

Lean Waste in Construction Industry

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Abstract: The construction industry is the most important factor to develop a powerful impact in economic growth all over the world. In construction, there are several activities which create a waste. Those activities will not increase the profit of the whole projects. So, the lean construction tools can reduce the construction waste at any stages of project. Reducing the wastage will improve the project execution, provide value for customers and positive results on the national economy.

Keywords: Lean waste, Materials, Sources of Waste, Waste Reduction.

I. INTRODUCTION

Waste is the any activity which does not give benefit to the project and client. The waste in construction project will increase the construction time, over cost and may be rework of the activity. The lean construction is the simple tool which can eliminate the unwanted activities. There are eight waste have been founded which affect the construction projects surely.

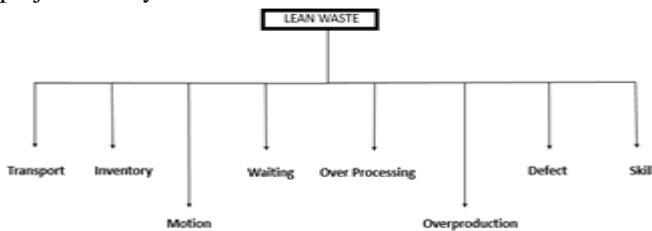


Fig 1.1 Waste in lean construction Fundamental of lean construction

Lean Construction is useful for developing a continuous improvement in all aspects of construction which may be time, cost and quality of the projects. Applying the lean construction, can try to lean and improve construction activity with minimum amount of cost and maximum the value as per customer requirement.

II. LITERATURE REVIEW

- **S. Dinesh, R. Sethuraman & Shruthi Sivaprakasam,** This paper explains the application of lean tools and lean techniques by construction projects, and it minimize the waste, improve the construction performance and increase the profit. This is anticipated that basic knowledge about lean construction provided through this paper and also assist the continuous improvement of construction industry.

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- **Karrar Raof Kareem, R.K. Pandey,** This paper describes, nine principles was identified in construction process through input-output model of their work.
- **A.Chandrasekar, M.Logesh Kumar,** if we effectively implemented the lean principles fully in construction industry means it will be possible to reduce the wastes in construction industry as well as increase the profit of the companies.
- **Lauri Koskela, TrondBolviken and John Rooke,** This paper has initially examined the understanding of waste and towards that creating the list of construction waste. It can also lead explicit the waste and value of the project.
- **T.Subramani ,Shanu Khan , Akhil Raj, Althaf M Najeeb, J.KarthickRajan,** It describes the very affected factors have been identified through ranking using SPSS analysis. Identifying the non-value added activity in the processes enable the project manager to recognize the better action and path for reduce waste, heading to project improvement.

III. SCOPE AND OBJECTIVE

3.1 Scope

- The study has been conducted over 50 different construction industries in all over Tamilnadu and Puducherry region.
- This study mainly concentrate on the factors of Lean wastages in construction industry.
- The critical factors are picked out by SPSS and ANOVA analysis methods.
- The analysis can be carried out based on the responses of engineers, project engineers and contractors.

3.2 Objective

By collecting the real data from construction industries about lean waste and analysis the data by SPSS software. To find the strategies to mitigate the problem and remedies to solve the problem.

The main objectives of this study:

- ❖ Study the problem of lean wastages in construction Sites.
- ❖ Identify the different elements which are responsible for the causes of value adding activities.
- ❖ Ranking the factors which are responsible for the causes of lean waste using analytical software like SPSS.
- ❖ Discuss the significant value obtained from collecting data and way to mitigate problems which cause value adding activities.
- ❖ Recommending suitable remedies to overcome the problems.



IV. METHODOLOGY

4.1 Design of Research

The first step in research was to identify the problem where and which it should occurred. Mainly there are identified through literature review in some case it also identified through internet. Then data collection is to be conducted through questionnaire survey. At last the data are analysis through analytical software. On basis of results the factors are ranked and their recommendation are given to rectify it.

4.2 Methodology

- Collected all data about lean waste in projects
- Identify the reason by questionnaire from consultants.
- Analyses the obtained data
- Understand the causes of lean waste
- Examine the reasons of waste
- Recommendation of measure that minimize and mitigate the problem

V. DATA COLLECTION AND ANALYSIS

5.1 Details of Questionnaire survey

This section presents about the questionnaire related survey which is conducted to know the opinion of engineers and top management in the construction industries. The questionnaire contains 30 numbers of questions. They are developed on the basis of degree of severity and overall importance. The results are examined on the analytical software to rank and determine the top factors.

5.2 Collection of data

Collection of data is the process of collecting the data about the factors which are influence the major role in non-value added activity in the projects. Those data are collected from engineers and top-level management like Contractor and project manager. Data are collected from all over Tamilnadu and Puducherry region.

