

# Application Of Lean Construction Tools to Minimize Waste Generated Due to Change Order

Ar. Pradnya Awate, Ar. Bhagyashree Apte

S. B. Patil College of Architecture and Design, Nigdi, Maharashtra, India

Corresponding Author: Ar. Pradnya Awate, p.awate@sapatilarchitecture.com

## Article Information

## ABSTRACT

### Article history:

Received Jun 10, 2023

Accepted Dec 10, 2023



Any construction project will always experience changes. A change order is a part of the change management process used in the construction projects and is used to carry out changes to the scope of work that have been approved by the client, contractor, and architect. To handle large changes to the ongoing project, a change order may fork a new project. A change order is often issued by the project manager which specifies the details of the new work that needs to be done (or, in certain situations, not done), and the cost associated with the same. This change order generally modifies the original contract in such a way that the change is now a part of it, once it is submitted and authorized. There are two different kinds of change orders: beneficial and detrimental. A positive change order is one which raises the standards. Any change order that has a negative effect on the client's value or the project's performance and generates waste is considered to be detrimental. This paper explores the causes of the detrimental change orders and the type of waste generated as a consequence. Lean construction is a new technology that reduces waste in construction projects increasing project's success. This paper also examines whether a lean construction framework can be used to reduce waste generated due to the change orders. Depending on the nature of waste, several lean building tools are advised.

**Keywords:** Change order, Waste, Lean construction, Lean tools

## 1. INTRODUCTION

There has been tremendous development and investment in the Indian construction sector in recent years. This growth continues in real estate, large infrastructure, and industrial expansion projects. Large and complex projects are created in which various national and international companies in the construction industry are involved. The Pune region in particular has seen tremendous growth in the housing sector in recent years. This is because the I.T. Industry and the economic boom it has given the city. The changing lifestyle of the people led to changes in the demand. The provision of additional amenities, higher material requirements, changed spatial organization, the growth of more nuclear families as a result of changes in designs are some of the reasons that have been identified as major drivers for changes in planning, design and building systems in the last few years applied in the construction sector. Construction projects

are typically complicated, unpredictable, take a long time to complete, involve several parties, and need the integration of numerous tasks in order for them to function as a single unit. The projects call for intricate planning and specifications, dangerous building techniques, efficient administration, capable, thorough oversight, and tight cooperation. Therefore, adjustments must be made in every building project. Any building project will inevitably undergo these modifications. In the course of planning, building, or market conditions, the owner's demands may alter.

### 1.1. RESEARCH QUESTIONS

**1. What is the type of waste produced due to change order in construction of projects?**

**2. What lean tools will be used to minimize the waste generated due to change order?**

## 2.1 AIM

To study different types of lean tools which will be beneficial in terms of reduction of change order waste.

## 2.2 OBJECTIVE

- To study and analyze sources and effects of change orders in construction.
- To Identify which types of waste generated due to change order.
- To study different lean tools which will minimize the waste generated due to change order.

## 2.3 SCOPE AND NEED OF THE PROJECT

Scope of the research involves identification of waste generated as a consequence of change order and according to framework developed using lean tools.

Construction projects in India sometimes deviate from the preplanned building procedures due to considerable alterations. Since they are frequently unanticipated, it is a severe problem that doesn't get enough attention from scholars. To ensure that the project is successfully finished, these adjustments must be effectively managed using a formalized process. The goal of this project is to clarify the situation by highlighting the main causes and effects and outlining potential solutions to lessen the negative effects of change orders. This study is limited to identification of causes of change order, its effect and suggesting the effective framework to lessen this waste from lean management.

## 3. METHODOLOGY

The steps in the research approach are as follows:

### Background study & Introduction

A few books and articles on change order and lean construction tools are studied as background material. From this background investigation, the research's baseline is selected, and an introduction to it is provided. Three research papers from national or international journals are examined in the literature review. From this research several facets of change order & lean tools are discovered.

### Interview with project participants and questionnaire survey

This process involves conducting interviews with several project participants, including the project engineer, the architect, the civil engineer, the project manager, and the site engineer. Based on the prepared questionnaire, this interview was conducted.

### Data Analysis

Table-formatted data from the survey and sample study research is presented. This displays certain waste generating causes.

### Findings & proposals

Based on all this research, some facts and insights are defined. Change order waste management framework Suggested through Lean tools.

### Conclusions and recommendations

Conclusions are drawn based on this study learning. New technologies such as lean construction and Co Certain techniques and principles are proposed, Recommended for those in the construction industry.

