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APPLICATION OF LEAN MANAGEMENT IN THE CONSTRUCTION INDUSTRY

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Abstract: The Construction Industry is one of the fastest growing industries worldwide and the second largest employer in India after agriculture, engendering a high amount of construction waste. Eliminating or reducing waste could yield prodigious cost savings for the construction industry. Lean production has boosted the performance of the production system against a standard of perfection to meet unique customer requirements. This article discusses the application of lean principles in construction industries through the use of apt tools for lean construction and germane case studies. In order to mend the efficacy and reduction of waste, lean construction has been introduced as a new management principle for enhanced implementation on site. There are many challenges to executing the lean concept in the construction industry. Due to the dearth of consideration and illiterate in the direction of the lean management belief, the owner, contractor, engineers etc. are still in the developing stage to implement this principle on the project. This reading mainly focuses on to recognize the possible wastes that are generated conferring to discernment of diverse project stakeholders on construction sites as well as compendious application of Value Stream Mapping on residential projects. This paper emphasises on implementation of Lean Management at site at Pune which can certainly upsurge the quality of work and profit rate by eliminating the wastage of materials.

Keywords - Lean Management, Construction waste, Optimisation

1. INTRODUCTION

The construction industry is largest industry in India after agriculture. Most of the Indian contractors are not well equipped to handle the growing demand and hence the projects quite frequently run in to time and cost overruns, disputes and lower quality. Another major factor causing delays is the lack of proper "faith" between the contractor and the owner due to which the disputes often end up as litigations and the work stalled (World Bank Report, 2008). The Indian construction industry is also facing a severe resource setback in terms of skilled and semi-skilled man power. Though the above-mentioned problems need noteworthy thought and time, it is crucial that increased emphasis is given to new project management strategies so that the Indian growth story doesn't meet a hasty end. As construction industry gets competitive, thinking and applying Lean to Construction activity is critical to winning customers and ensuring profitability. The aim of Lean Systems is to design, produce and deliver products/services, which exceed customer expectations in terms of Cost/ Quality/Time/Performance. Lean structure is a new way to manage construction. The objective, principles and techniques of lean construction taken together form the basis for a new project deliverance process.

1.1 Lean Management in Construction (Lean Construction):

Lean construction is a mixture of original research and development in design and construction with a mutation of lean manufacturing principles and practices to the end-to-end design and construction process. Unlike manufacturing, construction is a project-basedproduction process. Lean construction is disturbed with the holistic approach of simultaneous and continuous improvements in all dimensions of the built and natural environment: design, construction, maintenance, salvaging, and recycling (Abdelhamid 2007). This approach tries to manage and improve construction processes with the least cost and highest value by considering customer needs. (Koskela et al. 2002). The expression "Lean Construction" was coined by the International Group for Lean Construction in its first meeting in 1993.

1.2 Value Stream Mapping: Value Stream Mapping is a lean device that employs a flow diagram documenting in high detail every assessment of a process. Many lean practitioners see value stream mapping as the primary tool to identify waste, reduce process cycle times, and apply process improvement. Some organizations treat the value stream map as the hallmark of their lean efforts. Value stream mapping can be an essential tool to document processes and remove waste. Every process improvement initiative should begin with a clear understanding of the current routine and an idea of the waste minimization you can achieve

1.3 Wastes in Construction:

Waste is defined as anything which does not added value to the customer. Value-added work is what changes the form or function of the building or structure while non-value-added work or waste is everything else, such as waiting for inspection, movement around the site, and rework. In order to help us see waste within our course, we divide it down further into the 7 wastes Waiting – for materials or specifications for a job before it can start, waiting for others to finish their part of a job, waiting for sign off before moving on further. Over Production – producing more than is required by the customer; in a construction situation this may be working on items which are not on the critical path instead of items which are. Rework – any job which is not to the right requirement or quality and has to be rectified is fritter away. Motion – the movement around the site of the people themselves is not actually adding any magnitude to the site. Processing (over) – doing too much to a job, producing too high a specification when it is not important. Inventory – too much or too little inventory is waste, we need the right amount to enable us to do the job well. Transportation – moving equipment, tools or materials around the site is waste as it does not add value to the construction work

Figure 1. Representation of results of a model

2. LITERATURE REVIEW

Conventional construction consists of all activities as value-adding activities whereas in lean philosophy there are both value-adding and non-value adding activities. Conventional production philosophy focuses on control over cost of activities and lean philosophy focuses on cost, time and value of flows. In conventional practice there is scope of improvement by increasing efficiency using new technologies whereas in lean philosophy improvement can be achieved by elimination or suppression of non-value adding activities, increase of efficiency of value adding activities through continuous improvement and new technology [2].

