Factors Causing Non-Compliance In Construction Site

C.G. Rithick , V.R. Prasath kumar

Abstract*: Construction is a complex process which involves integrating and sequencing at different stages of the project. Lean is a systematic method used for controlling the waste generated and help in providing an increase in productivity. Lean method can be adopted in the construction. Lean methodology adds worth by reducing the nonvalue adding this management philosophy was used by Toyota production system. This project tends to aim at eliminating the non-compliances occurring in site by using the lean as a tool, where this can be adopted for future projects. The work sampling and the non-compliance data are collected from site this helps in understanding the factors influencing the non-compliance questionnaire is prepared based up on the non-compliance report it is analyzed using the statistical package for social science version (21.0). This attest to the factors that influence the non-compliance. As a constructive approach to eliminate the non-compliance value stream mapping is adopted in which current and future state mapping is done.

***Index Terms*: construction, lean, non-compliance, value stream mapping.**

I. INTRODUCTION

Lean is the combined form of operational research and practical development in design and construction with of adaptation of lean principles and practices. Lean helps to significantly increase the value of the project Construction process involves planning, sequencing of activities from lower order to the end of construction of the project that involves complex activities that have to be highly monitored and sequenced so that it does not affect the stability of the project Lean helps in controlling the project through monitoring results, providing value to the customer, minimizing waste through proper optimization. The lean construction uses systems that helps in eliminating the noncompliance activities formed during the construction of the project. In lean the waste resources generally are the resources that are not utilized or misused in the construction process, thus by adopting lean it results in better understanding of the factors affecting the project and help in reducing the waste that are The lean method helps in making the decision to be more transparent and the system helps in transferring of information in a stable and more convenient manner, lean helps is rescheduling of activities on the occurrence of noncompliance activity In order to help, manage and eliminate the non-compliance and the resources misspent during the project phase lean principle is adopted. The adaptation will help in reducing the noncompliance generated during the activities and also help in reducing the resourced that are wasted. According to lean the waste are unnecessary motion, over production, inventory, waiting, defects, under usage of skills of workforce, improper sequencing of the activities and transportation.

II. METHODOLOGY

In this project the reports of work sampling and the non-compliance were collected form construction site and the factors causing the non-compliance were studied and the questionnaire was framed. The questionnaire was analyzed using the statistical package for social science (SPSS) version 21.0

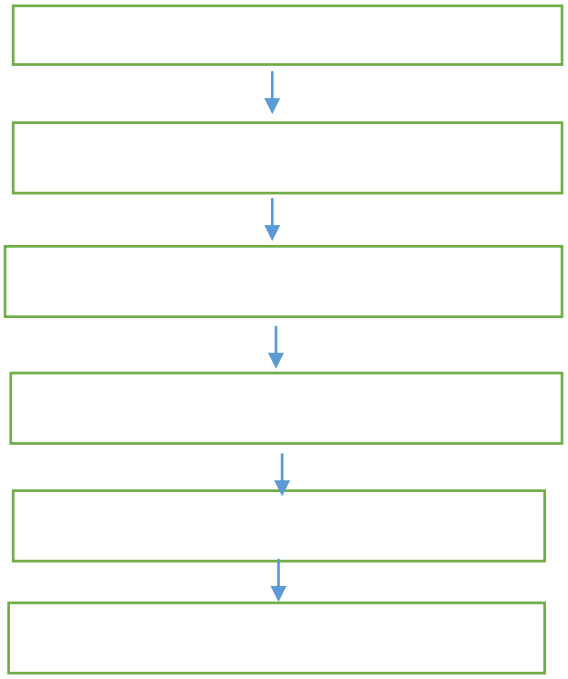

Figure 1: Shows the Methodology of the Project

III. DISCRIPTION OF METHODOLOGY

Work sampling is the methodology or technique used in determining the resources spent on the activity. it is done to find the required data for productivity and the quantity.

Based on work sampling the services are differentiated as

- Value added
- Nonvalue added but needed
- Nonvalue added

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C.G.Rithick, Post Graduate Student, Department of Civil Engineering, SRM Institution of Science and Technology, Chennai, Tamilnadu, India.

V.R.Prasath Kumar, Assistant Professor(Sr.G), Department of Civil Engineering, SRM Institution of Science and Technology, Chennai, Tamilnadu, India.

