# LEAN AND VALUE MANAGEMENT IN CONSTRUCTION PROJECTS

Bavithra K[1] , Karthigaipriya T[2]
Student [1],Assistant Professor[2],Department of Civil Engineering,
Thiagarajar College of Engineering,Madurai 625 015, Tamilnadu, India.
bavithrak1127@gmail.com, karthigaipriya@tce.edu

**Abstract— Lean philosophies are new emerging phenomenon in construction industries and manufacturing process for waste reduction. Lean management is a technique for reduction of unnecessary waste which will influence the total cost of works. It also creates value for money in construction projects by saving cost. The process of Lean management will automatically turned into Value management by achieving value for money without compromising function. Value management is a process of achieving the best value for customer satisfaction. Instead of integrating these two processes, by implementing Lean management in construction will automatically create value. Aim of this project is to obtain the best value by implementing continuous improvement method. A questionnaire survey that assessed the impact of applying Lean management and Value management in construction projects. Adoption of Lean management will definitely yield value management in construction industries by obtaining results from questionnaire. The study strongly suggests that implementation of Lean will deliver value from customer perspective**.

**Index Terms— Customer value, Cost, Lean management, Quality, Time and Value management.**

## I. INTRODUCTION

As the increased competition in global construction market, all construction companies are seeking perfection in each process in construction project in order to increase value by eliminating waste. Waste generation in construction industry had been the subject of various research projects all over the world in modern years. It is often recognized that a very high level of waste exists in construction. Although numerous techniques and practices have been developed to improve efficiency, Lean techniques promise to eliminate waste in order to improve efficiency. The end product of every construction project is customer value. Customer satisfaction is very important for recognition of each construction company. Value management is the process of achieving customer value. Value can be obtained by reducing cost from reduction of unnecessary waste.

### *A. Lean management*

It is an approach to work systematically in order to achieve incremental changes in process to improve Efficiency or Quality. Lean construction generally acknowledges its lack It mainly focuses on process/product efficiency.

### *B. Lean Techniques*

1. 5s visual workplace
2. Just in time
3. Continuous improvement
4. Value stream mapping
5. Work in process

### *C. Value management*

It is a systematic process of team based Decision Making to achieve Expected Outcome. Value management contributes to a clear customer perspective of value from the early stage of projects. It mainly focuses on process/product function.

### *D. Value management techniques*

1. Value Tree
2. Client Value System

3. Function Analysis
4. FAST Diagrams
5. Function/Cost Analysis

*E. Value through lean*

Lean and value management mainly focus on reducing non value added activities in order to save cost spent on waste which leads to achieve the best value for customer satisfaction.

1. What the client precisely needs or wants
2. Value improvement and value for money
3. Elimination of waste
4. Eliminating unnecessary cost

## II. Methodology

This chapter provides knowledge about implementation of lean and value management in construction industries. Literatures have been selected and studied for implementing lean and value management in construction project. In order to frame a perfect methodology and to know the details about the study to be undertaken, a wide literature survey was done. A lot of literatures related to lean and value management techniques have been reviewed. After reviewing literatures , questionnaire was prepared for data collection and suitable analysis techniques were used to find important factors to be implemented for achieving the best value for customer by eliminating waste.

*A. Questionnaire*

Structured questionnaire was prepared for collecting data from workers in construction industries. Almost 22 factors regarding lean and value management were considered for further analysis process. The following factors were taken from questionnaire

1. Awareness and knowledge about LM and VM
2. Frequency of site visit
3. Transportation time spent
4. Percentage of unused material
5. Time frame for material order
6. Duration of material stored in site
7. Handling of leftover material
8. Delay in work process
9. Reasons for delay Work process wasted
10. Recalculation of resources
11. Meeting with team members
12. Opinion about VM
13. Stage for executing VM
14. Factor influencing selection of alternative in VM
15. Effective VM method Impact of adopting VM
16. Challenges for implementing VM
17. Improvements taken for customer satisfaction
18. Determining customer value
19. Communication to suppliers and clients
20. Status of employee suggestions
21. Value of recycled service/product
22. Relationship between LEAN and VM

*B. Analysis of Questionnaire survey*

The next process after data collection is analysis of data. Quantitative analysis was done for questionnaire survey.