A lean tool, value stream mapping (VSM), and various other lean concepts were used, electronic versions of the submittals. Part of the coordination effort was eliminated. Activities in the process were reduced from (8 to 5), decrease lead time (40%) and process time (25%). E-copies affected review time of the submittal [3].

The use of Visual Control Management boards on construction sites has shown to improve overall staff engagement, improve quality and reduce safety related incidents. The use of 5S on-site design offices has ensured all work is done using the latest version of design and better organized on-site stores work efficiently on minimum stock and greatly reduced time for staff handling tools and materials at the start/ end of the work shifts [4].

A comparison of data is done by keeping a tally of establishing a Lean Team before and after the implementation of lean principles using PPC (Percent Plan Completion). The key learning from the experience is that for lean to become self-sustainable in a project the implementation efforts have to be initiated by the project team with the command coming from the project leader/manager and not from the senior leaders at head office [5].

Lean principles in local construction industries and came to the conclusion that there are several factors contributing as barriers. According to the research, lack of exposure to the need for lean Construction, uncertainty in the supply chain, the tendency to apply traditional management, culture & human attitudinal issues (mindset issues), lack of commitment from top management, non-participative management style for workforce, attitude, and ability to work in a group, difficulties in understanding the concept of lean construction, fragmentation, and subcontracting, lack of client and supplier involvement and lack of proper training are main factors contributing [6].

3. METHODOLOGY

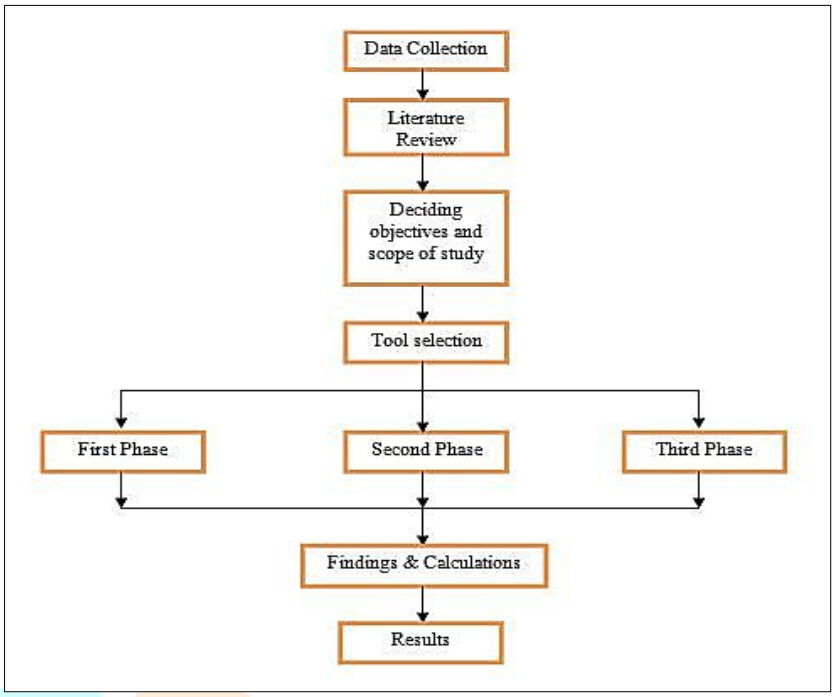

Figure 2. Methodology

3.1 Tool selection:

Lean tools that can be effective were needed to be selected, in this case Value Stream Mapping and implemented in three phases on a construction site.

3.2 Phases:

The three phases will include domains like -
1st Phase- Training on Lean, interviews with Project Managers and Planning Engineer, Questionnaire Surveys.
2nd Phase- Collection of survey responses, analysis of responses, identification of cycle times, resources required, inventory time, lead time and customer demands for each activity.
3rd Phase- Plot current state map and identify value adding activities, analysis of current state map and preparation of future state map.

4. OBSERVATIONS

A questionnaire survey specially designed for easy understanding to Lean or Non-lean practitioners was designed and the data collected was analyzed using a simple tool, Relative Importance Index (RII). A sample of survey responses is attached in the Appendix section.
Relative Importance Index (RII) is a method that is used to identify the relative importance of each factor and parameters included in the survey. This tool is widely used for delay analysis and identification of occupational health risks. Since this statistical tool is very much helpful in ranking the factors, it has been widely used by field experts and organizations to identify their priority factors for which the survey is adopted. The data is collected and is processed in tabular form and the sum of the weights of each factor is divided by the product of the highest point (in our case 5) and number of respondents participating.
In this research, the five-point scale is as follows;
Never-1, Very Rare-2, Seldom-3, Frequent-4, Very Frequent-5

$$RII = \frac{\sum W}{A*N} (0 \leq RII \leq 1)$$

Where,
W = weights given to each factor by the respondents and will range from 1 to 5
A = highest weight (i.e. 5 in this case), and N = total number of respondents i.e. 45 nos.
Responses of different project participants involved in the survey are given in the table below.