Value added consist of activity that is the planned activity and activity increasing the workflow of the activity. The nonvalue
added but required activity is the activity that is not planned but required in order for the planned activity to occur without any disturbance in the flow of work. The nonvalue added is the activity that does not benefit any value-added activity and is unplanned which breaks the workflow

The work sampling is taken in the site where they are analyzed and the data are encrypted. The data is collected using video sampling, photos, surveying the work done, work time allotted for the individual work.

The data are collected and stored in the form of files manually or it is electronically updated and stored and recorded. The noncompliance report plays a vital role in decision making for how to respond the noncompliance and the overall decision of how to act at the at most of the given time in regard to the method and correction proposed for the noncompliance

The labor productivity was done by activity-oriented model where labor productivity is calculated by output to the labor cost or by output to workhour it chosen based on the type of activity. The sampling was taken for the following works of a site where the work was carried out

- Wall putty
- Floor Tiling
- Grinding
- Dado work

These work sampling were taken in accordance to the noncompliance report due to the factors that was causing noncompliance.

Table 1: Process of work sampling

Activity	Sample No	VA	NVA	NVAN
Tiling	1	58%	19%	23%
	2	65%	14%	21%
	3	64%	14%	22%
DADO	1	56%	15%	29%
	2	50%	27%	23%
	3	68%	8%	24%
Wall Putty	1	52%	18%	30%
	2	53%	20%	27%
	3	55%	17%	28%
Grinding	1	60%	8%	31%
	2	51%	16%	33%
	3	47%	22%	29%

A. NON-COMPLIANCE

A non-compliance occurs due to failure of following the planned activity due to various disturbance occurring while executing the procedure. The non-compliance can be of major non-compliance and minor non-compliance

The non-compliance report comprises the noncompliance activity, location of the observed compliance, evidence of the noncompliance, type of the noncompliance, recommended remedies, the measure taken and the closure of date. The report is stored for future study and to find the preventive measures taken in accordance with the activity

The data collected is taken and the factors causing the each non-compliance is separated and the factors are determined, when the factors are identified the non-compliance factors show that they are factors which come under lean waste so in order to find that the lean waste factors influence the formation of non-compliance questionnaire was done and it was distributed and the data were collected

IV. RESULT DISCUSSIONS

This chapter presents the results of the data analysis based on the data collected from the employees of construction companies. The chapter included three sections, the first section discuss on the descriptive statistical analysis in which statistical techniques like frequency, percentage, mean and standard deviation were used to analyze the responses to the questionnaires used for data collection in the study. The next section focuses on the inferential statistics which includes hypothesis testing using statistical techniques like Independent Sample t-test and One-way ANOVA. The final section presents confirmatory factor analysis using structural equation model (SEM).

Table 2: Gender

Gender	Frequency	Percent
Male	143	81.7
Female	32	18.3
Total	175	100.0

Table 3: Educational qualification

Educational Qualification	Frequency	Percent
Diploma	31	17.7
Under Graduate	67	38.3
Post Graduate	44	25.1
Others	33	18.9
Total	175	100.0

Table 4: Work Experience

Experience in present organization	Frequency	Percent
Less than 5 years	23	13.1
5 to 10 years	69	39.4
10 to 15 years	48	27.4
More than 15 years	35	20.0

Total	175	100.0

Table 5: Designation

Designation	Frequency	Percent
Site Engineer	69	39.4
Design Engineer	30	17.1
Planning Engineer	18	10.3
Project Engineer	38	21.7
Project Manager	20	11.4
Total	175	100.0

A. Descriptive statistics

As an outcome of the research on background literature, the study identified nine factors that are perceived to be contributing to the noncompliance in Construction Projects. The nine factors were found to be the factors of lean waste management. The extent of contribution of each factor was measured using different number of variables on a scale of 1 to 5 with scale options like "Very Small Extent", "Small Extent", "Some Extent", "Large Extent", and "Very Large Extent".

The researcher developed a 66 items questionnaire to measure the nine factors contributing to the Lean Waste in Construction Projects. The factors identified items were "Motion", "Material Factors", "Inventory", "Defects", "Human Factors", "Leadership", "Management and Administration", "Technical Factors", "Information & Communication Factor" and "Environmental Factors".

The descriptive statistics for the data collected from the employees of the study is shown in Table 4.10. The descriptive statistics considered in the study are Minimum Statistic, Maximum Statistic, Mean, Std. Deviation, Skewness and Kurtosis.