## 4. LITERATURE REVIEW

Al-Dubaisi et al. (2000) state that the owner's modification of the plans is the primary cause of change orders, followed by errors and omissions in the design. The two primary consequences of change orders are an increase in cost and length. Mohammed F. Al-Hams (2010) asserts that design flaws are the second leading cause of change orders, behind scope and quantity of work. The primary impact of modification orders is more compensation for contractors. Amine Ghanem et al. (2012) claim that conflicts between the owner and the contractor are the second most common reason for change orders, followed by a decline in the quality of the work. Change orders have the effect of raising costs.

## 5.1 DATA COLLECTION

A change order is an activity that describes and supports a modification of the terms of a construction contract that changes the anticipated completion date, the estimated project cost, or both. It is sometimes described as any alteration to the contractual instructions that the owner, the owner's agent, or the design engineer gave to the contractor. Anything that causes the initial scope, execution time, or cost of the activity to change. A change order is a document that the architect creates and that the owner, contractor, and architect all sign.

### Types of Change Order :

From the sample studies of different types of buildings and by reviewing various literatures the data is collected as follows

There are four primary sorts of change orders. Actual, Constructive, Cardinal, and Conditional are these kinds. Normal change orders and emergency change orders are further sorts of change orders.

**Actual change:** An actual change occurs when the owner requests a modification to the scope of the project (Hunt, 2005).

**Constructive change:** According to Hunt (2005), a constructive change is when the owner alters the scope of the project via his actions or inaction.

In the federal contracting industry, a fundamental transformation has long been acknowledged (Hunt, 2005). Additionally, according to Libor et al. (2003) and Guerrant (1997), it is a change or sequence of adjustments that go beyond the parameters of the contract.

Situations in which contractors get instructions from owners that differ from those that were first presented are referred to as "change orders" or "variant orders." A claim is the sum that a contractor seeks to get as restitution for owner-caused delays, errors in design

specifications, and challenged alterations to contract work.

These kinds of requests are commonly made by owners or consultants. Despite the prevalent misconception that change orders are a source of additional cash for contractors, they have substantial implications and may present issues.

In addition to delaying project completion, change orders can impede procurement, result in drawn-out and challenging verification processes, delay final account releases, and increase project costs. Additionally, since their efforts must be allocated to existing projects, contractors may neglect opportunities to sign new deals.

|     |   |            |
|-----|---|------------|
| 1.  | Change of plans by owner                                    | Owner      |
| 2.  | Owner's financial problems                                  | Owner      |
| 3.  | Owner's change of schedule                                  | Owner      |
| 4.  | The objective of the project is not well defined            | Owner      |
| 5.  | Substitution of materials or procedures                     | Owner      |
| 6.  | Conflict between contract documents                         | Design     |
| 7.  | Change in design by consultant                              | Design     |
| 8.  | The scope of work for the contractor is not well defined    | Design     |
| 9.  | Errors and omissions in design                              | Design     |
| 10. | The lack of coordination between contractor and consultant  | Design     |
| 11. | Value engineering   | Design     |
| 12. | Technology changes  | Design     |
| 13. | Differing site conditions                                   | Contractor |
| 14. | Contractor's desire to improve his financial situation      | Contractor |
| 15. | The contractor's financial difficulties                     | Contractor |
| 16. | The required labor skills are not available                 | Contractor |
| 17. | The required equipment and tools are not available          | Contractor |
| 18. | Workmanship or material not meeting the specifications      | Contractor |
| 19. | Safety considerations                                       | General    |
| 20. | Climatic/Weather conditions                                 | General    |
| 21. | New government regulations                                  | General    |
| 22. | Poor design, poor working drawing details                   | Design     |
| 23. | Problems on Site  | General    |
| 24. | Change of project scope by owner (additional – enhancement) | Owner      |
| 25. | Poor planning by contractor                                 | Contractor |
| 26. | Change in procedures  | General    |
| 27. | Worker's labor's problems                                   | General    |

Table no 1. Causes of change order

|    |                                      |
|----|--------------------------------------|
| 1  | Decrease in productivity of workers  |
| 2  | Delay in completion schedule         |
| 3  | Dispute between owner and contractor |
| 4  | Decrease in quality of work          |
| 5  | Increase in project cost             |
| 6  | Additional revenue for contractor    |
| 7  | Delay of material and tools          |
| 8  | Work on hold in other areas          |
| 9  | Increase in contractor's overhead    |
| 10 | Demolition and re-work               |
| 11 | Delays in payment to contractor      |

Table no 2. Effects of change order

## 5.2 DATA ANALYSIS

A framework was created to demonstrate the efficiency of applying Lean ideas to the traditional management industry of building.

Lean thinking implementation on any project and its numerous implementation-related aspects are explored when the framework is being developed. The suggested framework demonstrated the use of lean construction, as well as its useful manual and suitable implementation techniques, in the construction sector. Data gathered through various methods is taken into account when developing the framework. The following are some methods:

### a) Last planner system

The Lean Construction Institute may have created the Last Planner System (LPS), a workflow technique, to increase employee accountability and productivity through strict scheduling.

