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.

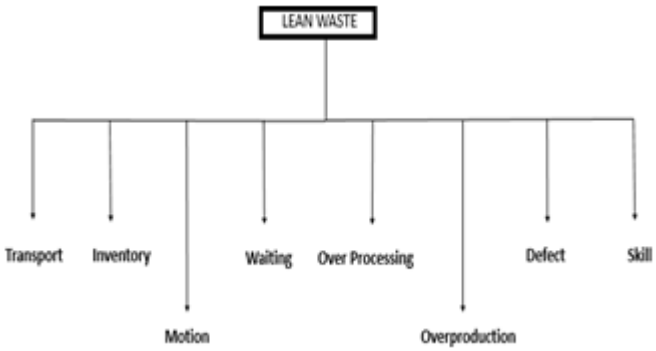

Fig 1.1 Waste in lean construction Fundamental of lean construction

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 withminimum amount of cost and maximum the value as per customer requirement.

II. LITERATUREREVIEW

- **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 leanconstructionprovidedthroughthispaperandalsoassist the continuous improvement of constructionindustry.
- **Karrar Raoof Kareem, R.K. Pandey,** This paper describes, nine principles was identified in construction process through input-output model of theirwork.
- **A.Chandrasekar, M.Logesh Kumar,** if weeffectively

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 andtowardsthatcreatingthelistofconstructionwaste.It can also lead explicit the waste and value of theproject.
- **T.Subramani ,Shanu Khan , Akhil Raj, Althaf M Najeeb,J.KarthickRajan,**Itdescribestheveryaffected 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 betteractionandpathforreducewaste,headingtoproject improvement.

III. SCOPE ANDOBJECTIVE

3.1 Scope

- The study has been conducted over 50 different construction industries in all over Tamilnadu and Puducherryregion.
- This study mainly concentrate on the factors of Lean wastages in constructionindustry.
- 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 andcontractors.

3.2 Objective

By collecting the real data from construction industries about lean waste and analysis the datas 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 addingactivities.

❖ Ranking the factors which are responsible for the causes of lean waste using analytical software likeSPSS.

❖ Discussthesignificantvalueobtainedfromcollectin g data and way to mitigate problems which cause value addingactivities.

❖ Recommending suitable remedies to overcome the problems.

Revised Manuscript Received on November 20, 2020.

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IV. METHODOLOGY

4.1 Design ofResearch

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 inprojects
- Identify the reason by questionnaire fromconsultants.
- Analyses the obtained data
- Understand the causes of leanwaste
- Examine the reasons of waste
- Recommendation of measure that minimize andmitigate theproblem

V. DATA COLLECTIONANDANALYSIS

5.1 Details of Questionnairesurvey

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 dataabout the factors which are influence the major role in non-value added activity in the projects. Those data are collectedfrom engineers and top-level management like Contractor and projectmanager.DataarecollectedfromalloverTamilnadu and Puducherryregion.

5.3 Scale for DataMeasurement

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 researchthefive-pointscalehasbeenused.Basedonthefive-point scale, we have the following table5.1,

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 Samplesize

Data collection questionnaires was developed in engineer side as well as top management. 30 numbers of questionnairesaskedrelatedtoleanwaste.Thequestionnaire was asked in the positive and negativeside.

5.5 DataAnalysis

Dataanalysisistheprocessofreviewingandcreating data with the final result of discovering the information and supporting decision-making. Analysis of data has multiple realitiesandapproaches,encompassingdiversetoolsunder a different ofnames.

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 ofVariance

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 continuousdata.

C. StandardDeviation

The standard deviation (SD) is determined as the square root of variance by finding each data point's deviation relativetothemean.Supposethedatapointisfurtherfromthe mean,thereisachanceofhigherdeviationwithinthedataset.

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 ANDDISCUSSION

6.1 SPSS AnalysisResults

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

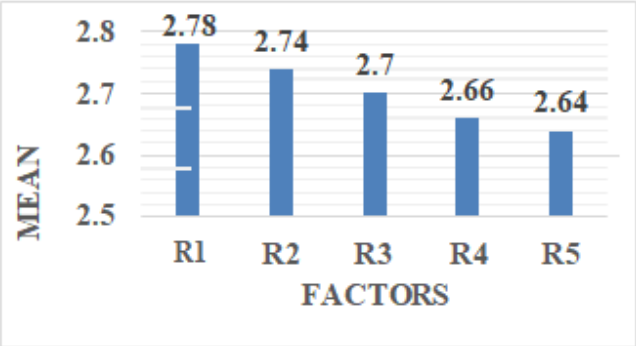

Fig 6.1 Mean value Ranking factor

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 classifiedaccordingtothesignificancebetweenthegroupsor Non significance between the groups based on the nature of theprojectandtypeofthebuildingandthetopfactorsareR1, R2, R3, R4 andR5.

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 significantvalueorP-value0.05.Thus,thenullhypothesisis 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 thenull 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 asreportedbyvariousprojectimplementingareUnnecessarily 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.

Fromthe 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 leads 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 constraintrather than result of designprocess.

Integrated projectdelivery

Theintegrated project deliveryor IP Dmeansa project delivery method in which there is a contract based agreement between agency and single participating organization for all kind of constructionactivityorcombinationofservices,foralsopublic project.

Visual management

Visual management is a way to communicate bya 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 requires interpretation tounderstand.

ACKNOWLEDGEMENT

I would like to express my sincere thanks and deep sense of gratitude to Dr. P.N. RAGHUNATH., M.E., Ph.D., Professor and Head of the Department of Civil & Structural Engineering, Annamalai University, andmy project guide Dr. A. Prabaghar., M.E., Ph.D., Associate Professor, Department of Civil & Structural Engineering, Annamalaiuniversity, fortheirsupport and blessings for carrying out thisresearch.

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