Implementation of Lean Construction Tools In Construction Sector

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Abstract- *Production management is at the center of lean construction (LC) and keeps running from the project initiation through project handover to maintenance. Several powerful lean production techniques and tools have been developed over the past decade to manage construction projects. Some of these are procedural, some are conceptual, and some are embedded in programming. Besides, while some of these tools are simple, complexities revolves around others, for instance, the last planner system (LPS) is considered complex. This different set of tools is very effective in the hands of managers stimulated by the lean project conceptualization and management. It has been indicated that Danish contractors had increased productivity by 20%, minimized project duration by 10%, expanded efficiency by 20%, and enhanced profitability 20% - 40% on projects where lean principles are adopted. However, no list would be conclusive and accurate for long because innovation is in progress and new techniques and tools emerge constantly. In this study, we identify suitable lean construction tools based on their applicability and ability to control delays in Malaysian construction projects. This study provides construction managements with suitable lean construction tools to build a realistic and rational lean application guide.*

Keywords- Lean Construction, Lean Tools, Construction Project, Lean Production, Applicability

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 problem of the construction are well known such as Low Productivity, Poor Safety, Inferior working conditions etc.

Nowadays, increasing foreign competitions, the scarcity of skilled labour and the need to improve construction quality are the key challenges faced by the construction industry. Responding to those challenges imposes an urgent demand to raise productivity, quality and incorporate new technologies to theindustry. With the lean construction paradigm, construction industry had started to be reviewed and evaluated the possibilities of implementing these 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 personnel.

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 recognised as waste. As the result of that, productivity of construction industry cannot be fully optimised.

Objectives

1) To identify the amount of time spent by labours in different wasteful activities through implementation of work sampling.
2) To monitor and acquire the productivity of labours 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.

- **Scope of Paper:-**

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 Godrej & Boyce, 'GODREJ PLATINUM' at Vikhroli, Mumbai due to site accessibility and availability of information.

- **Expected Outcome:-**

The study seeks to have positive implications on the Indian construction industry. Among them are, the results will enable building organizations to improve construction quality and efficiency through the implementation of the lean construction tools.

- **Lean Principles:-**

"Lean" is essentially about getting the right things to the right place at the right time, in the right quantity whilst minimizing waste and being open and responsive to change. Lean production has an underlying philosophy that, by eliminating waste, quality can be improved, and production times and costs reduced (Kempton,2006). Liker (2004) describes a way of implementing Lean through 14 principles of the Toyota way.

Understanding of Productivity:-

The term of "productivity" is used to donate a relationship between the output and associated input used in the production process. The simplest definition of productivity is the Ratio of output of goods and / or services to inputs of basic resources, e.g., Labour, capital, technology, materials and / or energy. The expression of productivity is calculated by using the following equation:

Productivity = Output / Input

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 oftime.

Productivity is the work hours during a specified time frame divided by the quantities installed during the same time frame. The time frame can be found daily, weekly, or at the end of entire Project (cumulative). This measure is commonly called the unit rate, Randolph (1995).

In another study, productivity is considered as a measurement dimension that sufficiently describes an operators` performance. The productivity in this context represents the quantity produced per operator hour and the number of work cycles performed per operator minute. To judge the level of performance, the actual productivity must be compared with a desired productivity(estimated).

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 labour productivity.

The Case Study:-

SUMMARY OF THE CASE STUDY	
Name of the project:	GODREJ Platinum
Type of the building:	Residential
No. of floors:	G+28
Client:	Godrej & Boyce Mfg. Pvt. Ltd.
Location:	Vikhroli, Mumbai

The case study project, GODREJ Platinum is a G+28 storey residential building which is located at Vikhroli, Mumbai. It is a prestigious undergoing construction project. The figure above shows the location map of the project. The case study duration was four months and due to the limited time framework of research study, three lean tools were selected accordingly for the study and its implementation onsite.

- **Site observations for work sampling:-**

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

(Image: - Cuttingof bars)

(Image: - Fixing ofbars)

(Image: - Fixingofformwork)

(Image: - Concreting)

(Image: - Curing)

- **Data Analysis – WorkSampling:-**

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 addingactivities**.**

Data Analysis – Daily Progress Report:-

The data was collected for RCC works of Upper Basement Slab (Part-1) and Service Floor Slab (Part-1). It includes Shuttering works, Reinforcement works and Concreting. For the analysis of these data, the observations for Shuttering, observations for Reinforcement and observations for concreting were separated and categorised individually.

All the observations for the shuttering works are brought together in a tabular format:-

Productivity for shuttering works							
Date	Male Coolie (m^2)	Female Coolie	Carpenter (m^2)	Fitter	Mason	Helper (m^2)	Overall Productivity
17/12/2013	15.53	-	6.31	-	-	101.00	4.29
18/12/2013	15.00	-	6.00	-	-	-	4.28
19/12/2013	14.09		5.34			77.50	3.69
20/12/2013	14.44	-	5.65	-	-	65.00	3.82
21/12/2013	16.50	-	6.60	-	-	82.50	4.46
22/12/2013	13.62	-	5.45	-	-	109.00	3.75
23/12/2013	11.00	-	5.00	-	-	-	3.44
03/01/2014	16.25	-	6.50	-	-	65.00	4.33
04/01/2014	12.22	-	5.00	-	-	36.66	3.23
07/01/2014	10.28		5.53			72.00	3.42
09/01/2014	10.83	-	5.90	-	-	65.00	3.61
10/01/2014	12.00	-	5.00	-	-	60.00	3.33
Average Productivity = 45.65 ÷ 12 = 3.80 m^2							

Above 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 3.80m^2. For carrying out the productivity of labours for reinforcement works, the observations are put together in a tabular form.

