Study and Implementation of Lean Construction Management

Aniket Dhundre[1], Dr. G. A. Hinge[2]
[1]Student, Department of Civil Engineering
[2]Vice Principal & Professor, Department of Civil Engineering
[1, 2] TSSM's BhivarabaiSawant College of Engineering &Research, Narhe, Pune.

Abstract- *Low productivity is the chronic problem in construction industry. One way to increase the productivity is to reduce non-value adding activities. Number of problems affecting productivity can be noted when the activities in progress on a typical construction site are closely observed. Productivity improvements achieve higher cost savings with minimal investment. Lean construction is relatively a new construction management philosophy which has evolved from Lean Manufacturing principles. Lean construction along with its various tools like The Last Planner System (LPS), Total Quality Management (TQM), Work Sampling (WS) etc. has gathered a lot of momentum in the developed nations. The challenge now lies in implementing it in the developing countries. The essence of Lean construction is increase in efficiency by elimination of non-value adding activities (Waste). The aim of the project was to implement the Lean construction tools in an ongoing construction project at Palaspa, near Panvel, Navi Mumbai. To identify wastes in construction activities and improve the process flow by eliminating wasteful activities.*

Keywords- Study & Implementation of Lean construction. Productivity, elimination of non-value adding activities.

I. INTRODUCTION

Construction is the key sector for the national economy for countries all around the world, as traditionally it took up a big portion in nation's total employment and its significant contribution to a nation's revenue as a whole. However, until today, construction industries are still facing numbers of contingent problems that were bounded to be resolved since the past time. The chronic problems of the construction are well known such as Low Productivity, Poor Safety, Inferior working conditions etc.

Now a days, increasing foreign competitions, the scarcity of skilled labor and the need to improve construction quality are the key challenges faced by the construction industry. Responding to those challenges imposes an urgent demand. With the lean construction paradigm, construction industry had started to be reviewed and evaluated the possibilities of implementing this new lean perspective of production concepts in the construction process to optimize the overall construction performance on construction stage as well as design stage. Performance Improvement opportunities in construction can then be addressed by adopting waste identification/reduction strategies in the flow processes in parallel with the value adding strategies with the introduction of new management tools and with proper training and education programs. Unfortunately, these new lean Construction concepts especially those on wastes and values most of the times are not well understood by construction person. Particularly, waste is generally associated with the waste of materials in the construction processes while non-value adding activities such as inspection, delays, transportation of materials and others are not recognized as waste. As the result of that, productivity of construction industry cannot be fully optimized.

Lean Construction is a philosophy based on the concepts of lean manufacturing. It is about managing and improving the construction process to profitably deliver what the customer needs. Because it is a philosophy, lean construction can be pursued through a number of different approaches. This Research thesis outlines the elements of lean manufacturing and suggests show these might be adapted to deliver lean construction in practice.

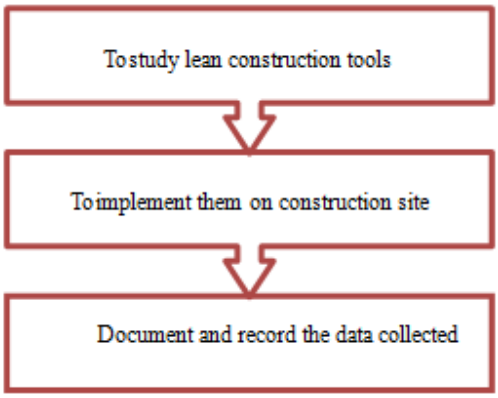
II. OBJECTIVES OF STUDY

1. To identify the amount of time spent by labors in different wasteful activities through implementation of work sampling.
2. To monitor and acquire the productivity of labors using daily progress report.
3. To identify wastes from the current process in construction by preparing the current state map and propose a future state map.

III. METHODOLOGY

1. Work sampling study will be carried out at the construction site for different RCC activities.

2. The productivity of labors will be monitored through the daily progress reports for different RCC activities and analyzed.
3. Waste will be identified from the current state map and more efficient future state map will be proposed for the RCC works of a typical slab.
4. Methods for data collection include direct observations, discussions and interviews. Site Observations were made for different construction activities and discussions were held with the site supervisors, site engineers, and project manager having experience more than five years during the study period. Figure shows the methodology adopted for data collection.



