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A Study onInfluence of Lean Management Practices on Reduction of Cost and Time in Construction Industries

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Abstract- This researchaims at identifying various dimensionsof Lean management practices and reduction of cost and time in construction industries. This study has been conducted in South India from June 2015 to January 2016. The researchers adopted random sampling method for collecting data from the respondents. Moreover, questionnaire method has been used by the researchers. The researchers also used Statistical tools like Cronbach's alpha, exploratory factor analysisfor the study. This study identified nine important dimensions ofreduction of cost and rate in Lean implementation. These are: Procurement, waste reduction, resource utilization, supplier performance, delivery on time, employee skill, proper planning, knowledge transfer and lean knowledge. Out of the identified factors,Procurement, waste reduction, resource utilization and knowledge transfer has significant impact on reduction in cost and rate of the project. The findings of this study would help the policymakers in framing suitable policies relating to lean application in construction industries.

Keywords- knowledge transfer; lean application; lean management; procurement; resource utilization; waste reduction.

I. INTRODUCTION

Achieving smooth work flow with negligible waste requires not only suitable construction planning, but also effective construction management (Rosemary R.Fullerton et al., 2014).Manufacturing firms functioning in the promptly changing and highly inexpensive market of the past two decades have involved the principles of Leanthinking. Progressively more competitive environments and markets have required manufacturing organisations to continuously search for improvements in their production processes as an alternative to reducing working costs(Garza-Reyes,2010).Lean production is embedded in the Toyota production system. Lean production or Toyota production system philosophies have evolved and were successfully implemented in Toyota motor company.The term LEAN was coined by the research team working on international auto production to replicate both the waste reduction nature of Toyota production system (Remon Fayek aziz and Sherif Mohamed Hafez,2013). Lean construction is a new idea oriented to construction production administration (Usama Hamed Issa,2013). It was taken from lean production that can be traced to Toyota production system with its focus on the saving and removal of waste.Lean construction is well-defined as a production management scheme for achieving significant improvement in the performance of the total business development of a contractor through removal of all wastes of time and other resources that do not improve value to the product or delivered service to the customer.

II. LITERATURE REVIEW

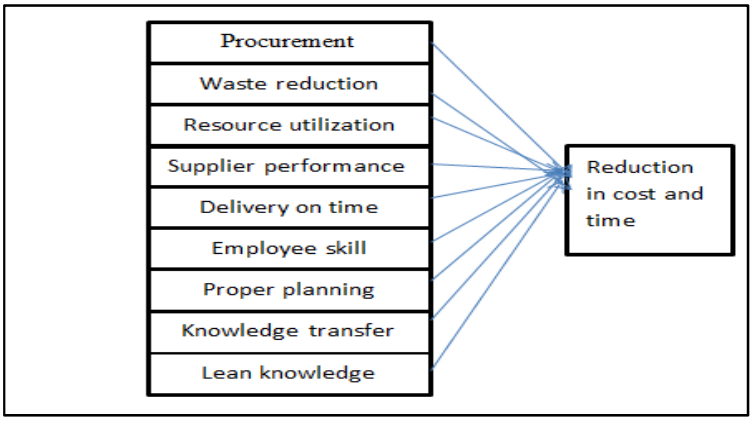
A study was made by Giuliano Almeida Marodin and Tarcisio Abreu Saurin (2015) to find the risks that affect lean production implementation. This study resultedin the development of several effective methods. Aat van den Bos, et al., (2014) studied the use of lean six sigma methodology in a construction company. Another problem was recognized as a major reason for project delay concerned the problems structuring that is required to both define the project's possibility and to untangle the problem into sub-issues.Gao Shang and Low Sui Pheng(2014) focused on barriers to lean implementation in the construction industry in China. Also they

