By conducting the questionnaire various types of waste were determined and analyzed through Relative Importance Index which have represented graphically below in fig no. 5.1

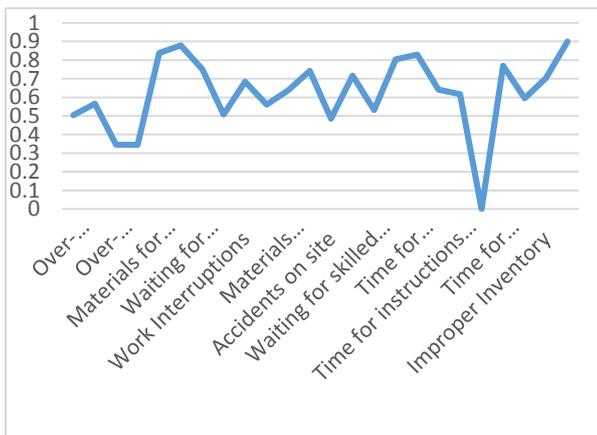


Fig 5.1 -RII of types of waste.

5.3.2 Analysis of Waste impact on Cost, Quality and Time:

The impact analysis of waste was carried on Cost, Quality and Time which has been represented graphically as shown in figures.

The impact of material and management related waste is comparatively higher than the impact of people and execution on cost is as shown in fig 5.2 Whereas, material, people practices and execution related waste affects the quality more as shown in fig. 5.3 and, Project time affects more by management related waste and people related waste as shown in fig. 5.4



Fig 5.2: RII of impact of waste on cost



Fig 5.3: RII of impact of waste on quality



Fig 5.4: RII of impact of waste on time

5.3.3 Top 10 waste & Its Main Causes:

These are the top most 10 ranked waste which have been analysed statistically, the highest ratings is for Material waste and the 10th

rating is for improper inventory. By conducting the discussion with the experts, the causes for the 10 top waste were found as shown in table no. 5.1

Table 5.1: Top 10 Waste & Causes

| Rank | Top 10 Waste factor | Main cause |
|------|--|--|
| 1 | Material Waste (Steel, Cement, Shuttering etc.) | Bad storage/ Storing method |
| 2 | Waiting for others to complete their works before the proceeding works can be carried out. | Lack of manpower/Material supply delay & shortage |
| 3 | Materials for reworks/repared works/defective works | Bad Workmanship, Poor /Bad Supervision |
| 4 | Time for reworks/repared works/defective works | Unskilled labours & Faulty Design &Methods. |
| 5 | Waiting for the clarification and confirmation by client and consultants | Waiting for Authority or consultant Approval/ Permits. |
| 6 | Time for transporting workers, equipment and materials | Availability of resources /Long distance procurement/ Remote site/ |
| 7 | Waiting for materials to be delivered on site | Lack of supply chain management/ Late order delivery. |
| 8 | Mishandling or error in construction applications/installation | Manual or Technical problem, bad workmanship |
| 9 | Waiting for equipment on site delivery | Collaboration of works/time for transportation. |
| 10 | Improper Inventory | High cost of inventory& storage, imbalance lead time. |

Conclusion:

1. In this study various types of literature work were studied which leads the work to recognise various types of waste which has been generated while implementation the work on actual sites, from this top 10 most probable waste were shortlisted and analysed its main causes.

2. The RII analysis of these various types of waste on Cost, Quality and Time were done through questionnaire survey and Ranked accordingly.

3. The Overall research work concludes that the implementation of the lean construction has many benefits as compare to traditional construction having many wastages and consumes more time any money.

4. Implementing lean management in construction industry reduces many wastages in the product development and saves time and gives quality in construction through design, execution and creates more value to customer point perspective and removes non value added activity in the processes.

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