Table 1. Ranking of Construction wastes based on survey

Sr. No.	Description	Scores					Weighted Total	R.I.I	Rank
		Never	Very Rare	Seldom	Frequent	Very Frequent			
1	Waiting for Raw Materials	1	5	7	12	20	180	0.8	4
2	Labor/Resources idle for long time	0	2	8	5	30	198	0.88	1
3	Equipments idle for long time without processing	0	0	9	12	23	190	0.84	2
4	Lack of available space for labor gang to work on site	1	3	15	18	8	164	0.73	5
5	Overproduction of concrete	0	2	8	16	19	187	0.83	3
6	Too early fabrication of steel reinforcements	1	13	21	6	4	134	0.6	12
7	Frequent changes in drawings andspecifications	0	15	18	8	4	136	0.6	10
8	Poor design and specifications	1	22	17	2	3	119	0.53	20
9	Lack of planning and control	3	17	12	9	4	129	0.57	15
10	Excessive thickness of plastering, door or window frames, etc.	10	12	8	7	8	126	0.56	16
11	Unnecessary movements done by workers on job site	5	6	10	12	12	155	0.69	6
12	Poor work site-layout	11	12	16	3	3	110	0.49	22
13	Travelling too far on a work site to accomplish the work assigned to worker	10	13	9	7	6	121	0.54	18
14	Over processing on surface finishes	0	23	8	8	6	132	0.59	14
15	Concreting and cleaning of mixer/pump	2	12	11	12	8	147	0.65	7
16	Concrete pump line choke up	1	18	22	3	1	120	0.53	19
17	Cement mortar waste during brick shifting	21	11	4	6	4	99	0.44	24
18	Due to inadequate stock conditions on site	11	12	9	8	5	119	0.53	20
19	Due to robbery, theft or vandalism	8	22	11	3	1	102	0.45	23
20	Deterioration of stocked materials like cement, sand, steel, etc.	2	15	13	11	4	135	0.6	11
21	Ordering materials and resources more than requirement	2	10	16	8	9	147	0.65	7
22	Breaking of fragile materials like glass	3	11	15	9	7	141	0.63	9
23	Bad conditions of pathway for movement ofmaterials from one place to another	5	13	17	9	1	123	0.55	17
24	Stockyard at far distance from installation point	3	17	11	7	7	133	0.59	13

5. RESULTS

The responses shows that the largest rank is of Labour/Resources idle for long time (88%). This is because most project managers and site supervisors fail to identify importance of on-time procurement of materials/resources required for executing the work. Labours mostly remain idle for long time because of delay in arrival of raw materials on-site. This also keeps machines idle for considerable time. Also, most of the time, labours are not informed thoroughly what they are supposed to do. This ultimately causes waiting of resources which is one of the prime wastes in lean. To control such wastes, management must plan each and every arrival of raw material to the site and should also keep some raw materials in inventory, if possible.

Equipments idle for long time before processing takes second position in table with 84% because of the very same reason given above. Delay in arrival of raw materials on site will keep machine idle also. This will not only stop timely production but also will increase time of completion causing further delay to activities planned.

The overproduction of concrete with third place in the table with an almost equal weight of 83% is because even after knowing the possible advantages of ready-mixed concrete, contractors keep swaying towards manual batching and mixing. In manual batching and mixing, chances of production of concrete in ample amounts are very rare nowadays. Ready-mixed concrete provides with exact amount of quantity required for a day's work and management can also keep a record of amount of concrete used per batch. Therefore, contractors or project heads can collectively prompt towards 'Continual Improvement' and capitalize new technologies that can serve them with profits of time and cost.

6. CONCLUSION

Based on the results, a detailed session was done for training. After training of major stakeholders, an action plan was made for the Aluform Construction Technology at the site considering the inputs from the survey as shown in Table No. 2.

Table 2. Action Plan

Sr No.	Description	By Whom	By When
1	Resource and logistic requirements to be assessed by Planning Engineers	Planning Engineer	07-Sep
2	Assign a dedicated person to check and control the flow of activities (including material check)	Contractor	05-Sep
3	Micro schedule should reach the supervisor by contactors PM	Contractor-PM	Immediate
4	Timely inspection and maintenance of the concrete pumps to be done	P&M team	Immediate
5	Idetify the wall elements where caging can be done and to be intimated to Client- PM	Contractor and PMC	05-Sep
6	Frequent training required for carpenters and fitters.	Under KaushalyaVikasYojana of Government of India	Starts from September
7	Upgradation of machinery (from auto level to laser)	SJCPL-PM	16-Sep
8	Proper inventory control should be followed		
9	List of materials and their SS to be decided	PMC	07-Sep
10	Additional concrete pumps to be deployed onsite		Analyses Report To Be Submitted To Client- PM
11	Contractor checking to be done as per the checklist before raising the check call to PMC	Contractor Senior Engineers	Immediate
12	Rewards and recognition for the best performance	Client- PM	Immediate
13	Log sheets to be maintained		06-Sep