suggested that the most crucial barriers to application of lean performs, as real by Chinese building specialists, include "their lack of continuedthinking", "the absence of lean thinking in their organizations", "the use of multi-layer subcontracting". Also shows the six underlying factors delaying the implementation of lean practices in the Chinese construction industry, namely, people and partner issues, supervisory and administrative issues, lack of support issues, culture and philosophy issues, government issues and procurement issues. Eric Singer and Kurt Becker (2013) found that the reallocation of time management from operators, management and support groups has improved compliancy and outputs, while driving down unnecessary costs. Rania A.M. Shamah (2013) provides guidance for the management of supply chains in order to increase the likelihood of lean thinking being generally adopted for the purpose of value creation, and to examine the potential role of the customer in improving supply chain performance.Usama Hamed Issa(2013) concluded that the impacts of factors affected by lean construction techniques decreases with the increase in time.Jose Arturo Garza-Reyes, et al., (2012) studied the development of a lean park homes production process and compares the factory method to traditional on-site construction methods. Raid Al-Aomar (2012) investigated the application of lean construction performs in the construction business and develops a practical and applicable framework that includes Six Sigma rating into the best practices of lean construction. Robert Conti, et al.,(2006) studied the effects of lean production on worker job pressure. The stress reduction and stress control opportunities identified in the study show the probable for designing and operating effective lean systems while also controlling stress levels. Concluded that lean production is not inherently stressful and worker well-being is not deterministic.

Research gap*:*

Even though, several studies have been undertaken on Lean principles in the construction industries in several parts of the world and several conclusions have been made. But none of the studies have been done in South India about the application of lean principles in the construction industries. Hence, a study on application of Lean management principles in construction industries in India is necessary to make lean principles more efficient.

III. PROPOSED RESEARCH MODEL



A. Objective

This study is approached with the following objectives.

- To identify the antecedents of lean management practices in construction industries.
- To study the impact of various dimensions of lean management practices on reduction in cost and time of the project.

B. Project Hypothesis

H_{01}: There is no significant impact on procurementon reduction of cost and time of the project.
H_{02}: There is no significant impact on waste reduction on reduction of cost and time of the project.

H_{03}: There is no significant impact on resource utilization on reduction of cost and time of the project.
H_{04}: There is no significant impact on supplier performance on reduction of cost and time of the project.
H_{05}: There is no significant impact on delivery on time on reduction of cost and time of the project.
H_{06}: There is no significant impact on employee skill on reduction of cost and time of the project.
H_{07}: There is no significant impact on proper planning on reduction of cost and time of the project.
H_{08}: There is no significant impact on knowledge transfer on reduction of cost and time of the project.
H_{09}: There is no significant impact on lean knowledge on reduction of cost and time of the project.

C. Scope

The scope of the study is restricted only to the project managers, supervisors and quality control managers of construction projects in South India.

D. Duration of study

The study was conducted during the period of June 2015 to January 2016.

E. Data collection methods

Major data collection was completed through questionnaire survey. The first part of the questionnaire consists of Demographic profile of the respondents. The second part consists of the respondent'sperception on the application of Lean principles in construction industries in South India. The third part consists of the business performance of the company.

F. Instrument development

The variable relating to the present study is drawn from the previous work done by- (Gao Shang and Low Sui Pheng 2014), (Giuliano Almeid Mrodin and Tarcisio Abreu Saurin 2015), (Inger Gamme and Silje H.Aschehoug 2014), (Koskela 1992), (Lucila M.S.Campos 2013), (Manimay Ghosh 2013), (Rania A.M.Shamah 2013), (Robert Conti, Jannis Angelis, Cary Cooper, Brian Faragher and Colin Gill 2006). The researchers made suitable modification in the Questionnaire to suit requirement of the study.

G. Pilot study

Before administering questionnaire to the respondents the researchers conducted pilot study. Based on the feedback received from the project managers, supervisors, quality control managers some alterations have been made in the existing questionnaire.