5.3 Scale for Data Measurement

The scale of data measurement should be known for which method has been used for analysis. Every type of measurement, there is a proper method can be used. In this research the five-point scale has been used. Based on the five-point scale, we have the following table 5.1,

Table 5.1 Five-point scale used for data measurement

tem	Scale
Strongly Agree	1
Agree	2
Neutral	3
Disagree	4
Strongly Disagree	5

5.4 Sample size

Data collection questionnaires was developed in engineer side as well as top management. 30 numbers of questionnaires asked related to lean waste. The questionnaire was asked in the positive and negative side.

5.5 Data Analysis

Data analysis is the process of reviewing and creatin

g data with the final result of discovering the information and supporting decision-making. Analysis of data has multiple realities and approaches, encompassing diverse tools under a different of names.

5.6. SPSS

SPSS is the abbreviation of Statistical Package for the Social Sciences, and this is mainly for complex statistical analysis of data. The SPSS software was founded for the variety of management and statistical analysis of social science data.

A. Analysis of Variance

Analysis of variance (ANOVA) is a statistical method used to analysis the difference between 2 or more mean values. Analysts have use the Analysis of variance test to find the influence that independent variables have on the dependent variables in a regression study.

B. Mean

The mean or average is used to equal to the sum of all the data values in the data set divided by number of data values in the data set. It is mostly used in the continuous data.

C. Standard Deviation

The standard deviation (SD) is determined as the square root of variance by finding each data point's deviation relative to the mean. Suppose the data point is further from the mean, there is a chance of higher deviation within the data set.

D. F-test

The objective of F-test is to determine whether the two independent estimates the population of variance varies significantly. The "F-tests" mainly arising when the models is fitted to the data using least squares.

VI. RESULTS AND DISCUSSION

6.1 SPSS Analysis Results

Mean and std deviation

These are the top 5 factors

R1- Unnecessarily Changing Material

Places R2- Buying wrong Materials

R3- Bring more Materials to the

Site R4- Buying low quality

Materials

R5- Bring more Equipment to the Site

Table 6.1 Descriptive statistics of factors for the top ranked mean

Factors	N	Mean	Std. Deviation
R1	50	2.78	1.13
R2	50	2.74	1.24
R3	50	2.7	1.24
R4	50	2.66	1.22
R5	50	2.64	1.24



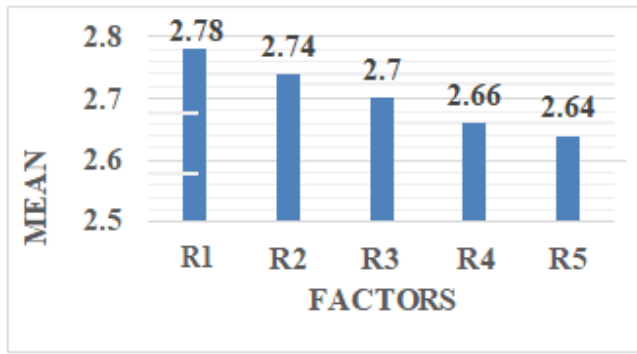


Fig 6.1 Mean value Ranking factor

6.2 Discussion

In this chapter we discuss about the significant values that are obtained from the collection of data, from the ANOVA results obtained from top factors of lean waste are to be classified according to the significance between the groups or Non significance between the groups based on the nature of the project and type of the building and the top factors are R1, R2, R3, R4 and R5.

One-way ANOVA results, based on nature of project; According to nature of project from the table 6.3, the factors R1, R2, R3, R4, and R5 had the significance value as 0.892, 0.777, 0.486, 0.492 and 0.642. It was higher than the significant value or P-value 0.05. Thus, the null hypothesis is agreed and it is examined that there is no significant difference between the nature of the project, which are P1-Private Sector, P2-Public sector and P3-Private partnership sectors and P4-Total.

Table 6.2 Top 5 factors of one-way ANOVA Result

Nature of project		Top Five Ranked Factors				
		R1	R2	R3	R4	R5
P1	Mean	2.82	2.80	2.74	2.54	2.57
	N	35	35	35	35	35
	Std. Deviation	1.248	1.324	1.313	1.196	1.145
P2	Mean	2.62	2.75	2.25	2.75	2.62
	N	8	8	8	8	8
	Std. Deviation	0.744	0.886	1.165	1.488	1.060
P3	Mean	2.71	2.42	3.00	3.14	3.00
	N	7	7	7	7	7
	Std. Deviation	0.951	1.272	1.000	1.069	0.816
P4	Mean	2.78	2.74	2.70	2.66	2.64
	N	50	50	50	50	50
	Std. Deviation	1.130	1.242	1.249	1.222	1.083
F- value		0.115	0.253	0.733	0.720	0.447
P-value		0.892	0.777	0.486	0.492	0.642

One-way ANOVA results, based on Type of building; According to the Type of building, the factors R1, R3, R4, and R5 had the significance value as 0.679, 0.186, 0.668 and 0.557. It was higher than the significant value 0.05 so the null hypothesis is agreed and it is examined that there is no significant difference between Type of building, which are

Residential, Commercial, Residential & Commercial and Residential and commercial and Industrial. The factor R2 had the significance value as 0.048, which is lesser than 0.05. So the null hypothesis was rejected, and it was examined that there was a statistically significant difference between the type of building, which are Q1-Residential, Q2-Commercial, Q3-Residential & Commercial and Q4-Residential and commercial and Industrial and Q5-Total.