Methodology adopted for the data collection

IV. DATA COLLECTION

The scope of the study is to understand the philosophy of lean construction, lean construction tools, different types of wastes, and implementation of lean construction tools in construction industry.

The study focuses on the undergoing construction site of A square associates PalaspaNavi Mumbai. Due to site accessibility and availability of information.

V. ANALYSIS OF DATA

The following are the key lean construction tools:
1) The Last Planner System (LPS),
2) Value Stream Mapping (VSM),
3) Work Sampling (WS),
4) Location Based Management System (LBMS)
5) Daily Progress Report (DPR).

Work Sampling:

Work sampling technique has been around since 1935. It is generally conceded that Leonard Henry Caleb Tippett, a British statistician, is the father of work sampling at that time it was used as a method of determining machine down time and its causes. Later this method was broadened to measure inactive time of men and machines to determine the causes and improve them (David F. Rogge et. Al, 1982).

To successfully conduct a work sampling study the following steps must be followed:
1. Establish the study objective;
2. Define the population to be studied;
3. Define the study period;
4. Formulate the activity categories (VA, NVAN and NVA)
5. Establish number of observations; and Develop random observation times.

Site observations for work sampling

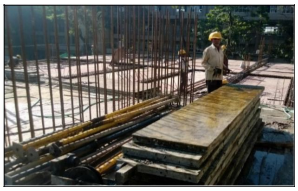
1. Following are the site pictures taken during the observation that shows the value added activitiesfor RCC works


Cutting of bars


Fixing of bars

2. Following are the site pictures taken during the observation that shows the Non value added but necessary activities for RCC works.


Cleaning of formwork


Oiling of formwork

Following are the site pictures taken during the observation that shows the Non value added activities for RCC works


Waiting for Materials/Concrete


Waiting for tools

Work Sampling has three main uses:

1. Activity and Delay Sampling: To measure the activities and delays of workers or machines (e.g. to measure the percentage of the day that a person is working or not working).
2. Performance Sampling: To measure working time and non-working time of a person on a manual task, and to establish a productivity of the person during his or her working time.
3. 3.Work Measurement: To establish a time standard for an operation.

The observations for work sampling show that the 36 observations out of total 173 were non value adding activities. 55 were non value adding but necessary activities and 82 were value adding activities.

RCC WORKS

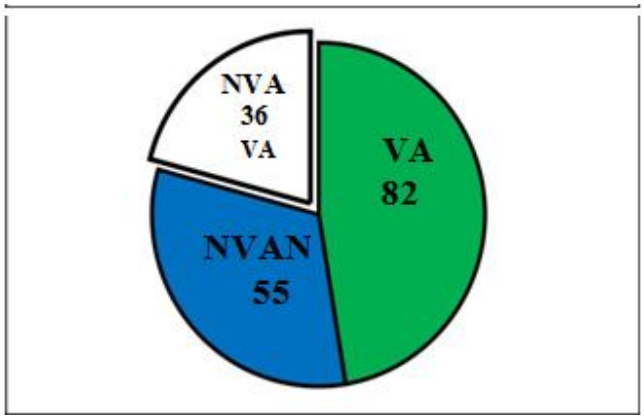


Fig. NVA for RCC works

According to the pie chart, 82 is value added and 55 are non-value added but necessary activities. To improve the work productivity, our only focus is to decrease 36 NVA while identifying the wasteful activities where the labors waste most of their time.

If we breakdown the total 36 observations of non-value added activities we get, 14 observations were 'Late Start/Early Quit/ Unavailability of labours, 9 were 'Break', 8 were personal talking and 5 observations were waiting It is shown in percentage in figure.