H. Content validity of questionnaire

The researcher constituted a committee that consists of an expert in Lean Construction and an academician. Based on their valuable suggestions some changes were made in the existing questionnaire.

IV. DATA ANALYSIS, INTERPRETATION AND RESULTS

A. Demographic profile

Within the context of the construction industries, some of the most commonly investigated demographic variables are gender, experience, job position, nature of the project, form of business, years of existence, turnover of the company. An analysis of the gender composition of the respondents showed that 100 per cent of the respondents were male. Only 12.6 per cent of the respondents were having less than 3 years of experience while 33.9 per cent were between 3 and 5 years, with 23.6 per cent of the respondents were between 5 and 7 years and 29.9 per cent of the respondents were above 7 years.

B. Reliability analysis

The coefficient alpha scores were calculated forevaluating reliability of the lean principles which are listed dimension wise in Table I. the coefficient alpha values for variables are well above the criterion as recommended by Nunnery(1978) for assessing reliability of the scale.

TABLE I Reliability Statistics

Cronbach's Alpha	No. of Items
0.926	30

C. Factor analysis

A principal component factor analysis with varimax rotation was performed on 30 variables that calculated the perceived lean management practices in construction industries. The statistical test result (KMO=0.753 Bartlett's test of sphericity=435.00, significance=0.000) revealed that the factor analysis method was appropriate. The nine dimensions and the percentage of variance explained are listed in TableII.

TABLE II KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.753
Bartlett's Test of Sphericity	Approx. Chi-Square	2511.025
	Df	435
	Sig.	0.000

Factor 1, which was labelled as procurement, was composed of four variables and accounted for 20.425 per cent variance. Factor 2 comprised of four variables that relate to the waste reduction of lean practices and accounts for 8.500 per cent of the variance. Factor 3 was labelled as resource utilization that includes three variables. It accounts for additional 8.115 per cent of variance. Factor 4 was supplier performance that contained three variables accounted for additional 7.186 per cent. Factor 5 was interpreted as delivery on time and comprised of three variables. It accounted for an additional 7.007 per cent of variance. Factor 6 was labelled as employee skill. It consists of three variables and accounted for 6.345 per cent of variance. Factor 7 was named as proper planning that composed of four variables. It accounted for an additional 5.682 per cent of variance. Factor 8 and 9 was labelled as knowledge transfer and lean knowledge which consists of three variables each.

TABLE III Lean Application Dimensions in Cost and Time (LADCT)

Sl.No.	LADCT	No. of variables including	Eigen value	Percentage of variance explained	Cumulative percentage of variance explained
1	**Procurement**	**4**	**31.164**	**20.425**	**20.425**
2	**Waste reduction**	**4**	**9.056**	**8.500**	**28.925**
3	**Resource utilization**	**3**	**6.870**	**8.115**	**37.040**
4	**Supplier performance**	**3**	**5.820**	**7.186**	**44.226**
5	**Delivery on time**	**3**	**5.075**	**7.007**	**51.233**
6	**Employee skill**	**3**	**4.331**	**6.345**	**57.578**
7	**Proper planning**	**4**	**4.232**	**5.682**	**63.260**
8	**Knowledge transfer**	**3**	**4.079**	**5.586**	**68.846**
9	**Lean knowledge**	**3**	**3.435**	**5.216**	**74.062**

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D. Multiple regression analysis

In order to test the impact of reduction of cost and time on lean management practices in construction industries, multiple regression analysis was performed. Mostlyreduction in cost and ratewas used as the dependent variable even as the independent variables were represented by procurement, waste reduction, resource utilization, supplier performance, delivery on time, employee skill, proper planning, knowledge transfer and lean knowledge. The compute command in SPSS version 20 was used to compute the value loadings associated with the variables measuring each of the factors based on numeric transformations in order to obtain values for both the dependent and independent variables. Table IV and table V presents a summary of the multiple regression results for the dependent and independent variables.

