

# Management of Waste Minimization in Construction Industry Using Lean Technology

Mr. R. Venkatakrishnaiah

*Associative Professor  
Department of Civil Engineering  
Adhiparasakthi Engineering College  
Melmaruvathur, TN, India*

Miss. S.Saranya

*Student M.E (CE&M)  
Department of Civil Engineering  
Adhiparasakthi Engineering College  
Melmaruvathur, TN, India*

**Abstract** - The construction sector is undergoing important technological and organizational changes, and construction companies will have to adapt to these changes in order to survive. For this to happen, we need to incorporate and apply production and organizational techniques from other more advanced sectors. For this, the application of lean production principles to the construction industry - known as lean construction - takes on special importance. This study deals with the various lean practices which should be adopted to achieve lean construction. Also Value Stream Mapping (VSM) a lean tool has been used to take survey at two different construction sites. The observation from survey reveals the time spent on non-productive activities and the means of reducing them as a goal towards attainment of lean construction. Waste in the construction industry has been the subject of several research projects around the world in recent years. It is commonly acknowledged that a very high level of waste exists in construction. Lean construction considers construction materials wastes as potential wastes that hinder flow of value to the client and should be eliminated. The creation of this waste can be prevented by applying lean construction principles. The main tools for the collection of data included questionnaires, interviews and site observations. The target population for the data collection included project managers of building construction organizations and senior consultants of architectural and quantity surveying firms. Microsoft Excel was employed to analyze data obtained. Mean score rankings were adopted for the analysis of data on perception of professionals on lean concepts. Materials storage and handling, operational factors, design and documentation factors and procurement factors were considered as the main sources of waste on building construction sites. Among the causes of materials wastes are last minute client requirement, errors by tradesmen or operatives, purchased products that do not comply with specification and lack of onsite materials control.

**Index Terms**:- Value Stream Analysis, Types of Waste in Construction, Likert Scale, Waste Causes.

## I. INTRODUCTION

Lean construction is a way to design production systems to minimize waste of materials, time and effort in order

to generate the maximum possible amount of value. It is also a holistic design and delivery philosophy with an overarching aim of maximizing value to all stakeholders through systematic, synergistic and continuous improvements in the contractual arrangements, product design and method of selection, the supply chain and the workflow reliability of site operations. Lean construction much like current practice has the goal of better meeting customer needs while using less of everything. But unlike current practice, lean construction rests on production management principles, the “Physics” of construction. The result is a new project delivery system that can be applied to any kind of construction but is particularly suited for complex, uncertain, and quick projects.

### A. Lean Principles

Perfect first-time quality - Achieve zero defects, revealing and solving problems at the source.

Waste minimization - Eliminating all non-value adding activities and maximizing the use of resources.

Continuous improvement - Reduction of costs, increase quality and productivity.

Pull processing - Products pulled from the consumer end, i.e. not pushed from the production end.

Flexibility - The production of different mixes and/ or greater diversity of products, without compromising efficiency

Relationships - Building and maintaining long-term relationships with suppliers.

### B. Value Stream Analysis

A value stream is all the actions, both value added and non-value added, currently required to complete a product or service from beginning to end.

Value adding Activities (VA) - It generates a positive return on the investment of resources and cannot be eliminated without impairing a process.

Non Value adding Activities (NVA) - It generates a zero or negative return on investment of resources and usually can be eliminated without impairing a process.

*Necessary Waste (NW)* - The waste which is necessary for the activity and also generates zero return of the investment.

### C. Classification of Activities

*Construct* - When a construction worker performs an activity that is value adding, e.g. pouring concrete or processing the material, the activity should be registered as construct

*Material Handling* - Whenever material needed to be transported or moved in some way at the construction site it was registered as material handling. Tools were more or less also moved along with material thus tool handling came to be registered as material handling as well.

*Discussion* - Every time a conversation was started it was registered as discussion. However, the sort of discussion varied mainly between two types; (1) problem solving and (2) small talk. One can see the first one as necessary waste since the discussion is needed to be able to precede the construction in a correct way whereas the small talk is pure waste given that it has nothing to do with the construction work. If discussion and walk happened simultaneously the discussion is registered and appropriate time is noted in order to avoid missing out on problem solving conversations.