From the table, it is very clear that, the factor "Motion" was the top contributing factor toward Lean Waste with mean value of 4.31, followed by Material Factors with mean value of 4.30. Inventory was the third highest contributing factor toward Lean waste with mean rating of 4.03. The Defect factor and Human Factors received a mean rating of 3.96 and 3.84.

Skewness and Kurtosis for all the variables are within prescribed limits of between (+2 to -2) indicating that the data is normal and appropriate for further statistical analysis. The study found that the least contributing factors toward Lean Waste included "Information & Communication Factor" and "Leadership, Management and Administration" with mean value of 3.71 and 3.68 respectively.

Table 6: Descriptive Statistics (N=175)

Lean Factors	Min	Max	Mean	Std. Deviation	Skewness	Kurtosis
Motion	3.33	5.00	4.31	0.46	-0.02	-0.58
Material Factors	3.80	5.00	4.30	0.39	0.74	-0.72
Inventory	3.00	5.00	4.03	0.41	0.64	1.15
Defects	3.00	5.00	3.96	0.51	0.99	0.20
Human Factors	3.00	5.00	3.84	0.61	1.05	-0.27
Leadership, Management and Administration	2.80	4.60	3.68	0.54	0.12	-0.94
Technical Factors	2.60	5.00	3.81	0.48	0.15	0.85
Information & Communication Factor	2.00	5.00	3.71	0.61	0.36	0.11
Environmental Factors	2.00	5.00	3.72	0.50	-0.15	2.11

B. Reliability Statistics

The reliability of the survey instrument was measured using coefficient of reliability using "Cronbach's Alpha'. The value of Cronbach's Alpha ranges from zero to one. The greater the value of Cronbach's alpha, the better will be the reliability of the survey instrument (Nunnally 1975).

In general, value of Cronbach Alpha above 0.7 is an indication that the reliability of the questionnaire is good. Table 4.11 shows that the Cronbach's alpha values of the study variables. It can be inferred that all the items used for measuring the variables have higher Cronbach's alpha value exceeding the threshold limit of 0.7. Hence, the survey instrument used in the present study is reliable and can be applied among the sample of respondents of the study for data collection.

Table 7: Reliability Analysis of Contributing Factors in Lean Waste in Construction Projects (N=175)

Lean Waste Factors	No. of Items	Cronbach's Alpha
Motion	3	0.724
Material Factors	8	0.898
Inventory	3	0.723
Defects	6	0.931
Human Factors	12	0.974
Leadership, Management and Administration	8	0.944
Technical Factors	10	0.946

Information & Communication Factor	5	0.923
Environmental Factors	4	0.776

C. Correlation Analysis

The Correlation Analysis was performed to analyze the existence of relationship among the Lean Waste factors like "Motion", "Material Factors", "Inventory", "Defects", "Human Factors", "Leadership, Management and Administration", "Technical Factors", "Information & Communication Factor" and "Environmental Factors". The level of relationship among the two variable was expressed using Pearson Correlation Coefficient (R).

From the table no.8, it is clear that all the factors are significantly (positively) correlated with other factors. The level of significance of correlation is given in the table below.

Table 8 Correlation Analysis

Factors		MTN	MF	INV	DFCT	HF	LMA	TF	ICF	EF
Motion (MTN)	Pearson Correlation	1								
	Sig. (2-tailed)									
Material Factors (MF)	Pearson Correlation	.393**	1							
	Sig. (2-tailed)	.000								
Inventory (INV)	Pearson Correlation	.401**	.259**	1						
	Sig. (2-tailed)	.000	.001							
Defects (DFCT)	Pearson Correlation	.643**	.357**	.206**	1					
	Sig. (2-tailed)	.000	.000	.006						
Human Factors (HF)	Pearson Correlation	.705**	.482**	.359**	.656**	1				
	Sig. (2-tailed)	.000	.000	.000	.000					
Leadership, Management and Administration (LMA)	Pearson Correlation	.510**	.398**	.298**	.466**	.520**	1			
	Sig. (2-tailed)	.000	.000	.000	.000	.000				
Technical Factors (TF)	Pearson Correlation	.297**	.159*	.156*	.296**	.343**	.456**	1		
	Sig. (2-tailed)	.000	.036	.040	.000	.000	.000			
Information & Communication Factor (ICF)	Pearson Correlation	.662**	.396**	.335**	.580**	.644**	.610**	.393**	1	
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000		
Environmental Factors (EF)	Pearson Correlation	.324**	.241**	.165*	.386**	.332**	.402**	.398**	.496**	1
	Sig. (2-tailed)	.000	.001	.029	.000	.000	.000	.000	.000	

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-tailed).**

A. HYPOTHESIS

Hypothesis testing was carried out to study the significance in the difference in the mean rating among the respondents based on their gender, age, educational qualification, experience and designation on the study variables like Motion, Material Factors, Inventory, Defects, Human Factors, Leadership, Management and Administration, Technical Factors, Information & Communication Factor and Environmental Factors. The results of the hypothesis are presented in Table 9.