For Reinforcement works, resources required to perform the activities are like, Cutting/bending of bars, shifting of materials, shifting of tools, fixing of bars, putting cover blocks etc.

Productivity for Reinforcement works							
Date	Male Coolie (m^2)	Female Coolie	Carpenter (m^2)	Fitter	Mason	Helper (m^2)	Overall Productivity
17/12/2013	-	-	-	0.05	-	1	0.052
18/12/2013				0.05		1	0.052
19/12/2013	-	-	-	0.06	-	0.5	0.055
20/12/2013				0.09		1.25	0.089
21/12/2013	-	-	-	0.06	-	-	0.066
22/12/2013				0.08		1.25	0.080
23/12/2013	-	-	-	0.08	-	1.25	0.075
03/01/2014	-	-	-	0.07	-	2	0.071
04/01/2014	-	-	-	0.08	-	-	0.083
07/01/2014	-	-	-	0.03	-	-	0.038
09/01/2014	-	-	-	0.05	-	1	0.055
10/01/2014				0.05		1	0.052
Average Productivity = 0.768 ÷ 12 = 0.064 ton							

Above table 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 0.064ton. The observations for the concreting were made for 7 times. Its

observations for daily progress report is put together in the table. Concreting is the most critical activity in RCC works which requires maximum resources.

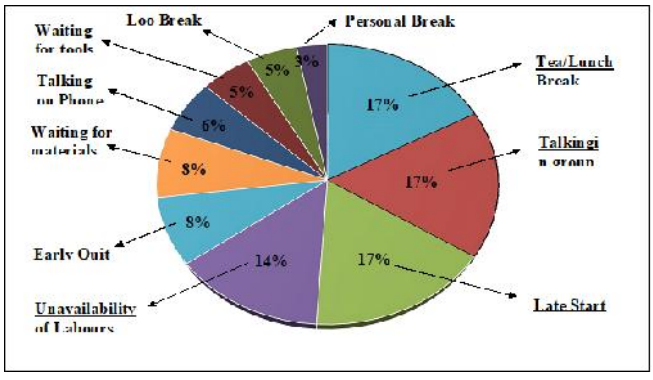
For concreting, Resources required to perform the activities are: (like, concreting, vibrating, turning on/off the pressure pump, holding pipes, RMC transit mixer handling, and other helps etc.)

Productivity for Concreting							
Date	Male Coolie (m^2)	Female Coolie	Carpenter (m^2)	Fitter	Mason	Helper (m^2)	Overall Productivity
18/12/2013	5.46	76.5	-	-	38.25	38.25	4.02
21/12/2013	2.10	10.5	-	-	5.25	5.25	0.87
23/12/2013	0.30	1.75	-	-	0.75	0.75	0.14
03/01/2014	0.29	1.50	-	-	0.75	1.50	0.17
07/01/2014	0.29	1.50	-	-	0.58	1.50	0.16
09/01/2014	0.25	2.00	-	-	0.66	2.00	0.15
10/01/2014	0.25	2.00	-	-	1.00	2.00	0.16
Average Productivity = 5.67 ÷ 7 = 0.81 m^3							

Above Table shows the productivity of Male coolie, Female coolie, Mason and Helper for each day during the study. The overall productivity is 5.67 $m^3$for 7 observations. Therefore, the average productivity of labour for the reinforcement works is 0.81m^3.

Results of Work Sampling:-

This should be an alarming statistic as it is indicating that 21% of the activities are non- value added activities. Ideally, these inefficiencies could be eliminated and the time to perform these processes should be reduced. By being able to achieve this, the construction industry would see a dramatic improvement inproductivity. The result show that the major reasons for 21% of NVA activities for RCC works are,



Losses in construction labour 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 labour productivity. It would indirectly help to save project time as well as the cost of the project.

Results of Daily Progress Report:-

Productivity for RCC works	
Activity	Productivity
Shuttering	3.80 m^2 /Labour/Day
Reinforcement	0.064 T /Labour/Day
Concreting	0.81^3 /Labour/Day

II. CONCLUSION

This case study deals with the reason for low productivity which is the chronic problem in construction industry. One way to increase the productivity is to reduce non-value adding activities. Productivity improvements achieve higher cost savings with minimal investment.

Labour productivity is one of the least studied areas within the construction industry. It is one of the most important factor that affects overall performance of construction industry. There are numerous factors that directly affect the productivity of labour, thus it is important for any organization to study and identify those factors and take appropriate actions for improving the labour productivity. 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.

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. Poor productivity of construction workers is one of the causes of cost and time overruns in construction projects. There can be many reasons behind the poor productivity such as inherent dislike of the work, poor health, social or psychological condition of the worker etc. but the main reason behind that is the workers' attitude towards the work. This result will become worthwhile information in determining the major steps to improve the performance of project completion time and project cost. 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.

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