Two types of quantitative analysis were carried out.

1. Descriptive analysis
2. Inferential analysis

*C. Descriptive analysis*

Descriptive statistics is the exploration of data that aids to narrate and outline data in a significant way. It is an easy way to express our data. It is used to describe a situation. Descriptive statistics is very important to present our raw data in effective way using numerical calculations or graphs or tables.

*Types of Descriptive statistics*

1. Measure of Central Tendency
2. Measure of Variability

*1) Measure of central tendency*

A measure of central tendency is an exclusive value that can endeavor to represent a set of details by recognizing the middle position within that set of data.

a) Mean
b) Median
c) Mode

*a) Mean*

The mean is the average of a data set collected. It is the most accessible and conventional standard of central tendency.

*b) Median*

The median is intermediate value of the given data set. To find the median, data points are arranged in ascending order and then the middle number is found.

*c) Mode*

The mode is the most customary number in a data set. Mode is the only measure of central tendency that can be used for definite data.

*2) Measure of variability*

A measure of variability is a condensation of statistics that constitutes the proportion of dissipation in a dataset.

I. Standard deviation

II. Coefficient of variance

a) Standard deviation

The standard deviation is the standard or typical difference between each data in data set and the mean value of data set.

b) Coefficient of variance

It is a respective standard deviation which is a systematized measure of dispersion of a probability distribution. It is expanded as the ratio between standard deviation to mean.

$$CV = \sigma/\mu$$

Where $\sigma$ = standard deviation and $\mu$ = mean.

*Inferential statistics*

In inferential statistics projections are assembled by taking sort of data. It can be described as an arbitrary sample of data taken from a population to define and produce assumption about the population. It acknowledges us to differentiate data, produce hypothesis and predictions. It is used to explicate the chance of happening of an event.

a) Relative Importance Index ( RII )

RII is the most customary method of determining the relative importance among every determined factor. It is calculated by using the following formula

$$RII = \Sigma(ax)/A\times N$$

Where, a = weights given to every response, ranging from 1 (first scale or lowest scale) and expanded numerically by addition of 1 till the last scale (Highest weight),

X=Frequency of occurrence of "a",

A=Highest weight and N=Total number of respondents

b) Chi-square test

The chi-square test of goodness of fit test is used to determine whether there is a significant difference between factors. Significance value of 0.05 was used to test the differences. Chi –square value can be computed from the following formula

$$\chi 2 = \Sigma (Oi - Ei)^2 / Ei$$

Where , Oi = observed frequency, Ei = expected frequency

c) Content analysis

Content analysis is an investigation tool used to establish the presence of definite words, themes, or concepts within some given qualitative data.

*D. Questionnaire survey*

The questionnaire was sent to 50 respondents, however, a total of 36 responses were received back. Preliminary investigation is carried out for the decisiveness of the survey. A total of 36 responses were kept for further analysis making a response rate of almost 72% which is considered.

Out of the 36 respondents who responded to the questionnaire, 6% were from Assistant managers, 8% from Billing engineers, 8% from the Construction managers, 11% from Design engineers, 3% from Draughtsman, 8% from Executive engineers, 6% from Project directors,8% from Project managers,6% from Proprietor,22% from Site engineers,8% from Supervisors and 6% from Trainee engineers.

The bulk of the respondents (66%) have an average experience between 11-15 years and 5-10 years. Whereas 17% have experience for less than 5 years and 14% have experience between 16-20 years. The minimum response rate (3%) was from respondents having more than 20 years of experience.

*Analysis theme*

The collected data were analyzed using Descriptive statistics, relative importance index (RII),Chi-square test and content analysis.

Table 1 Analysis theme

| **Response type** | **Descriptive analysis** | **Chi Square a= 0.05** | **Content Analysis** | **RII** |
|---|---|---|---|---|
| Single option | ✓ | ✓ | | |
| Multiple option | ✓ | ✓ | | |

| | | | | |
|---|---|---|---|---|
| Open ended | | | ✓ | |
| Likert Scale-Multiple cells and Single cell (Factor analysis) | | | | ✓ |

## III. FINDINGS

From the table and histogram, it is clearly known that most of the respondents are not having awareness and knowledge about lean and value management. Degree of knowledge about both lean and value management is dependent based on the different position of employees in construction industry.