Table 9: Results of Hypothesis Testing

S. No.	Hypothesis		Technique Used	Result	Level of P – Value
1.	H1:	There is no significant difference in the mean rating given by respondents based on their Gender toward various factors contributing toward Lean Waste in Construction Industry	Independent sample t-test	**Accepted for:** "Motion", "Material Factors", "Defects", "Leadership, Management and Administration", "Technical Factors", "Information & Communication Factor" and "Environmental Factors" **Rejected for:** "Inventory", "Human Factors"	0.05
2	H2:	There is no significant difference in the mean rating given by respondents based on their Age toward various factors contributing toward Lean Waste in Construction Industry	One Way ANOVA	**Accepted for:** "Motion", "Material Factors", "Defects", "Leadership, Management and Administration", "Technical Factors", "Information & Communication Factor" and "Environmental Factors", "Human Factors" **Rejected for:** "Inventory"	0.05
3.	H3:	There is no significant difference in the mean rating given by respondents based on their Qualification toward various factors contributing toward Lean Waste in Construction Industry	One Way ANOVA	Accepted for: "Motion", "Material Factors", "Inventory", "Defects", "Human Factors", "Leadership, Management and Administration", "Technical Factors", "Information & Communication Factor", "Environmental Factors". Rejected for: "Leadership, Management and Administration", "Technical Factors".	0.01
4.	H4:	There is no significant difference in the mean rating given by respondents based on their Experience toward various factors contributing toward Lean Waste in Construction Industry	One Way ANOVA	Accepted for: "Material Factors", "Human Factors", "Technical Factors", "Environmental Factors" Rejected for: "Motion", "Inventory", "Leadership, Management and Administration", "Defects", "Information & Communication Factor"	0.01 0.05
5.	H5:	There is no significant difference in the mean rating given by respondents based on their Designation toward various factors contributing toward Lean Waste in Construction Industry	One Way ANOVA	Accepted for: "Material Factors", "Inventory", "Technical Factors", "Information & Communication Factor", "Environmental Factors". Rejected for: "Defects", "Human Factors", "Motion", "Leadership, Management and Administration".	0.01 0.05

A. SEM Model

The Structural Equation Modelling was used to develop confirmatory factor analysis with various Lean Waste Factors like "Motion", "Material Factors", "Inventory", "Defects", "Human Factors", "Leadership, Management and Administration", "Technical Factors", "Information &

Communication Factor" and "Environmental Factors". Figure 2 and Figure 3 shows the unstandardized and standardized estimates of the Lean Waste Factor Model developed in the study.

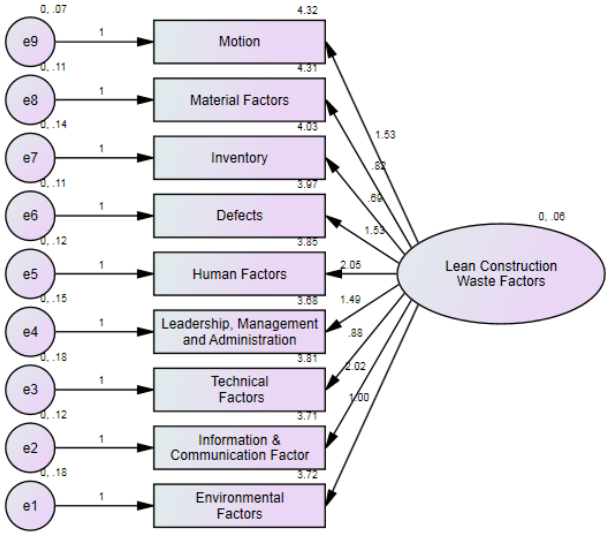

Figure 2: Unstandardized Estimate of the Lean Waste Factor Model

The loading of the factors (as shown in Figure 2) on the overall Lean Waste was above the threshold value of 0.30 which indicates that the actual model perfectly fits with the hypothesized model.