As soon as the action plan was acted upon detailed Visual Stream Mapping was done for Aluform Construction Technology at the site in Pune. During the preparation of the baseline schedule, the aluform activity duration was considered to be of 10 days. After Value Stream Mapping, non-value-adding activities were identified and the planned duration of aluform shuttering activity was decreased to 72 hours considering 12 hours of working per day.

Implementation of lean management will reduce the effective duration per slab cycle by 40%. It will also boost labor productivity by 25% and will reduce overhead charges by 40% resulting in increasing in operational profits.

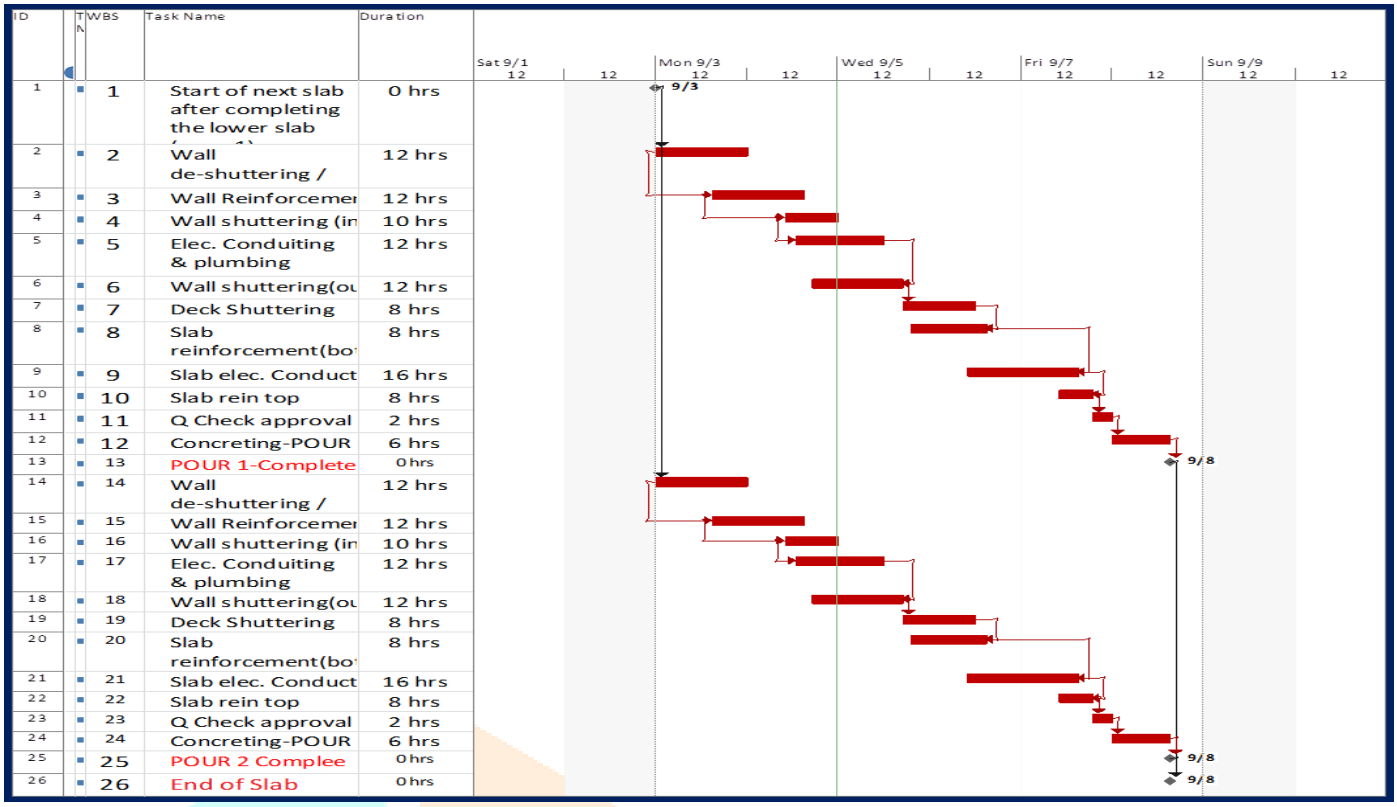

Figure 3. Value Stream Mapping for Aluform Shuttering Activity

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