Table 2 Response percentage for awareness and knowledge

| Categories | Having Awareness and Knowledge | Lack of Awareness and Knowledge |
|---|---|---|
| Lean management | 44% | 56% |
| Value management | 33% | 67% |

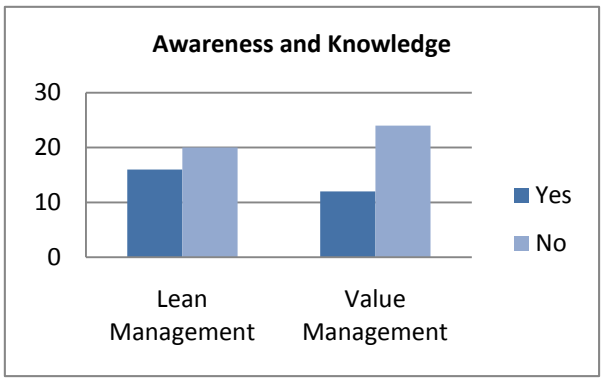


Fig 1 Awareness and Knowledge

*A. Relationship between LM & VM*

Chi-square test was done for checking the relationship exists between awareness and knowledge about lean and value management. The table shows that there is some association exists between awareness and knowledge of lean and value management.

From this preliminary factor analysis,there is a necessity for implementing lean and value management in construction industries.Further analysis for factors were carried out.

Table 3 Chi square test for awareness and knowledge

| Categories | Chi square (@ 0.05 Sig) | Conclusion |
|---|---|---|
| **Awareness and knowledge** | | |
| Lean Management | 0.935 | SE at 0.05 sig that there is some association exists between awareness and knowledge of Lean and Value management |
| Value Management | | |

*B. Measure of central tendency*

Mean,median,mode values were calculated for all 22 factors. After calculating the values, top 10 factors were determined.

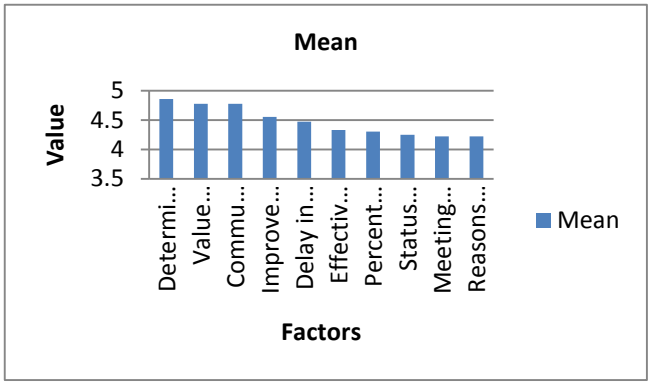


Fig 2 Mean value for important factors

*C. Measure of variability*

Standard deviation and coefficient of variance values were calculated for all 22 factors. After calculating the values, top 10 factors were determined.

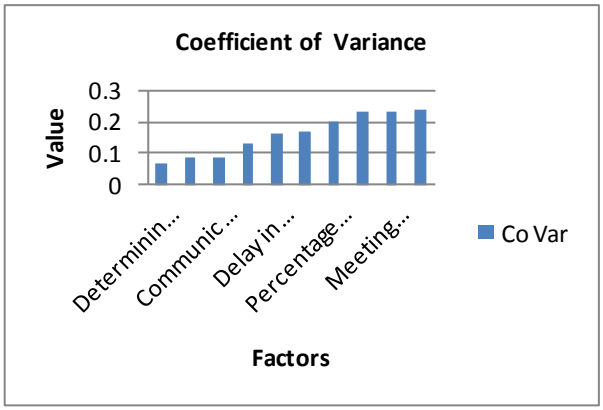


Fig 3 Coefficient of variance

*D. Relative importance index*

Relative importance index values were determined for finding relationship among all implementation factors.RII values for most important factors were shown here.