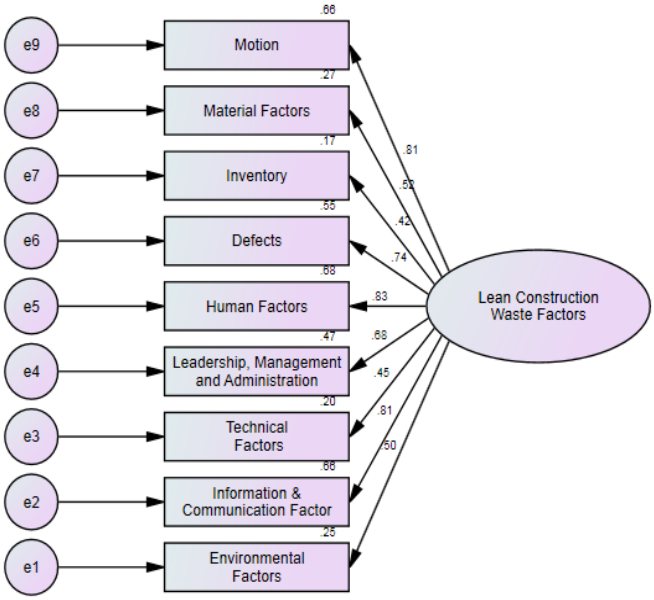

Figure 3: Standardized Estimate of the Lean Waste Factor Model

Standardized and Unstandardized Regression Weights of the SEM Model is presented. All the Lean Waste Factors like Motion, Material Factors, Inventory, Defects, Human Factors, Leadership, Management and Administration, Technical Factors, Information & Communication Factor and Environmental Factors have loading greater than 0.40 and the contribution of the factors to the overall model was significant as the p-value is less than 0.05.s.

V. CONCLUSION

The study was made to analyze the Factors contributing to noncompliance in Construction Industry The study was conducted with selected construction company in the Chennai Region, Tamilnadu. The study used descriptive research design and a survey instrument developed by the researcher was used to collect responses from the randomly selected 175 employees of construction companies.

- The study collected data related to the demographic profile and general information of the respondents like gender, age, experience, qualification and designation. As a outcome of an in-depth review of literature, the study identified nine factors that are hypothesized to be contributing to the Lean Waste in construction industry.
- The nine factors were measured using 66 items questionnaire. The factors identified were "Motion", "Material Factors", "Inventory", "Defects", "Human Factors", "Leadership", "Management and Administration", "Technical Factors", "Information & Communication Factor" and "Environmental Factors".
- Frequency and percentage analysis of the data collected from the respondents' shows that majority of the respondents are male employees (81.7%) and female constituted only (18.3%). The results of age group show that majority of the respondents are young belonging to the age between 18 – 28 years (60.0%).
- The educational background show that 38.3% of the study respondents are Under Graduate and 25.1% have Post Graduate qualification Majority of the respondents (39.4%) have 5 to 10 years of work experience and 27.4% of the respondents have 10 to 15 years of experience. 39.4% of the respondents were Site Engineers who are directly involved in promoting Lean Principles in their workplace.
- The study also included respondents with Project Engineer (21.7%) and Project Manager (11.4%) designations.
- The education and experience level of respondents of the study show that they have better education and good experience to divulge accurate information regarding the factors contributing to the Lean Waste in construction industry in their respective organizations.

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- The sample size of site engineers was kept high, considering the fact that they are directly involving in dealing with Lean Waste Management in construction industry.
- An analysis of the descriptive statistics of the factors contributing to the Lean Waste in Construction Projects show that Motion (M=4.31), Material Factors (M=4.30), Inventory (M=4.03) were the top-rated factors which are contributing significantly to Lean Waste. The study found that Information & Communication Factor (M=3.71) and Environmental Factors (M=3.72) were the least important factors in Lean Waste Management.

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AUTHORS PROFILE

C G Rithick: Pursuing M.Tech (Construction Engineering and Management) in SRM Institute of Science and Technology, Kattankulathur, Chennai. India. Completed B.E (civil Engineering) from Anna University, Coimbatore, Tamil Nadu, India.

V R Prasath Kumar: Assistant professor, Department of Civil Engineering, SRM Institute of Science and Technology, Kattankulathur, Chennai, India. Pursuing Ph.D in Construction Engineering and Management from SRM Institute of Science and Technology, Kattankulathur, Chennai, India. Completed M.Tech. (CEM), SRM University, Chennai, Tamil Nadu, India. Completed B. E. (Civil Engineering), kongu engineering college, Tamil Nadu, India.