RCC WORKS

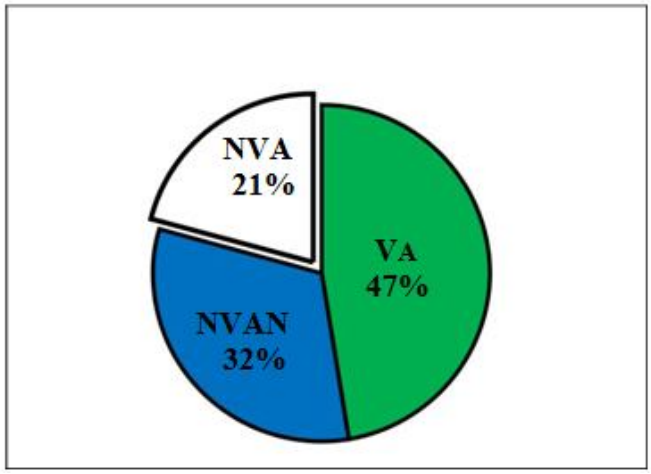


Fig: NVA for RCC works (Percentage)

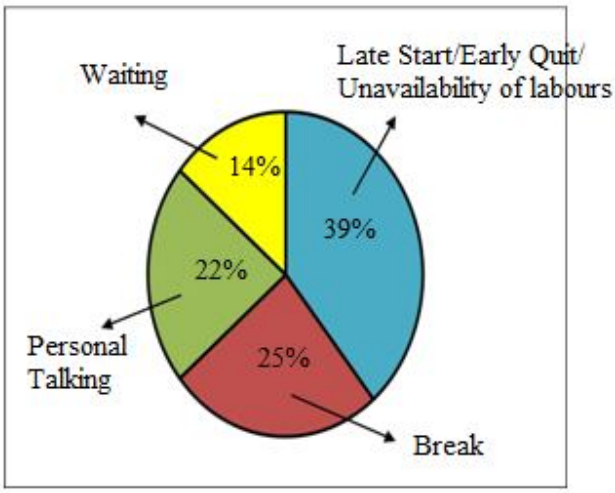
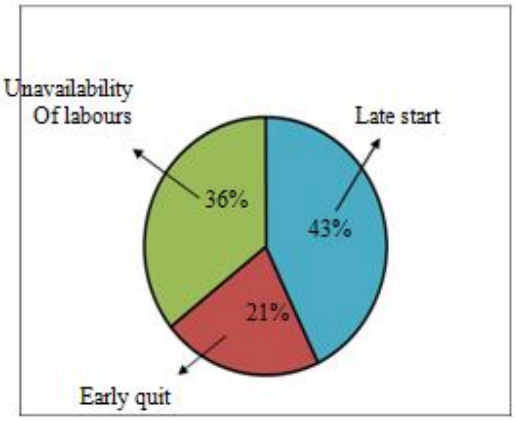


Fig. First Break down of NVA

Breaking down the 14 observations of Late Start/Early Quit/ Unavailability of labours, it was found that 6 observations were 'Late Start', 3 observations were 'Early Quit' and 5 observations were 'Unavailability of Labours'

Late Start/ Early Quit/ Unavailability Of Labours



Break down of Late Start/ Early Quit/Unavailability of Labours Understanding of Productivity:

It is apparent from this mathematical formula that increasing Output under the same amount of Input or decreasing Inputs, while keeping the original volume of outputs, can increase productivity. In the construction industry, the reduction of man-hours in the completion of a unit of work is an example of increasing productivity by decreasing inputs. Productivity of a construction operation is defined as the output of system per unit of time.

The main outcome from the literature is that there is no standard definition of productivity. This study provides guidelines for necessary steps required to improve construction labor productivity.

Value Stream Mapping:

Due to the unique nature of most on-site projects, it can often be difficult to define generic production steps that are adding value. This is perhaps more evident in civil engineering construction projects as value is often viewed differently by different participants. Also, the time between award of contract and start of the construction work is normally short. Even though the construction process is not standardized and needs to be re-developed each time, the contractors focus is not to plan and optimize the on-site building process. Several productivity also indicates that there is much waste generated on construction sites

.