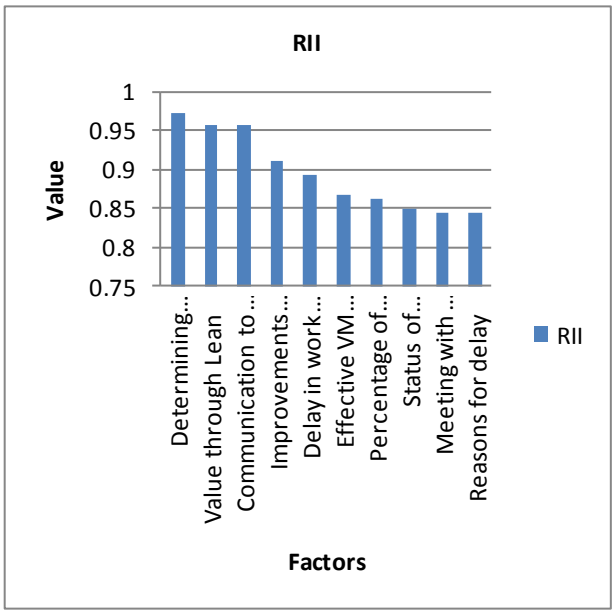


Fig 4 Relative Importance Index

Table 4 RII

| Factors | RII |
|---|---|
| Determining customer value | 0.972 |
| Value through Lean | 0.956 |
| Communication to suppliers and clients | 0.956 |
| Improvements taken for customer satisfaction | 0.911 |
| Delay in work process | 0.894 |
| Effective VM method | 0.867 |
| Percentage of unused material | 0.861 |
| Status of employee suggestions | 0.850 |
| Meeting with team members | 0.844 |
| Reasons for delay | 0.844 |
| Duration of material stored in site | 0.833 |
| Work process wasted | 0.822 |
| Time frame for material order | 0.822 |
| Stage for executing VM | 0.817 |
| Impact of adopting VM | 0.811 |
| Handling of leftover material | 0.806 |
| Value of recycled service/product | 0.806 |
| Frequency of site visit | 0.783 |
| Recalculation of resources | 0.778 |
| Challenges for implementing VM | 0.756 |
| Transportation time spent | 0.739 |
| Factor influencing alternative in VM | 0.706 |
| Opinion about VM | 0.700 |

*E. Important factors*

In descriptive analysis,both measure of central tendency and measure of variability were calculated for all factors. Based on the calculated values from descriptive analysis,the most important factors to be implemented first in construction industries were detected by ranking system.

