

Effective Utilization of Lean Management in Construction Industry

A.Chandrasekar, M.Logesh Kumar

Abstract— In order to improve the efficiency and reduction of waste, the lean construction has been introduced as a new management principle for better implementation. Currently several construction companies from USA, UK, Australia, Brazil, and Singapore are started to implementing the lean construction with nebulous hopes of obtaining better result from their current projects. There are many challenges to implement the lean concept in construction industry. In India, the implementation of lean management in construction industry is a major task. Due to lack of attention and illiterate towards the lean management principle the owner, contractor, engineers etc. are still developing stage to implement this principle in their project. This project mainly focuses on to identify the possibilities of implementation of lean management in construction industry. It will be achieved by preparing the questionnaire and also conducting the interview with the project personals like top management, engineers and site supervisors etc. The questionnaires were evaluated to adopt the techniques through statistical methods. This paper presents the possibilities of effective utilization of lean management principle in construction industry, which can surely increase the quality of work and profit rate by eliminating the wastage of materials.

Index Terms- lean, construction, management, and implementation.

I. INTRODUCTION

In India, the construction industry is second largest industry after agriculture (Lascar and Moorthy 2004) it is diversified and involved in all spheres of construction like as following:

- ✓ Roads
- ✓ Railways
- ✓ Urban infrastructure
- ✓ Ports
- ✓ Airports

Lean construction has been introduced as a new management approach to improve the productivity in construction industry. Lot of researches is going on towards the lean concepts and principles to get results of the successful adaption of lean ideas from car manufacturing industry to the construction industry. The construction companies struggling to transform their current forms of project management into the lean management approach.

A. Objective of the study

The following are the objective of the project:

- ✓ Access lean construction from the view point of various project participants.
- ✓ Identify the benefits and barriers associated with lean implementation.

- ✓ Identify the requirements for improvement of lean implementation.
- ✓ To improve the quality of the project and profit by minimizing the waste.

B. Scope of the study

The following are the scope of the project:

- ✓ Just in time construction
- ✓ Delivery system
- ✓ Improve the quality, reduces rework and implementation time.
- ✓ Identification of waste in construction process
- ✓ Deliver a custom product instantly, without waste.

C. Need for study

Now days in India so many construction firms are newly out coming due to the need of infrastructure development in the country. Due to the huge requirement and to get well profit, the competitions among the companies are increasing day by day. In Indian construction industry, availability of skilled or literate labours is a major problem. Due to the unskilled labour and the lack of technology the quality of the project is reduced. To avoid such a problem, construction firms are required new and innovative technology. Such a technique name is called lean management. This is the principle is to be used in construction industry to avoid the above mentioned problem. The lean management principles in the construction industry will increase the profit and quality of project in reasonable time. The main theme of lean management principle is "Drive more value by using less of everything".

II. DEFENITIONS

Lean: The core idea is to maximize customer value while minimizing waste. Simply, lean means creating more value for customers with fewer resources.

Construction: Building construction is the process of preparing for and forming buildings and building systems. Construction starts with planning, design, and financing and continues until the structure is ready for occupancy.

Management: The organization and coordination of the activities of a business in order to achieve defined objectives. Management is often included as a factor of production along with machines, materials, and money. According to the management guru Peter Drucker (1909-2005), the basic task of management includes both marketing and innovation

III. BACKGROUND ON LEAN MANAGEMENT

A. Origin of lean principles

The credit of the development of the lean principles goes to the **Toyota Car Company** of Japan which has revolutionized the way of manufacturing of automobiles. From the mass production theory which was being followed by Henry ford by US, the manufacturing industry today has certainly come a long way. But before elaborating on contributions of Toyota in the development of lean principles, it is important to understand the reason behind the need of a new manufacturing technique when Ford was going great guns in delivering the customer a cheap and yet an efficient product.