TABLE IV ANOVA

Model	Sum of squares	dF	Mean square	f	Sig.
Regression	188.821	9	20.980	37.184	0.000
Residual	66.013	117	0.564	-	-
Total	254.835	126	-	-	-

The results indicate that there is a strong and significant relationship between reduction in cost and rate and the lean management practices in construction industries (F=37.184, probability F statistics < 0.000). The R^2 value=0.861 indicated that the independent variables explained 86.1 per cent of the variance in quality of the project with an adjusted $R^2$of 74.1 per cent. On the individual determinants, resource utilization was found to be the most important determinant of reduction of cost and rate of the project (β=0.419, t=5.979,p=0.000<0.05). This was followed by procurement (β=0.293, t=4.257, p=0.000<0.05), knowledge transfer (β= 0.210, t= 3.877, p=0.000<0.05) and waste reduction (β=0.158, t=2.614, p=0.000<0.05).

TABLE V Influence of Lean Application on Reduction in Cost and Time

Sl.No	Independent variables	Standardized coefficient	t	Sig.	Collinearity Statistics	
					Tolerence	VIF
1	Procurement	0.293	4.257	0.000	0.468	2.139
2	Waste reduction	0.158	2.614	0.010	0.610	1.641
3	Resource utilization	0.419	5.979	0.000	0.450	2.220
4	Supplier performance	-0.082	-1.419	0.158	0.659	1.518
5	Delivery on time	0.036	0.653	0.515	0.729	1.371
6	Employee skill	0.055	0.959	0.340	0.674	1.484
7	Proper planning	0.028	0.503	0.616	0.694	1.440
8	Transfer of knowledge	0.210	3.873	0.000	0.742	1.348
9	Lean knowledge	0.005	0.078	0.938	0.621	1.610
	R square					0.741
	Adjusted R square					0.721

E. Testing of hypothesis

The results of the testing of the hypothesis in the context of lean application criteria with nine factors are detailed in Table VI.

TABLE VI Testing of Hypothesis

Sl. No.	Hypothesis	t value	Beta	Results
H_{01}	Procurement will have no significant impact on reduction in cost and rate	**4.257**	**0.293**	**Proved**
H_{02}	Waste reduction has no significant impact on reduction in cost and rate.	**2.614**	**0.158**	**Proved**
H_{03}	Resource utilization has no significant impact on reduction in cost and rate.	**5.979**	**0.419**	**Proved**
H_{04}	Supplier performance has no significant impact on reduction in cost and rate.	**-1.419**	**0.082**	**Not Proved**
H_{05}	Delivery on time has no significant impact on reduction in cost and rate.	**0.653**	**0.036**	**Not Proved**
H_{06}	Employee skills have no significant impact on reduction in cost and rate.	**0.959**	**0.055**	**Not Proved**
H_{07}	Proper planning has no significant impact on reduction in cost and rate.	**0.503**	**0.028**	**Not Proved**
H_{08}	Knowledge transfer has no significant impact on reduction in cost and rate.	**3.837**	**0.210**	**Proved**
H_{09}	Lean knowledge has no significant impact on reduction in cost and rate.	**0.078**	**0.005**	**Not Proved**

V. CONCLUSION

This study has identified nine important factors of lean practices. These are: procurement, waste reduction, resource utilization, supplier performance, delivery on time, employee skill, proper planning, knowledge transfer and lean knowledge for lean implementation. Moreover, this study also confirmed that there is a significant relationship between procurement, waste reduction, resource utilization, supplier performance, delivery on time, employee skill, proper planning, knowledge transfer and lean knowledge. This study has some limitations. This paper considers only nine independent variables procurement, waste reduction, resource utilization, supplier performance, delivery on time, employee skill, proper planning, knowledge transfer and lean knowledge. This study consists of one dependent variable. In future similar studies could be conducted by adding more number of dependent variables and independent variables. This study has been conducted only in South India. Similar study can be conducted throughout the India.

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