Table No 6.3 Top 5 factors of one-way ANOVA Result

Type of building		Top Five Ranked Factors				
		R1	R2	R3	R4	R5
Q1	Mean	2.82	2.11	3.11	2.76	2.82
	N	17.00	17.00	17.00	17.00	17.00
	SD	1.074	0.992	0.992	1.091	0.882
Q2	Mean	2.00	2.00	1.00	4.00	2.00
	N	01.00	01.00	01.00	01.00	01.00
	SD	0	0	0	0	0
Q3	Mean	2.65	3.00	2.43	2.52	2.43
	N	23	23	23	23	23
	SD	1.070	1.314	1.342	1.377	1.121
Q4	Mean	3.11	3.33	2.77	2.66	2.88
	N	09.00	09.00	09.00	09.00	09.00
	SD	1.453	1.118	1.301	1.118	1.364
Q5	Mean	2.78	2.74	2.70	2.66	2.64
	N	50.00	50.00	50.00	50.00	50.00
	SD	1.130	1.242	1.249	1.222	1.083
F- value		0.507	2.851	1.673	0.525	0.699
P-value		0.679	0.048	0.186	0.668	0.557

From the ANOVA results 9 out of factors results are significant between the groups and 1 out of 10 factors are Non-significant between the groups, from the mean value of the factors we can identify the Top 5 factors which are mainly influenced the lean waste.

VII. CONCLUSION ANDRECOMMENDATION

Lean Waste in construction industry has the major problem for every stages like Increase project value, Project Delay and Increase Resources etc., The reason for lean waste as reported by various project implementing are Unnecessarily Changing Material Places, Buying wrong Materials, Bring more Materials to the Site, Buying low quality and Materials Bring more Equipment to the Site. These factors are ranked according to the mean value of lean waste factors. According to the SPSS analysis 10 factors are noted as important factors which influences the lean waste in all the sectors.



Lean Waste in Construction Industry

From the results, most of the factors results are more than 5% or 0.05 (constant value from ANOVA table) so they are 9 significant between the groups and 1 of the factors are Non-significant between the groups because their values are lesser than 0.05, from the analysis factors of significant between nature of project and type of building. So, these factors are mainly occurring in all sectors and levels of construction building. It will lead to unprofitable situation, So Proper Visualization and Better management will rectify these problems. Recommendations for mitigating this problem are Target value delivery, integrated project delivery and visual management etc.

Target value delivery

The target value delivery is one of the lean process for providing benefit to public and private clients as well as other construction project stakeholders, within economic, environment and social satisfaction. Cost is a constraint rather than result of design process.

Integrated project delivery

The integrated project delivery or IP D means a project delivery method in which there is a contract based agreement between agency and single participating organization for all kind of construction activity or combination of services, for also public project.

Visual management

Visual management is a way to communicate by a lean thinker uses to improve a system by preventing errors and resolving issues. The basis of visual management here is that through communicating this information visually, it does not require interpretation to understand.

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REFERENCES

1. Esin, T. and Cosgun, N. (2007), "A study conducted to reduce construction waste generation in Turkey", *Building and Environment*, 42, pp 1667-1674.
2. Farrar, J. M., Abou Rizk, S. M. and Mao X. (2004) Generic implementation of lean concepts in simulation models. *Lean Construction Journal*, 1 (1), 1- 23.
3. Formoso et al. (2002) C. T. Formoso, L. Soibelman, C. De Cesare, and E. L. Isatto, "Material waste in building industry: Main causes and prevention." *Journal of Construction Engineering and Management*, ASCE, Vol. 128, No. 4, 2002, pp 316-325.
4. Senaratne, S. and Wijesiri, D. (2008) Lean construction as a strategic option: testing its suitability and acceptability in Sri Lanka. *Lean Construction Journal*, 34-48
5. Thomas, H. R., Horman, M. J., Lemes de Souza, U. E. and Zavr'ski, I. (2002) Reducing variability to improve performance as a lean construction principle. *Journal of Construction Engineering and Management*, 128 (2), 144-154
6. Flyvbjerg, B., Holm, M. K. S., and Buhl, S. L. (2004). "What causes cost overrun in transport infrastructure projects?" *Transp. Rev.*, 24(1), 3-18.
7. Hassan, M. M. and Gruber, S. (2008) Simulation of concrete paving operations on Interstate-74. *Journal of Construction Engineering and*

- Management, 134(1), 2-9.
8. Johansen, E., and Walter, L. (2007). "Lean construction: prospects for the German construction industry". *Lean Constr. J.*, 3(1), 19-32.
9. Womack, J.P. and Jones, D.T. (1996) *Lean Thinking: Banish waste and create wealth in your corporation*, Free Press Business, London.
10. Dunlop, P. and Smith, S.D. (2004) Planning, estimation and productivity in the lean concrete pour. *Engineering, Construction and Architectural Management*, 11 (1), 55-64.

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