B. Overview of Lean Management

The lean management principle was first originated by Japanese manufacturing industries (Toyota Car Company). It was implemented by a researcher named John Krafcik in the year 1988.

C. Lean Construction

Lean construction is defined as the continuous process of eliminating waste, meeting or exceeding all customer requirements, focusing on the entire stream and pursuing perfection in the execution of the project work.

D. Waste Elimination

Waste elimination is very important process in the construction industries to improve the quality and profit of the project. Waste may be produced directly or indirectly during the construction in the construction industry.

IV. LITERATURE REVIEW

Daeyoung Kim, Hee-Sung Park (2006) had analyzed about assessment of lean construction principles, techniques and concepts for better implementation and to get results of the successful adoption of lean ideas from car manufacturing application in the construction industries [6]. Eric Johnansen, Lorenz Walter (2007) had done questionnaire survey among the German construction companies to discover the current understanding of lean principles and perceptions of lean and trends in lean development [9]. Sepani Senaratne, Duleesha Wijesiri (2008) carried out Lean Construction as a strategic option: Suitability and Acceptability in Sri Lanka study to explore the suitability and acceptability of Lean Construction in Sri Lanka. The study adopted an opinion survey using Delphi Method to collect empirical data [11].

V RESEARCH METHODOLOGY

The following methodology shows figure (a) was proposed one to analyze and implement the lean management principles in construction industry.

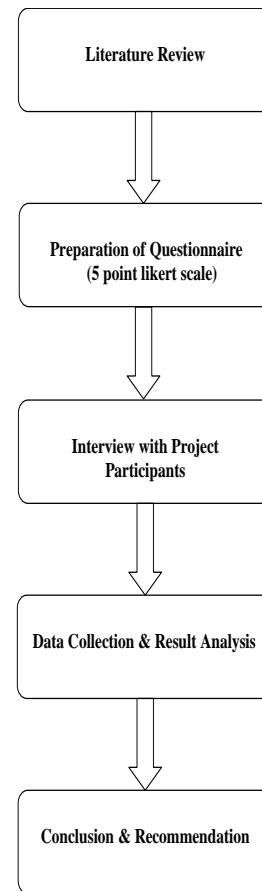


Fig 1: Methodology Adopted

A. Questionnaire Survey

The preliminary structure of this questionnaire is consists of 50 questions and its categorized under seven criteria according to its type of waste. Totally 30 companies were surveyed by using Personal Interview Method. The design of questionnaire was prepared by using 5-point likert scale. In order to quantifying the criteria, they are given by weightages. Finally the percentages of wastes were accepted by the project personals are graded according to data given in Table 1.

Table – 1 Likert Scale

Grading	% compliance	Rank Scale
Most Agree	80-100	R1
Agree	60-80	R2
Neutral	40-60	R3
Disagree	20-40	R4
Most Disagree	0-20	R5

The prepared questionnaires were given to the various project participants from management level to labour level (Project Manager, Design Engineers, Executive Engineers, Supervisors and Labours).

B. Identification of waste

In this step, the wastages which produced during the project are to be identified and examined, causes are analyzed. Based on the questionnaire survey collected from the companies they are cluster together and formulated related to their usage and divided in to seven categories as follows,

- ✓ Resource Wastes
- ✓ Management Related Waste
- ✓ Design Related Waste
- ✓ Operational Related Waste
- ✓ Waste due to Labour
- ✓ Waste while Procurement
- ✓ Miscellaneous Waste

The bar and pie chart prepared by using quantitative method. The following bar and pie chart showing the percentage of waste occurred in construction industry.

The questionnaire survey was carried out among 70 companies in various parts of Tamil Nadu in India. The following result are obtained based on the questionnaire survey is shown in figure for each wastes.

Resource Waste:

The resource waste (cement, brick, steel etc) is the major problems in the construction sites. It's calculable that on the average construction resource waste constitutes 15-30% of the entire construction sites. It happens frequently in all sites because of carelessness of unskilled labours.

