

Management of Construction using Lean Technique

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Abstract— The Construction industry of India is an important indicator of the development as it creates investment opportunities across various related sectors. The construction industry has contributed an estimated US\$ 308 billion to the national GDP in 2011-12 (a share of around 19%). The industry is fragmented, with a handful of major companies involved in the construction activities across all segments; medium-sized companies specializing in niche activities; and small and medium contractors who work on the subcontractor basis and carry out the work in the field. In 2011, there were slightly over 500 construction equipment manufacturing companies in all of India. The sector is labor-intensive and, including indirect jobs, provides employment to more than 35 million people. 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. After some research the medium and big firms need to look to the developed nations and also China for new strategies and implement them here.

Key words: Lean Construction, Relative importance Index (RII), Lean Based Waste Construction

I. INTRODUCTION

Lean construction is an amalgamation 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 based-production process. Lean construction is concerned with the holistic approach of concurrent 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 minimum cost and maximum value by considering customer needs. (Koskela et al. 2002). The term "Lean Construction" was coined by the International Group for Lean Construction in its first meeting in 1993.

A. Study of the Waste in Construction

Wastes in Construction: Past researchers have identified the following wastes in construction - Waiting for resources, Travelling time movement (of operator or machine), Idle time (of operator or machine), Resting and Rework

1) Identifying Waste:

Value Stream Mapping (VSM) is a good process-mapping tool for identifying waste and studying the flow. The tool focuses on the value stream, helping companies understand the delivery of value to customers. Planning tools, meeting and education are also some of the tools for identifying the waste.

2) Measuring Waste:

The most common measure of waste is time and cost. This is because time and cost are the most critical performance factors in construction. A client and the contractor as well, want the project to be completed on time and on budget.

3) Waste Prioritization:

Prioritization can be made, by using the criteria: Importance, Urgency and Tendency Time and cost are two aspects important for the success of a project and are the most important factors when prioritizing.

4) Potential Effects of a Lean Approach:

The potential effect of a lean approach and the effects of getting rid of certain types of waste are important both in order to prioritize but also to justify the effort put into reducing waste. The effort of reducing waste and trying to become lean must yield a positive net effect.

B. Problem Statement of the Study

- Indian Construction Industry lack knowledge of implementing Lean Philosophy thereby considerable wastes are generated.
- There is no better option available to eliminate process wastes.
- A level of expertise is necessary to evolve more in Profits from the projects.
- Reduction of waste is prominent in any profit maximization theory.
- If there is a break in the chain, lean cannot work there.
- There are certain people in an organization who take interest in transformations and those who don't, oppose the transformation.
- Management has various goals and agendas and therefore they avoid using alternatives for improvement.

For any Lean thinking to be implemented, there are two major aspects; a) engaging teams in the transformation effort, and b) having leaders as mentors, both requires efforts and time to get in picture therefore general avoidance for change is created within the organization.

II. OBJECTIVES

The objective of the proposed system is given below

- 1) To identify and record perception of different construction project participants on lean based wastes on construction sites and quantify them via. Questionnaire Survey.
- 2) To study and demonstrate Value Stream Mapping on residential projects as a Lean Tool and identify possible benefits emerging from application of this tool.
- 3) To increase output value through a systematic consideration of customer requirements.
- 4) To access lean construction technique from the view point of various experts and top management.
- 5) To enhance the quality of the project and profit by minimizing the wastages.

- 6) To examine non-value adding activities from the current state map and then give provision for process improvement in future state map.

III. LITERATURE SURVEY

A. *Alocron, Letal* "Assessing the impact of implementing lean construction" (2006). *Last Planner System and other Lean Construction techniques in over one hundred*

construction projects for five years in Chile were selected for study by author. Benefits of the concerned study was 7% to 48% performance improvement reported by 8 companies along with improved reliability of planning and PPC. The concluding remark by the author was that IT tools can support a more complete and standard implementation LPS. Bygballé, L., E., and Anna Sward (2014). "Implementing Lean Construction: A Practice Perspective". The Lean construction concept is created and recreated as people at various levels in the internal project based organization learn and engage in the new practice. Second, as Lean construction at a project site will involve people from various companies, we also need to consider how the external project based organization would engage in the translation and transformation process of the Lean construction concept.

B. *Ballard G*, 'Bringing Lean into India's Construction Industry', *Indian Lean Construction Conference, Mumbai - ILCC 2015*.