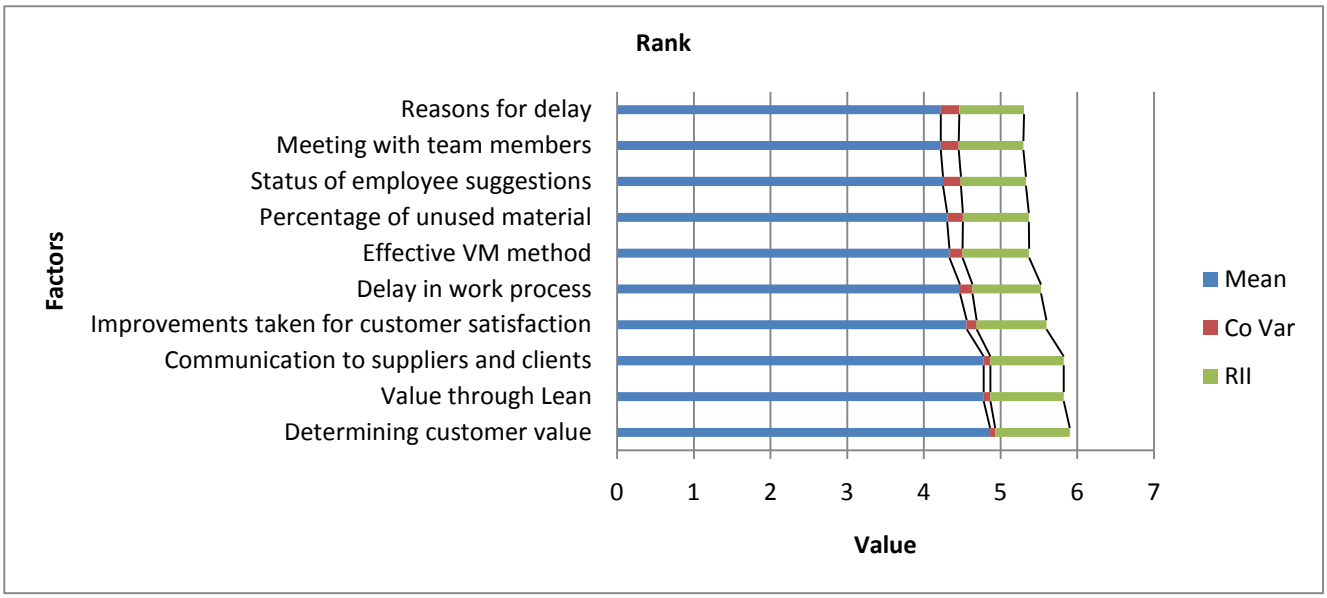


Fig 5 Important factors based on rank

*F. Content Analysis*

Table 5 Theme analysis

| **Themens** | **Codes** | **Frequency** | **Proportion** |
|---|---|---|---|
| Waste reduction | W | 7 | 19 % |
| Cost saving method | C | 5 | 14 % |
| Customer satisfaction | S | 4 | 11 % |
| Valuable | V | 7 | 19 % |
| Ignorance | I | 13 | 36 % |
| Total36 | | | 100 % |

*G. Chi-square test*

Most imporant factors were priorized based on ranking system.Chi square test was done for all factors.Results obtained from chis square test were shown for top 10 factors.

Table 6 Chi square test

| **Categories** | **Chi square (@ 0.05 Sig)** | **Conclusion** |
|---|---|---|
| **Determining Customer value** | | |
| Regular survey from customers | | SE at 0.05 sig that Customer value can be determined |
| Occasionally | 46.167 | |
| Never ask customers | | by **Regular survey from customer** |
| **Categories** | **Chi square (@ 0.05 Sig)** | **Conclusion** |
| **Value through Lean** | | |
| 0-10% | 105.333 | SE at 0.05 sig that Value can be obtained by implementing Lean was achieved as **76-100%** |
| 11-25% | | |
| 26-35% | | |
| 36-50% | | |
| 51-75% | | |
| 76-100% | | |
| **Communication to suppliers and clients** | | |
| Yes.We have a great communication stream | 34.667 | SE at 0.05 sig that Communication to suppliers and clients should have a **Great communication stream** |
| We have a fair relationship,but sometimes there are errors and mishaps | | |
| Always errors and mishaps | | |
| **Improvements taken for customer** | | |

| satisfaction | | |
|---|---|---|
| 0-10% | 69.333 | SE at 0.05 sig that **76-100%** Improvements have been taken for customer satisfaction |
| 11-25% | | |
| 26-35% | | |
| 36-50% | | |
| 51-75% | | |
| 76-100% | | |

| Categories | Chi square (@ 0.05 Sig) | Conclusion |
|---|---|---|
| **Delay in work process** | | |
| 0-10% | 56.181 | SE at 0.05 sig that only **0-10%** delay is occured in all work process |
| 11-25% | | |
| 26-35% | | |
| 36-50% | | |
| 51-75% | | |
| 76-100% | | |
| **Effective VM method** | | |
| Value management workshops | 21.222 | SE at 0.05 sig that **All three methods** are effective for achivement of anticipated project performance |
| Value engineering change proposal | | |
| Lifecycle costing | | |
| Combination of a,b,c | | |
| Other | | |
| **Percentage of unused material** | | |
| 0-10% | 47.000 | SE at 0.05 sig that Average percentage of unused material for the entire project is **11-25%** |
| 11-25% | | |
| 26-35% | | |
| 36-50% | | |
| 51-75% | | |
| 76-100% | | |
| **Status of employee suggestions** | | |
| Yes.We ask lot of inputs from employees and update them | 18.000 | SE at 0.05 sig that **Lot of inputs should be asked from employees** and it should be updated |
| We try to ask input,but we are so busy | | |
| We never ask input | | |
| No.We don't update inputs from employees | | |
| **Meeting with team members** | | |
| Once a week | 29.278 | SE at 0.05 sig that **Once a week** a meeting should be organized with team members |
| 2-3 times a week | | |
| Daily | | |
| Fortnightly | | |
| Once a month | | |
| **Reasons for delay** | | |
| Failure in planning of time | 13.778 | SE at 0.05 sig that Delay is due to **Bad communication and Delivery of wrong material** |
| Not enough workers | | |
| Bad communication | | |
| Bad preparation of construction plan | | |
| Wrong material is delivered | | |
| Quality of the material is poor | | |
| Material is coming late | | |