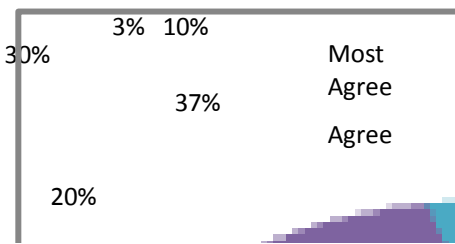


Fig 2(B): Waste due to Resources

Here the pie chart shows that the 67% of respondents were agreed that the resources are wasting in everyday and it's clear from the figure (b). It hit the profit level of the company due to above mentioned causes.

Operational Waste

Operational waste mainly happens due to error by trade person or laborer, equipment malfunction, Equipment frequently break down, Unreliable equipment, inclement climate, accidents, damages caused by subsequent trades, use of incorrect material requiring replacement etc.

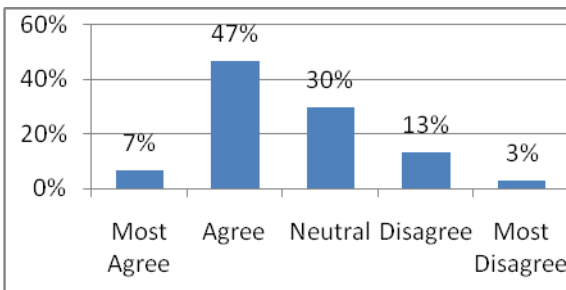


Fig 2 (C): Waste while operation

Here the bar chart presents the survey result that 84% of respondents felt that wasting happens by above mentioned operational waste and it is very clear from figure (c).

Management Waste

The management related waste are Slow in making decisions, poor coordinating among project participants, Poor planning and scheduling, poor provision of information

providing to participants etc. this bar chart shows that 81% of respondents thought that the waste happens due to above mentioned management related problems. It shows by the figure (d).

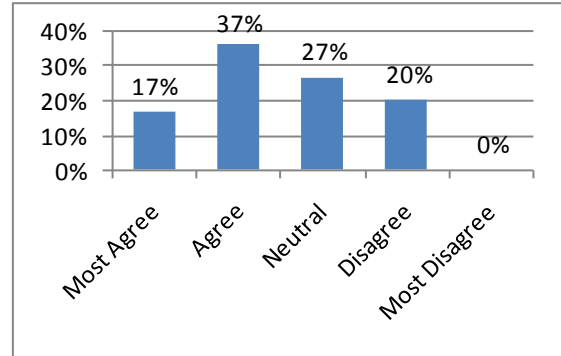


Fig 2 (D): Waste due to Management

Design Waste

Mostly it happens due to error in contract documents, incomplete at the commencement of project, change in design after commencement of project. Designers have to be compelled to embody rationalization of specification in every material and element that's required within the contract. Sometimes, ordered material cannot attain the location on time, forcing them to use substitute material terribly very short time. With a restricted time, designers are susceptible to opt for material that's low in quality rather than the initial demand.

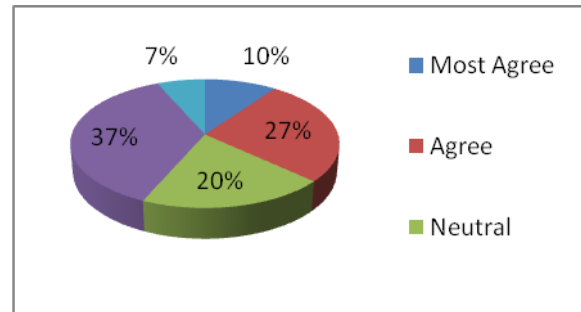


Fig 2 (E): Waste due to Management

Here the pie chart shows that the 57% of respondents believed that the resources are wasting in everyday and it led the project delay and it is clear from the figure (e). If the designers need to minimize waste to the optimum level, designers have to be compelled to take into account the development method for every component.