The last planner is regarded as a managerial strategy for effectively managing a building project. The system's directive is to ensure that each contractor and subcontractor on a building site is capable of managing their workload while keeping them responsible for the job they are committed to do. This is accomplished through a cooperative exercise in which the main contractors and subcontractors identify the tasks they will carry out and choose which stage of the project must be finished before moving on to the next. It is now recognised how processes are evolving to support the readiness and timing of the next step.

There must be one person in charge of deciding when the next phase starts when using Pull Planning in LPS. The Last Planner allows us to keep an eye on this person. Each phase of a large-scale building project will often have its own Last Planner. Although this strategy seems to place more responsibility on certain people than others, the Last Planner System nevertheless has a community nature. By tracking and allocating accountability throughout whole workflows, LPS is successful in guaranteeing that each employee on a construction project may be a stakeholder. All project phases are interconnected and dependent on one another, so everyone on the team has a stake in seeing it through to the finish.

LPS was developed to provide projects with more dependable and predictable output. Assists in the movement of labor across the project. engages with a project team while fostering trust. quicker and safer project delivery

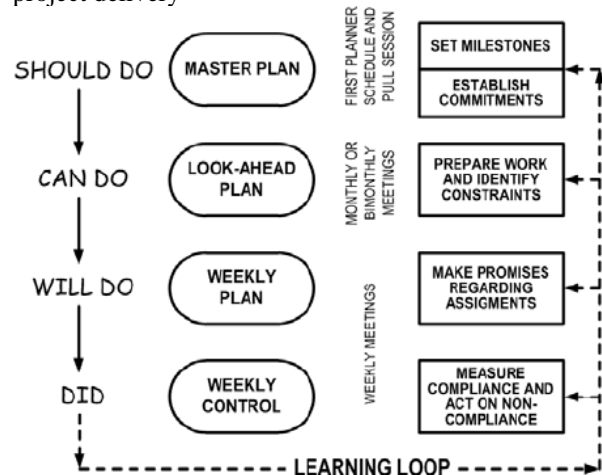


Fig .1 Last Planner System

### b) The 5s

The 5S methodology, which consists of the steps Seiri, Seiton, Seiso, Seiketsu, and Shitsuke, is one of the most effective Lean Manufacturing tools. To increase productivity, improve visual management, and assure the adoption of standardized working, 5S might be a

simple tool for organizing your workplace. It is extremely clean, effective, and safe.

It's not a tool that will be imposed by an outsider onto a location without the knowledge and cooperation of the people inside it; rather, 5S might be a team to run a process and will be conducted by the individuals that operate within the environment during which the principles of 5S are being implemented.

Origin of 5S- 5S as a strategy is based on the Total Productive Maintenance (TPM) and Toyota Production System (TPS) methods.

5S concept- 5S can be systematic because it organizes the workplace and work practices and represents a comprehensive philosophy and way of working. Divided into 5 stages, each stage is named after a term unique to Japan beginning with the letter 'S'.

(Sort, set in order, set up, seiketsu, shitsuke) So these names are his 5S.

These five distinct phases are (with English descriptions)

5S Seiri : Sort, Classify, Clearing.

5S Seiton : Straighten, Set so as, Configure, Simplify.

5S Seiso : Sweep, Shine, Clean and Check Scrub.

5S Seiketsu : Standardize, Conformity, Stabilize.

5S Shitsuke : Sustain, Custom and Practice, Self discipline.



Fig .2 The 5-S

**c) Gemba walk**

The term "genba" comes from Japan and means "real place". In Lean Principles, the "field" is where the actual work is done and is the most important place for the team. A manager, project engineer, supervisor, or other senior executive visits the site.

Here, work is done to gain greater insight into how the process is performed and identify areas for improvement.



Fig .3 Gemba walk in 7 steps

**d) Lean principles**

1. Specify a value.

We set value based on the customer's own definitions and desires, and determine the value of activities that add value to top-of-the-line products.

2. Identify your value streams.

Identify value streams by eliminating those that don't create top-of-the-line product value. This means that if something goes wrong, you should stop the montage and change it immediately. Avoidable process terminated

production, storage of materials, defective or unnecessary processes, movement of labor, transportation of materials and products, and ultimately production of products that do not meet customer standards. Additionally, it can cause unnecessary waiting time.

3. Process:

Ensure uninterrupted flow within your processes and value chain, dedicated to your entire supply chain. The focus should be on technique, not top-of-the-line products.

However, the process will not be optimized until customer benefits are identified.

4. Pull:

The production and building process uses pull rather than push.