This literature review is an attempt to answer key questions about implementing lean in India's Construction Industry: Why bring lean thinking and practice into India's construction Industry? Heathrow Airport's Terminal 5 began construction in 2001 with a budget in excess of 7 billion British pounds—fully 80% of the airport owner/operators net worth. Glenn Ballard was personally involved in the civil phase of the Terminal 5 project, working as technical director for Strategic Project Solutions, a management consultant for both BAA and Laing O'Rourke, the prime civil contractor. They built their own reinforcing steel fabrication shop at one of the two project logistics centers. 5 days before scheduled pours of reinforced concrete structures, they used Last Planner software from Strategic Project Solutions to request that one of those 3 person detailing teams detail the relevant structure in the model. They decided to begin with the rule: We deliver today what you install tomorrow. That way, every evening when the workers went home, they walked past their next day's work. Once we had their confidence, the lead time was reduced from 5 days to 4. This effectively made detailed engineering the first act of construction, rather than the last act of design, and enabled them to keep on schedule and to save almost 800,000 British pounds in on-site labor. The civil phase was completed on time and 10% under its 1.25 billion dollar budget—a good start for a project that threatened to bankrupt BAA, the airport owner/operator. The \$125 million was shared 50/50 between the owner and all the framework suppliers, from architect to subcontractors. The overall project was completed on time and on budget in 2008.

C. *Devaki M, Jayanthi R*, 'Barriers to Implementation of Lean Principles in the Indian Construction Industry', *International Journal of Engineering Research & Technology (IJERT)*.

The researchers led a comprehensive survey to identify barriers in implementing Lean principles in local construction industries and came to conclusion that there are several factors contributing as barriers. According to the research, lack of exposure on the need for lean Construction, uncertainty in the supply chain, 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 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.

D. *Dhivyamenaga T*, 'Study on Application of Lean Construction - Quality Rating Model to Construction Companies', 2014.

The objective of this study was to assess the application of lean construction of construction companies and give quality rating model to construction companies. The main tool for the collection of data was structured questionnaire. As a result, the performance level of construction companies in relation to the use of Lean Construction was obtained, to check how it was understood and how its principles were applied. After this, the results were evaluated and suggestions were made to the companies to help them implement Lean Thinking. The risk factors influencing Lean Construction are identified by the questionnaire survey and based on overall results were Auxiliary Mechanisms, Last Planner System, Clear Relationship, Production Cells, Multi Purpose Labor Force, Top Management, Documente Procedure and Visual Management. These are all the risk factors which plays major role in Lean Construction in Construction Industries.

E. *Fatima A. et al.*, "Analysis of Lean Construction by Using Last Planner System" (2014).

The objective of the study is to analyze the Last Planner System in reducing the construction complexities involved in the project and to analyze the last planner system to complete the project within the stipulated time and cost and to study the concept of lean construction and how it is being implied in the local construction industry. The researchers kept keen control over project master schedule, look ahead schedule and prepared a weekly work plan for the upcoming works scheduled to be attained. After analyzing the Last Planner system it is observed that there is a saving of Rs.1, 15, 5800.00 for the total project.

F. *Garrett et al.*, "Lean Construction Submittal Process—a Case Study" *Quality Engineering* (2011).

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

G. Harsha N, et al, 'Implementation of Lean Concepts in the Construction Engineering Project', 5 May – 2013.

This paper has strongly addressed the application of lean practices in construction. Overall it was very effective, giving a great summary of what the current state of practice is. But the paper gives a great summary of applicable steps toward becoming lean and likely benefits to a construction organization. Significant research still remains to be complete for the translation of construction to lean thinking. There has however, been relatively little research on case studies, research based on quantitative data or research making categorization of the types of waste that exist in construction. The Last Planner System is briefly explained in above article along with Indian Construction Overview, Analysis of Waste, Core elements of lean construction, Lean Models and case studies of Pacific Contracting and IIT Guwahati.

H. Howell G et al, "Implementing Lean Construction- Understanding and Action", IGLC-1998.

In this paper, authors gave advice on implementation of Lean application. They claimed that implementing lean thinking will lead to change in almost every aspect of project and company management. On the commercial side, begin to form long term alliances with like minds along the value stream. As a citizen of the industry, spend time and effort developing lean thinking in others, even competitors. More than one firm changing to lean has come up against the inability of their suppliers to support lean projects. Once on the way to becoming lean, these suppliers become almost schizophrenic as part of their customers work one way and the others lean. If this advice sounds wrong, it probably means you have not confronted the depth of opportunity and change lean offers you and your organization.

I. Lauri Koskela (1993), "Lean Production in Construction", Elsevier Science Publishers.

In this paper, the concepts, principles and methods of lean production are reviewed, and their applicability in construction is analyzed. The implications of lean production to construction practice and research are considered. Author also described difference between conventional production philosophy and new lean production philosophy. According to author, conventional production 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.