Laborer Waste

Every year, owner operators, engineering, procurement, and construction companies, and contractors are hit with billions of dollars in construction claims as a result of inefficiency factors impacting labor. In India 88% are unskilled or with low skill levels, 11% with medium to high skill levels and the rest (only 1%) are at managerial levels shows the figure (f). Due to above reason the waste frequently happens.

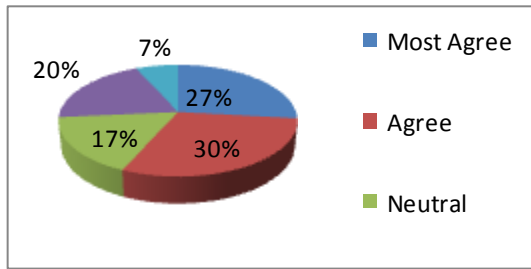


Fig 2 (F): Waste due to Laborer

Procurement Waste

Ordering error, over ordering, under ordering, suppliers error, damage during transportation to site, inappropriate storage etc causing the wastage while procurement.

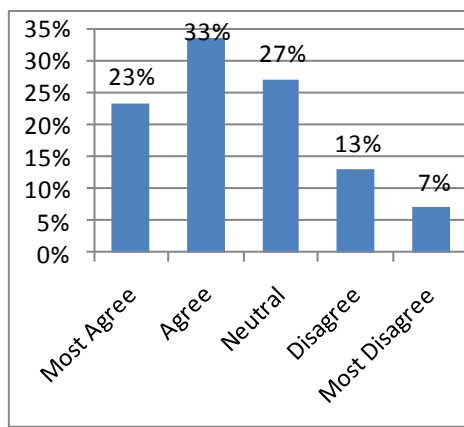


Fig 2 (G): Waste while Procurement

The above bar chart shows that the 83% of respondents are agreed that the operational wastage are happening in every construction sites and it can see in the figure (g)

VI. DATA ANALYSIS AND RESULTS

The gathered data from all the sites were analyzed by using Statistical Methods and each waste parameter were given grading depending upon the points gained by various companies. The following tests were conducted such as,

- ✓ Average Index Analysis
- ✓ One sample t - test
- ✓ Two sample t - test
- ✓ Chi-square test

Average Index Analysis (A.I)

Average Index Analysis (A.I) is aimed at getting the average response to the Questions in the questionnaire survey in term of fractions of the Likert Scale of 1 to 5 .This will give an indication on the level of agreement to the issues raised in each of the sections of the questionnaire. The average index analysis for each variable is calculated by using the formula below (Samsul, 2008):

$$\text{Average index (A.I)} = \frac{\sum 1X1 + 2X2 + 3X3 + 4X4 + 5 X5}{\sum X1 + X2 + X3 + X4 + X5}$$

$$\sum X1 + X2 + X3 + X4 + X5$$

Where,

- X1= Number of respondents for Most Disagree;
- X2= Number of respondents for Disagree;
- X3= Number of respondents for Neutral;

X4= Number of respondents for Agree;

X5= Number of respondents for Most Agree

One Sample t- Test

One-sample t-test produces tests whether the mean of a single variable differs from a specified constant. The mean, standard deviation, and standard error of the mean would be found from each test variable.

For this study, errors will be accepted if it is less than 5%, which means carried a confidence level of 95%. So, the data could be concluded as having significant relationship among the variables if the significant value, which p value is less than 0.05 (p< 0.05).

Two sample t-test

To compare responses from two groups. These two groups can come from different experimental treatments, or different natural "populations". For this research, errors will be accepted if it is less than 5%, which means carried a confidence level of 95%. So, the data could be concluded as having significant relationship among the variables if the significant value, which p value is less than 0.05 (p< 0.05).

Chi-Square Test

Chi-square test procedure tabulates a variable into categories and computes a chi-square statistic Base System, SPSS Version 15. It is used to compare observed and expected frequencies of a variable which has three or more categories, to test whether more than two populations can be considered to be equal. (Richard and Anita, 2003).