*Walk* - The walk activity was registered every time the construction worker walks at the site. The activity can be initiated by the need to pick up material, go looking for tools or that the worker is needed to work at another place at the site. If discussion and walk happened simultaneously the discussion was used in order to avoid missing out on problem solving conversations.

*Break* - If the construction worker had to make a break from the work tasks this was registered as break. Activities that registered as break should be coffee- and smoke breaks. It was also used to indicate lunch break and when the work day had come to an end.

*Other* - It was used for administrative handlings and all the activities that did not match with the former described activities. Other activities like double checking, and redoing earlier work.

*Preparation* - It was used for those occasions when material or tools needed to be prepared in some way before the construction worker could use them. Work tasks that had to be done to facilitate value adding activities such as unpacking material, measuring, marking, etc. were registered as preparation.

## II. TYPES OF WASTE OBSERVED FROM STUDIES

The three most observed types of waste were over processing, waiting and unnecessary movement. Over processing was identified in interviews as material waste; a great deal of material is thrown away during production because material needs to be adapted to the

building itself. Due to this, it is difficult to get rid of this type of waste (especially when renovating old constructions) but through creative planning and design, adapting the design to the material available this spill can be decreased (especially for new constructions).

It was seen how the complexity of the building greatly affected the amount of work. In addition, it was observed quite often that the workers disregard for the little things like screw, nuts and bolts. The workers need to be made aware of waste in construction and how their actions affect their work environment, cost, time and ultimately, customer satisfaction. Waiting and unnecessary movements were also identified. Waiting could be for material but for tools and colleagues as well. Unnecessary movement was a type of waste that was very visible during the observations. A great deal of time was spent searching for tools, material, colleagues or walking back and forth for different reasons.

Often material needed for a job was located in one place while the job was performed in another part of the construction site. Workers miscalculating how much material was needed and having to go back accounted for some of the unnecessary movement too. It was found that that people with less care for structure and control were those causing most non-value adding activities in form of unnecessary movement.

It is believed that better planning would make it possible to decrease the amount of material brought to the construction sites. Having a lot of material on site leaves it more susceptible to damage and loss because often the material is not kept orderly or stored correctly but haphazardly kept in cardboard boxes stuffed in a corner or stacked on top of each other, also making material more difficult to find.

## III. METHODOLOGY PROCESS

- Review the relevant literature regarding lean technologies in construction.
- Form the clear methodology about the paper
- Design of questionnaires with the help of field people, literature review and previous datas in construction industry
- Conduct the questionnaire survey
- Analysis the data in Microsoft Excel
- Conclude with suggestion.

This step by working sequence is been given in a flow chart manner below fig: 1.