## IV. RESULTS AND DISCUSSION

Most of the respondents were not having awareness and knowledge about both lean and value management. Awareness could be provided to workers in order to achieve the best value for money. In addition to that key factors were analyzed for implementing lean and value management in construction industry. Regular survey from customer could help for determining customer value. Almost 76-100% waste reduction will reach the best value for customer satisfaction. Communication to suppliers and clients could be proper for reducing errors. Improvements were taken for Customer satisfaction was suggested as 76-100%. Delay in work process was determined as 0-10%. Bad communication and delivery of wrong material could be the reasons for delay in construction projects. Percentage of unused materials in construction process could be as minimum as 11-25%. In order to know the work progress, once a week the meeting could be organized with team members and lot of inputs could be asked from employees which might be updated in construction process.

*Interpretation of result*

Lean management involves both cost and time factors whereas value management contributes both cost and quality factors. Three factors which are contributing the implementation of both lean and value management are time, cost and quality. By interpreting results obtained from questionnaire, it is clearly observed that the common factor which connects lean and value management is the cost factor. Around 30% of total cost of construction project was saved by adopting value management. Almost the reduction of waste was achieved as 50% in construction process by implementing lean practices. As a result of reducing waste in construction project, the best value for customer satisfaction was achieved as 76-100%. Hence the reduction of waste which will influence the total cost of works will generate the best value for customer satisfaction.

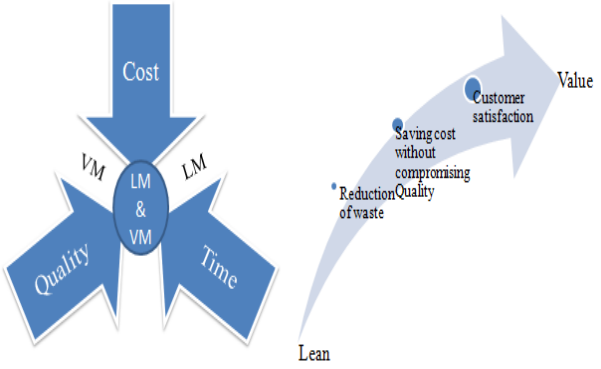


Fig 6 Value through Lean

## V. CONCLUSION AND RECOMMENDATIONS

*Conclusion*

Customer needs are satisfied by reducing waste which will influence the total cost of works from the results obtained from questionnaire analysis. When waste and waste generation factors are eliminated in each and every process of construction works, the utilization of resources will be reduced. So the cost spent on generation of waste will be reduced or eliminated. Customer needs are satisfied while reducing the utilization of resources without compromising the quality. Satisfaction level of customers will be high while utilization of resources will be low. By implementing Lean management in construction, Value management can be created automatically. Hence it is concluded that implementation of Lean and Value management definitely gives the positive results on cost, time and quality.

*Recommendations*

In order to achive the best value for customer needs,it is necessary to implement lean management in construction industries.The following guidelines are suggested to adopt lean and value management in construction works.

1. Awareness of Lean and Value management should be initiated in construction industries.
2. Proper information should be passed among team members
3. Necessary to adopt proper communication with team in order to avoid delay in work process.
4. Time frame for ordering material should be sufficient to avoid ordering errors.
5. Coordination between designers and industries should be proper in order to avoid delivery of wrong material.
6. In order to achieve all objectives, Value management should be executed throughout the project.
7. To avoid wrong construction method, everyday site visit should be carried out.
8. To enhance value (Quality) in construction, Clients' willingness is important to pay for reasonable fee.
9. Recalculation of resources should be done to achieve minimum percentage of unused/left over materials.
10. To avoid Risk at the end of finished project, design team could take a regular survey from customers.

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