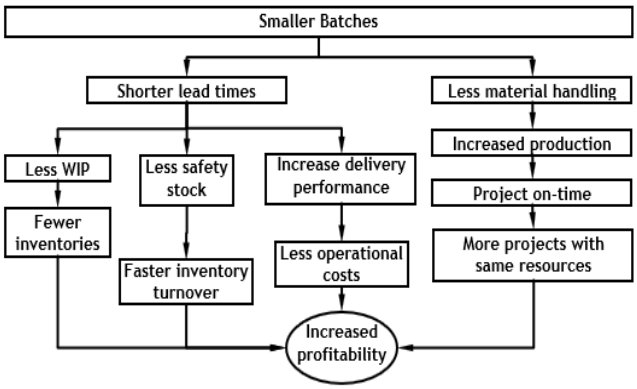
Value Stream Mapping (VSM) is a special type of flow chart that uses symbols known as “the language of Lean” to depict and improve the flow of inventory and improve the flow of inventory and information.

VSM is divided into,

1) The Current State Mapping,
2) The Future State Mapping.

Work Flow:

The key to improving on-site construction is in the management of flow of materials, resources and information. For this, site management must be trained to differentiate between value adding and wasteful activities and hence, eliminate waste from the construction process.



Economic benefits of Improving lead time, reducing inventories and lowering manufacturing costs.

Value Stream Mapping (VSM), originating from the manufacturing industry, is often used to visualize material and information flows and to make these flows transparent for the whole organization (Peter Simonsson et al., 2012). The VSM methodology should also be readily applicable to the unique nature of civil engineering projects and useful as a tool to help on-site construction practitioners see the flow of work.

Identification of wastes in the current process

According to the present state map, the 5.5 T steel is ordered 11 days before the execution of work. Steel is received on the 7th day of order.

Fig. Steel Inventoryfig. Securities At Inventory

Once the raw steel is received at the steel yard, which is at 100 meter distance from the construction site, it is sent for cutting/bending according to the bar bending schedule. To cut and bend the quantity of 5.5 T steel, 2 days and 5 labours are required. Shifting of cut/bent steel of 5.5 T steel to the construction site takes 2 days for 2 labours.

Daily wages paid to the semi-skilled labour for cutting and bending of steel is Rs. 300. So, for 2 days, wages paid to each labour is Rs.600. Therefore, total money spent for cutting and bending of 5.5 T steel is Rs. 3000.

Daily wages paid to the unskilled labour for shifting of steel is Rs. 270. So, for 2 days, wages paid to each labour is

Rs. 540. Therefore, total money spent for shifting the steel of 5.5 T is Rs. 1080. So, total money spent after cutting, bending and shifting of steel is,
Rs.3000 + Rs. 1080 = Rs.4080 and the whole process took 11 days.

DAILY PROGRESS REPORT:

The analysis of daily progress report gives the productivity of labors for different activities. The productivity gives the actual picture of work at construction site. No. of resources required to perform any activity can be found with the help of productivity of labors. The amount of work to be carried out is divided with the productivity of labor gives the no. of resources required to perform that activity.

Losses in construction labor productivity have often been attributed to poor management of construction projects. Construction professionals and academicians have voiced the need of proper management to achieve productivity improvement. These results would enable the construction manager to focus on the NVA and to take some steps to reduce them to increase the labor productivity. It would indirectly help to save project time as well as the cost of the project. Here, few recommendations were given to the management to reduce the Non-value added activities on this typical construction site.

Table shows the productivity of Male coolie, Carpenter and Helper for each day during the study. To carry out the shuttering work, these labours are required. The overall productivity is 46.65 m^2 for 12 observations. Therefore, the average productivity of labour for the shuttering works is 3.80 m^2

Productivity for shuttering works

Date	Male Coolie (m^2)	Female Coolie	Carpenter (m^2)	Fitter	Mason	Helper (m^2)	Overall Productivity
17/02/2017	15.53	-	6.31	-	-	101.00	4.29
18/02/2017	15.00	-	6.00	-	-	-	4.28
19/02/2017	14.09	-	5.34	-	-	77.50	3.69
20/02/2017	14.44	-	5.65	-	-	65.00	3.82
21/02/2017	16.50	-	6.60	-	-	82.50	4.46
22/02/2017	13.62	-	5.45	-	-	109.00	3.75
23/02/2017	11.00	-	5.00	-	-	-	3.44
03/03/2017	16.25	-	6.50	-	-	65.00	4.33
04/03/2017	12.22	-	5.00	-	-	36.66	3.23
07/03/2017	10.28	-	5.53	-	-	72.00	3.42
09/03/2017	10.83	-	5.90	-	-	65.00	3.61
10/03/2017	12.00	-	5.00	-	-	60.00	3.33