For this study, the x2 distribution is assumed to be excluded if any cell contains an expected frequency of less than 5. Furthermore, the probability of error is 5%, which p< 0.05.

VII CONCLUSION AND RECOMMENDATION

Based on the work carried out it is found that 70% of companies accepted the criteria that wastes are generated in the construction industry which is accepted by the companies according to the responds of the various project participants in construction industry. The primary objective has been achieved whereas the foremost used 4 techniques are known that is identification of waste reduction. Based on this study, the following recommendations are offered to support the effort of implementation of lean management in construction industry,

- ✓ Orientation programs need to be developed for subcontractors. Because lean concepts and principles may be complex for the contractors to understand.
- ✓ The companies may provide adequate training for management level employees.
- ✓ Weekly meeting may held to the skilled and unskilled labours to discuss about the ongoing project at site.
- ✓ Consider a maximum use of local available materials
- ✓ To ensure every project participants involved in the construction process in full fledged manner.
- ✓ Establish good relationship between manufacturers and management.

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

ACKNOWLEDGMENT

F.A and S.A would like to thanks to all the participants from various companies in Tamil Nadu.

REFERENCES

- [1] Alarcón, L. F. and Seguel, L. (2002) 'Developing Incentive Strategies for Implementation of Lean Construction', proc. 10th Ann.conf.Intl.Group for lean construction. Gramado, Brazil, 6 - 8 August 2002.
- [2] Alarcon, L.F. (1994). "Tools for the Identification and Reduction of Waste in Construction Projects". In: L.F. Alarcon, ed. Lean construction. Rotterdam: A.A. Balkema, 365-377.
- [3] Alves, T.C.L and Tsao, C.C.Y. (2007). Lean Construction – 2000 to 2006. Lean Construction Journal, 3(1) 46-70.
- [4] Ballard, G. and Howell, G. (1997). "Shielding Production: an Essential Step in Production Control" Journal of Construction Engineering Management, Vol. 124, No. 1, pp. 11-17.
- [5] Ballard, G., and Howell, G. (2003). "Lean Project Management". Building Research and Information, 31(2), 119-133.
- [6] Daeyoung Kim, Hee-Sung Park (2006) "Innovative Construction Management Method: Assessment of Lean Construction Implementation" Nov.2006, Vol.6, pp 381-388.
- [7] Diekmann, J. E., Balonick, J., Krewedl, M. and Troedle, L. (2003) Measuring Lean Conformance'. proc. 11th Ann.conf.Intl.Group for lean construction .Blacksburg, USA, 22 - 24 July 2003.
- [8] Eaton, D. (1994). "Lean Production Productivity Improvements for Construction Professionals". In: L.F. Alarcon, ed. Lean Construction. Rotterdam: A.A. Balkema, 279-289.
- [9] Johansen, Eric (2007). "Lean Construction: Prospects for the German Construction Industry" Lean Construction Journal, 3(1), pp 19-32.
- [10] Koskela, L., Howell, G., and Dr. Tech. (2000) "Reforming Project Management: The Role of Lean Construction" Proc., IGLC-8, 8th Conf. of Int.Group for lean Construction, Brighton, Brazil
- [11] Senaratne, Sepani, Duleesha (2008), "Lean Construction as a Strategic Option: Testing its Suitability and Acceptability in Sri Lanka" 1555-1369, Lean Construction Journal, pp 34-48.

AUTHOR'S PROFILE

Name: A.Chandrasekar,
Qualification: B.Tech. in Civil Engineering,
M.E. in Construction Engineering and Management.
Membership: Member of Indian Society for
Technical Education



Name: M.Logesh Kumar,
Qualification: B.E. in Civil Engineering,
M.E. in Construction Engineering and Management.
Membership: Member of Indian Society for
Technical Education