It means producing exactly what the customer needs, when they need it, and always ready for change by the customer. The concept is to reduce wasteful production and use JIT (Just in Time) management tools.

5. Perfection:

Strive for suitable solutions and continuous improvement. deliver the product

Meet customer needs and expectations within agreed schedules and in the face of deficiencies. The only reason for that is the intensive communication not only with customers/clients, but also with managers and employees.



Fig .4 Lean Principles

## 6. FINDINGS & PROPOSAL

The overall study indicated an active participation of owners during design and construction of residential buildings.

The common contract format in large residential building construction is the fixed price (per sq.ft).

Most changes in large building projects are in services craft or architectural in nature.

The working relation between principal parties in the construction process is generally very good

The cost overrun due to change orders is shown to be between 6 and 10% of the original contract value in large building construction.

Similarly, the schedule overrun is shown to be less than 10% of the original project duration.

The owner is the main source of changes in large building projects. Change of plans by the owner is the main cause of changes. There are three possible explanations to this. First, the owner was not involved in the design development. Second, the owner did not understand or visualize the design. The designer may not have made the design clear or the owner just lacks the ability to read the drawings. Third, it is merely a change of mind while not appreciating the negative impacts of changes.

The goal of lean management is to maximize profit. Lean practices are designed to reduce costs so that any savings can be reinvested in the business. Lean management started with the customer in mind. Communication with staff, responding to customer concerns, and product experience are the main drivers of reducing wasteful practices. This should lead to improved customer interactions and improved overall service. Company expenses can balloon if leaders are unaware of how inventory is accumulating. A strategy to manage this is to have a 'pull' mentality instead of a 'push' mentality. This means that later stages of production determine what's happening in previous processes. This can help companies avoid overproduction and higher carrying costs. Companies

will order only what they need. Lean management involves a lot of attention to details. The aim is to reduce the number of defects and rework in products.

## 7. CONCLUSION

'change' or 'variation orders' are defined as instances in which contractors receive instructions from owners that differ from those that were originally specified. In turn, the term 'claim' refers to the amount that a contractor seeks to collect to compensate for owner-caused delays, errors in design specifications, and disputed variations in contract work.

Requests for such changes often originate from owners or consultants. It's generally assumed that altered orders are a source of additional revenue for contractors, but there are high implications and potential risks associated with change orders.

Change orders can delay project completion, decrease productivity, increase project costs, hamper procurement, trigger lengthy and complex verification procedures, and stall final account releases and retention payments. In addition, contractors can miss opportunities to sign new projects as their resources have to be placed into ongoing project negotiations.

Despite being involved during the design phase, due to a lack of detailed research and an inability to understand consultants' design documents, owners often request changes during the construction process when they realize that a project is not being built according to their vision.

Consultants, meanwhile, are the second-largest contributors when it comes to change orders. These instances usually arise because of incomplete designs or conflicting tender documents, and typically result in ambiguity over the scope of work.

The causes of change orders and the effects that they have on project costs and schedules are influenced by a range of interrelated factors. To reduce the effects of change order and the waste generation due to it, utilization of Lean tools is the best possible solution.

## 8. FUTURE SCOPE OF STUDY

The current study aims to reduce change order waste by implementing lean management tools. While comparable research can also be done for betterment of the Indian construction industry. Many industries, including the construction sector, have embraced lean techniques, but there has not been much adoption of this new technology (LC) in India. Lean construction is used by various industries throughout the world to increase project productivity and efficiency, from top-level management to on-site construction. India has been researching the obstacles to implementing lean construction, and the results of this research have revealed numerous difficulties. The study's future focus will be on downplaying these obstacles.

## REFERENCES

1. Aliya AlaryanPublication, “Causes and Effects of Change Orders on Construction Projects in KuwaitInt”. Journal of Engineering Research and Applications ISSN : 2248-9622, Vol. 4, Issue 7(Version 2), July 2014, pp.01-08
2. Abdulghafoor Habib , Al-Dubaisi King “Change Orders in Construction Projects In Saudi Arabia”University Of Petroleum & Minerals Research paper June 2000.
3. Jaydeep N. Desai, Jayeshkumar Pitroda, Prof. Jaydev J. Bhavsar, “A Review On Change Order And Assessing Causes Affecting Change Order In Construction” Journal Of International Academic Research For Multidisciplinary Impact Factor 1.625, ISSN: 2320-5083, Volume 2,Issue 12, January 2015
4. <https://www.long-intl.com/articles/change-order-management/>
5. <https://www.scribd.com/document/380355617/Lean-Technology-And-Waste-Minimization-In-Construction-Industry-Using-SPSS>
6. ISTE approved one day workshop on “Overview of Lean construction efficiency improvement program” 31st Jan 2020.