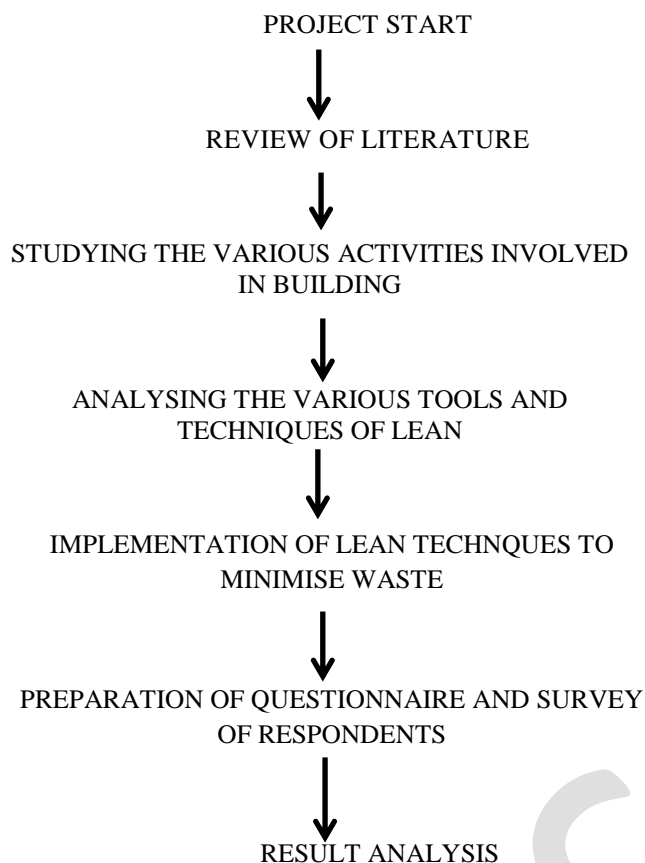


Fig: 1 Flow chart of work sequence

IV. QUESTIONNAIRE

Structure of Questionnaire

The questions were constructed using the Likert scale. The respondents were asked to rank on a scale of 1-5 factors that cause materials waste on construction sites where 1= Highly unimportant, 2= Unimportant, 3= Neutral, 4= Important and 5= Highly important. For each waste minimization measure, the respondents were asked to score the level of contribution to waste minimization on the Likert scale of 1 to 5 where 1= very low, 2= low, 3= Medium, 4= High and 5= Very high.

1. SOURCES AND CAUSES OF WASTE

Likert Scale:

1	2	3	4	5
Not a waste cause	Insignificant waste cause	Neutral	Significant waste cause	Major waste cause

Table:1 Waste Causes in Construction

WASTE CAUSE	1	2	3	4	5
Design and documentation					
Operational					
Materials storage and handling					
Procurement					

Table:2 Causes of Design and Documentation

S.No	Design and Documentation	1	2	3	4	5
1	Poor site layout					
2	Lack of attention paid to standard sizes available on the market					
3	Complexity of detailing in the drawings					
4	Incomplete contract documents at commencement of project					
5	Overlapping of design and construction					
6	Variations in the design while construction is in progress					
7	Designer's unfamiliarity with alternative products					
8	Selection of low quality products					
9	Designer's inexperience in method and sequence of construction.					
10	Lack of attention paid to dimensional coordination of products					
11	Lack of information in the drawings					
12	Last minute client requirement (resulting in rework)					
13	Poor communication leading to mistakes and errors					
14	Poor/ wrong specifications					
15	Lack of knowledge about construction techniques during design activities					

It was used for those occasions when material or tools needed to be prepared in some way before the construction worker could use them. Work tasks that had to be done to facilitate value adding activities such as unpacking material

Table:3 Causes of Operational Factors

S.No	Operational Factors	1	2	3	4	5
1	Unfriendly attitudes of project team and labors errors					
2	Choice of wrong construction method					
3	Damage to work done caused by subsequent trades					
4	Inappropriate placement of the material					
5	Required quantity unclear due to improper planning					
6	Delays in passing of information to the contractor on types and sizes of products to be used					
7	Accidents due to negligence					
8	Equipment malfunctioning					
9	Inclement weather					
10	Poor interaction between various specialists					
11	Frequent breakdown of equipment					
12	Difficulties in obtaining work permits					
13	Poor technology of equipment					
14	Effects of political and social conditions					
15	Shortage of tools and equipment breakdown					
16	Errors by site engineer					
17	Use of incorrect material, thus requiring replacement					

Table:4 Causes of Procurement Factors

S.No	Procurement Factors	1	2	3	4	5
1	Ordering errors (eg., ordering significantly more or less)					
2	Changes in material prices					
3	Purchased products that do not					

	comply with specification					
4	Unsuitability of materials supplied to site					
5	Substitution of a material by a more expensive one (with an unnecessary better performance)					

Table:5 Causes of Materials Storage and Handling

S.No	Materials Storage and Handling	1	2	3	4	5
1	Manufacturing defects					
2	Unnecessary inventories on site leading to waste					
3	Use of whatever material close to working place					
4	Insufficient instructions about handling					
5	Theft					
6	Poor method of storage on site					
7	Waste resulting from cutting uneconomical shapes					
8	Using excessive quantities of materials than required					
9	Lack of onsite materials control					
10	Damage to materials on site during transportation					
11	Poor handling of materials					
12	Use of wrong method of transport					
13	Overloading of transport equipment					
14	Overproduction/ production of a quantity greater or required than necessary					

CONCLUSION

From value stream analysis it is clear that roughly 49.556% of the workers' time at the construction site is spent on value adding services that needs to be optimized while 31.433% of time is spent on non-value adding activities which needs to be eliminated. There is also necessary wastage accounting for 19.011% which needs to be minimized. 31.433% pure waste indicates that the construction industry is struggling with efficiency problems. If lean construction is adopted the non- value adding activities can be eliminated and waste can be minimized with a view of optimizing value adding. This study will create awareness of wastage and safety to all level construction companies especially in building

construction sector and also it is useful for minimizing the wastages.

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