Average Productivity = 45.65 ÷ 12 = 3.80 m^2

Table 4.2 shows the productivity of Fitter and Helper for each day during the study. The overall productivity is 0.768 ton for 12 observations. Therefore, the average productivity of labour

Table 4.2 shows the productivity of Fitter and Helper for each day during the study. The overall productivity is 0.768 ton for 12 observations. Therefore, the average productivity of labour for the reinforcement works is 0.064 ton.

Productivity for Reinforcement works

Date	Male Coolie (m^2)	Female Coolie	Carp (m^2)	Fitter	Mason	Helper (m^2)	Overall Productivity
17/02/2017	-	-	-	0.05	-	1	0.052
18/02/2017	-	-	-	0.05	-	1	0.052
19/02/2017	-	-	-	0.06	-	0.5	0.055
20/02/2017	-	-	-	0.09	-	1.25	0.089
21/02/2017	-	-	-	0.06	-	-	0.066
22/02/2017	-	-	-	0.08	-	1.25	0.080
23/02/2017	-	-	-	0.08	-	1.25	0.075
03/03/2017	-	-	-	0.07	-	2	0.071
04/03/2017	-	-	-	0.08	-	-	0.083
07/03/2017	-	-	-	0.03	-	-	0.038
09/03/2017	-	-	-	0.05	-	1	0.055
10/03/2017	-	-	-	0.05	-	1	0.052

Average Productivity = 0.768 ÷ 12 = 0.064 ton

The Project Manager and other key Project personnel must record Project information for daily progress report including

1. Project Name, Location, Date and the description of the Work
2. Estimated quantities performed that day.
3. Comparison between scheduled work activities (from Contractor's schedule) and actualwork activities.
4. Weather
5. Days or periods when no work is in progress or no work was accomplished.
6. Statement of Ready Mix Concrete

Data collected during the observations were,

1. Nature of work
2. Quantity of work planned (at the beginning of work)
3. Quantity of work achieved (at the end of work)
4. No. of resources required to perform the work.

This analysis will give the productivity of labours for Reinforcement works, shuttering works and concreting Works.

VI. CONCLUSION

- Labour productivity is one of the least studied areas within the construction industry.
- If the productivity is improved at the micro level, it reduces or decreases the unit cost of project and gives overall best performance of project.
- Effective use and proper management regarding labour is very important in construction operations without which those activities may not be possible.
- The study results show that the great amount of time in construction industry is wasted in the non-value added activities which causes high construction project costs and delayed project delivery time.
- A very good result can be achieved in the productivity if the labours, management team and contractors make a team effort to reduce non-value added activities in the construction work.
- The study results confirm that majority of the construction labour productivity losses arise as a result of managerial inefficiencies. Construction managers should change the traditional approach and take some steps to reduce the non-value added activities to improve the labour productivity.

REFERENCES

[1] R. Sacks1; A. Esquenazi2; and M. Goldin3 (2007); "LEAPCON: Simulation of Lean Construction of High-Rise Apartment Buildings." Journal of construction engineering and management ASCE. 133(7); 529-539.

[2] O. Salem, M.ASCE1; J. Solomon2; A. Genaidy3; and I. Minkarah, M.ASCE4 (2006). "Lean Construction: From Theory to Implementation."Journal of construction engineering and management ASCE, 22(4); 168-175.

[3] R. Sacks1; M. Treckmann2; and O. Rozenfeld, Ph.D.3,(2009). "Visualization of Work Flow to Support Lean Construction." Journal of construction engineering and management ASCE, 135(12):1307-1315.

[4] Stan J. Tuholski, Ph.D., S.E.1; A. Petek Gursel2; Iris D. Tommelein, A.M.ASCE3; and Geoff Bomba, C.Eng.4 (2009). "'Lean' Comparison Using Process Charts of Complex Seismic Retrofit Projects" Journal of construction engineering and management ASCE. 135(4); 330-339.