J. Lúcia H., et al, "Lean Techniques and Methodology Applied To UK Road Schemes", Indian Lean Construction Conference - ILCC 2015.

The above article presents how HA of UK has benefited by using Lean Techniques on their Road Schemes and

displayed few examples over it. The Highways Agency (HA) is an executive Agency of the UK Department for Transport (DfT). The UK government has been instrumental in encouraging the UK public sector to find ways to improve efficiency and has launched a Continuous Improvement (CI) initiative across all government departments. The HA has successfully applied Lean Techniques as a driver to delivering CI.

The Author concluded that, from 2009 to date the HA has achieved solid savings by application of Lean methodology in the UK Road schemes. Savings of over £100 Million have been attributed to Lean Intervention. These savings made considerable contribution to the efficiency savings of £114 Million demanded by the UK Treasury. Savings of up to 30% on scheme completion have been reported by encouraging discussions among stakeholders at Collaborative planning meetings. The use of Visual 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.

K. Maitreya Yadav et al, "Implementation and Scaling Up Of Lean Construction Practices at AFCONS", ILCC 2015.

The above article presents the outcome of how the PPC (Percent Plan Complete) rate has changed from adopting lean principles. A comparison of data is done by keeping tally of establishing a Lean Team before and after implementation of lean principles. The key learning from the experience is that for lean to become self sustainable at 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.

Concluded that both the top down and bottom up approaches were ineffective for a full scale lean implementation to become self sustainable. In the presence of continuous monitoring – IITM in case of the Project 1 & Project 2 and lean coordinator in case of PS1-PS9, lean implementation continued successfully.

L. Sonali D, "Benefits of Building Information Modeling (BIM)-A Case Study" ILCC-2015.

Excelize has worked as a BIM Consultant on IT SEZ Projects for TCS at Pan India locations. 4D helped the project to track the schedule and monitor delays, eradicate sequential issues in construction and streamline the construction process. Excelize team linked the project plan (from Primavera) with the BIM model. To the 3D model they added the 4th dimension of time and generated the construction simulation for every activity. This linking was done initially for a base line project plan and routinely updated (every 2 weeks) for actual updates to the project plan. The results show a difference of 2-3 % between the BIM estimated quantities and consumed quantities. Using the model, the Clash Detection & Resolution (CDR), phase of the project was completed in one month as compared to

the three months required using the conventional process. Author suggested that early coordination between structural, Mechanical-Electrical-Plumbing (MEP), architectural consultants and the general contractor reduce the construction cost and project schedule significantly based on the results.

IV. PROPOSED SYSTEM

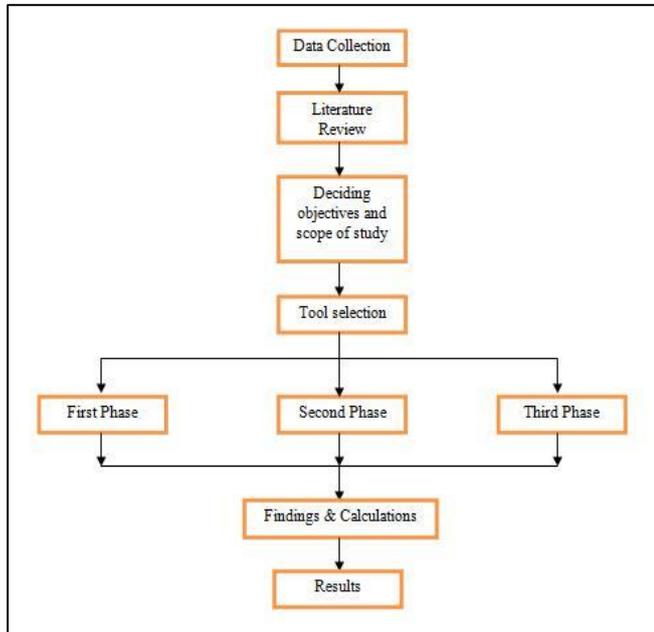


Fig. 1: System Architecture:

A. Data Collection:

Collection of various data, literature and methodologies available in various sources like Journals, Articles and with the help of Internet.

B. Literature Review:

Thorough study of relevant articles, atleast 15, from various nationally and internationally recognized journals showing prior implementation and results that are availed by using Lean Philosophy in Construction industry.

1) Deciding objectives and scope of study:

Based on the literature reviewed, objectives that are important to be implemented for completion of project are necessary to be decided and these objectives will act towards actual completion of project. Furthermore, scope or limitations of this study are also decided well in hand. Scope of study will help in only prioritizing on important factors that are supposed to fulfill the requirements of objectives decided.

C. Tool selection:

After all above works are completed, Lean tools that can be effective to be selected, in this case Value Stream Mapping and implemented in three phases on a construction site.

1) Phases:

The three phases will include domains like;

- 1) 1stPhase: Training on Lean, interviews with Project Managers and Planning Engineer, Questionnaire Surveys.

- 2) 2ndPhase: Collection of survey responses, analysis of responses, identification of cycle times, resources required, inventory time, lead time and customer demands for each activity.
- 3) 3rdPhase: Plot current state map and identify value adding activities, analysis of current state map and preparation of future state map.

2) Findings and Calculations:

By implementing above methodology included are the results that are concluded in this domain. Difference in actual and planned cost and time schedule of studies are observed in this domain.

3) Results:

After all the above domains are completed, results are concluded whether the implementation of Lean will be successful on the concerned construction site or not. Various barriers and implementation problems that were seen during project are also to be studied thoroughly.

V. RESEARCH DATA COLLECTION

A. Interview and Survey Response Analysis

A questionnaire survey specially designed for easy understanding to Lean or Non-lean practitioner was designed and the data collected was analysed using a simple tool, Relative Importance Index (RII). A sample of survey response is attached in Appendix section.

Relative Importance Index (RII) is a method which is used to identify 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 weights of each factor is divided by product of highest point (in our case 5) and number of respondents participating (P Abhiram et al. 2016).

In this research, the five point scale is as follows;

- 1) Never-1
- 2) Very Rare-2
- 3) Seldom-3
- 4) Frequent-4
- 5) Very Frequent-5

VI. RESULTS AND SIMULATION

VII. CONCLUSION

A. Introduction:

With very few exceptions, construction researchers have to date taken it for granted that lean production is a 'good thing'. The assumed neutrality of management techniques reflects a general absence of critical reflection amongst management academics. There have been few attempts to relate concepts such as lean construction to the broader social, moral and political context. This self-imposed restriction to narrow concepts of instrumental rationality is a gross dereliction of academic responsibility. Thoughtfulness is seemingly in terminal retreat in the face of an imposed

ideology. It is not the responsibility of university academics to improve the efficiency of the construction industry. This merely replicates the responsibility of those who work in industry. The primary concern of construction academics should be the development of the industry's intellectual capital. The promotion of thoughtfulness and critical reflection has been neglected for too long. The articulation of a critical perspective on lean construction provides a small step towards correcting the current imbalance. Lean construction results from the application of a new form of production management to construction. This research work has strongly addressed the application of lean practices in construction. Overall it was very effective, giving a great summary of what the current state of practice is and what can be the possible measures to improve the project outcome in future state mapping.

B. Conclusion:

Based on the research work done, it can be easily interpreted that according to different project participants waste in construction is obvious to happen. Since, one cannot control thoroughly on waste from construction but one can strive to control it through different measures and latest innovative techniques.

According to questionnaire responses, it can be actually seen that project participants are very much eager to reduce wastes in construction. These wastes do not only hamper the finance of projects but also many a time viewed as a minus point under the perception of customers.

Based on the survey I, 80-77 % of wastes according to the project stakeholders are directly related by waiting for materials and idle state of labours and resources. This delay in procurement in quantity of resources is mainly due to poor supplier-client relationship or communications. Moreover, management is also responsible for such delays. Tools like Last Planner System and Just-In-Time can be very much helpful in tackling such delays. Ordering materials and procuring them well before the initial execution of the activity will ultimately serve in proper and timely completion of processes.

By going through Survey II which is based on waste sources due to Managerial attributes, it can be judged that many wastes occur on project sites due to management negligence. Poor control of management over project, poor planning and misuse of resources is the major factor which serves as a prominent source of waste in construction projects, either large one or small scale construction. Frequent design changes also lead to dissatisfaction of labours for doing work which many a time serves as a factor in quality degradation of project. Even excessive supervision leads towards workers feeling a bit stressed upon. If the internal customer is not fully satisfied with the way the work is executed then how can be the external customer?

According to case study I, by using Value Stream Mapping, if one can save 65 days from complete construction schedule and save Rs. 21100 per slab manufacturing, then for 5 floors, one can calculate the overall savings for just slab construction. On the other hand, in case study II, practically, duration of particular set of

works got reduced from 15 days to 11.5 days, which is also a good sign from project timely completion point of view.

VSM helps project managers or contractors to successfully track their construction activities. One can implement process improvement strategies and an opportunity can be established for reducing waste on construction sites. These case studies have remarkably shown that the future state map has better demonstrations of improvement rather than current state map.

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