



A CRITICAL STUDY OF VARIOUS LEAN TECHNIQUES IN PRACTICE AND DEVELOPING A FRAMEWORK FOR DIFFERENT CONSTRUCTION BUILDING PROJECTS

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ABSTRACT

The productivity of the construction industry worldwide has been declining over the past 40 years. One approach for improving the situation is using lean construction. Essential features of lean construction include a clear set of objectives for the delivery process, aimed at maximizing performance for the customer at the project level, concurrent design, construction, and the application of project control throughout the life cycle of the project from design to delivery. Lean construction is implemented through various lean-based tools or in other words lean techniques. Implementation of these techniques in simple and complex projects makes the projects easier to manage, safer, completed sooner, and cost less and is of better quality. This paper involves the study of principles, methods, and implementation phases of lean construction showing the waste in construction and how it could be minimized. A field study was conducted to evaluate the effectiveness of some lean construction techniques including last planner, increased visualization, daily huddle meetings and the 5s process. The data collected through direct observations, interviews, questionnaires, and documentary analysis from Indian as well as foreign organizations. Thus, the data obtained is used to develop a framework which will provide an environment for construction organization to survive in any economic condition of our Indian society. Therefore, this project aims at managing the construction site as well as organization efficiently with minimum waste.

Key words: Daily huddle meeting, 5s Techniques, Last planner, Communication, Increased visualization, SPSS (Statistical product and service solutions).

INTRODUCTION

Lean construction much like current practice has the goal of better meeting customer needs while using less of everything. But unlike current practice, lean construction rests on production management principles, the “physics” of construction. The result is a new project delivery system that can be applied to any kind of construction but is particularly suited for complex, uncertain, and quick projects. Lean production was developed by Toyota led by

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engineer ohno. He was a smart if difficult person dedicated to eliminate waste. The term “lean” was coined by research team working on international auto production to reflect both the waste reduction nature of the Toyota production system and to contrast it with craft and mass forms of production. Engineer ohno shifted attention to entire production system from narrow focus of craft production on worker productivity and mass production on machine. Waste is defined by the performance criteria for the production system. Failure to meet the unique requirements of a client is waste, as is time beyond instant and inventory standing idle. Moving toward zero waste, perfection shifts the improvement focus from the activity to the delivery system. Hence waste in construction industry can also be reduced and managed in similar ways by improving the delivery system, in here, it refers to the construction production system.

Managing construction under lean is different from typical contemporary practice because it:

- Has a clear set of objectives for the delivery process
- Is aimed at maximizing performance for customer at project level
- Designs concurrently product and process
- Applies production control throughout the life of project.

Conceptual study

Lean techniques was initially introduced for production system and then extended to construction production system. Hence each lean construction techniques needs to be thoroughly understood and analyzed. Among many lean construction techniques the only suitable techniques for creating our framework are to be selected and analyzed. For analyzing and understanding the lean construction techniques and principles, a thorough literature survey has to be carried out.

- An analytical study by implementing lean thinking in construction and found performance improvement in a project carried out in Egypt. This research confirmed all the principles of lean thinking effectively into construction production process which includes identifying sources of waste, examine general perception of construction industry, reduction and elimination of waste according to lean techniques, improvement on time, material usage, perspective and goal. This paper also proposed a dynamic model of performance improvement process. [Remon Fayek Azis, sheriff mohammed hafeez, Alexandria Engineering Journal (2013) 52, 679–695].

- A study comparing lean techniques for construction with that of for manufacturing which gives detail insight on concept of lean construction process. This paper provides a simple and comprehensive approach that is transferable to any construction project. In this study they proved that lean construction assessment shows an improvement at the end of study in most of lean elements. They also thoroughly analyzed some lean techniques like last planner, daily huddle meeting, first run studies, and fail for safe quality. [O. Salem, J. Solomon, A. Genaidy and I. Minkarah (2010), ISSN: 1555-1369].
- An analysis on waste in construction by using lean and six sigma principles. Primary objective of the study is to derive the reasons contributing to the amount of material wasted on residential building sites, which needs to bring down substantially by devising suitable method. A case study follows that demonstrates, how lean thinking and six sigma principles, tools and techniques be applied to a public and semi government authorities. This study distinctly reveals that each aspect of working needs to integrate to reduce the amount of waste material on site. [Sunil V. Desale, Sharad V. Deodhar (2013)].
- Lean Construction (LC) is aimed at reducing waste, increasing productivity and health and safety in fulfilling the of the construction industry. This paper provided the fundamental knowledge of LC and highlighted its implementation in the construction industry. It was discovered that the knowledge of stakeholders are reasonably significant as the principles of LC is widely implemented in the work field.[Mohd Arif Marhani, Aini Jaapar, Nor Azmi Ahmad Bari (2012), 68 (2012) 87-98].
- Implementation requires action be shaped by a deeper understanding of the goals and techniques. This paper explains the implications of the goals and key production principles, and how when taken together they result in a different way to manage construction. Implementing lean in construction then becomes a matter of developing and acting on this new knowledge. Advice on implementation is offered. [Greg Howell and Glenn Ballard (1998), Proceedings IGLC '98].
- The construction projects involve various risk factors which have various impacts on time objective that may lead to time-overrun. This study suggests and applies a new technique for minimizing risk factors effect on time using lean construction principles. The lean construction is implemented in this study using the last planner system through execution of an industrial project in Egypt. [Usama Hamed Issa (2013), Alexandria Engineering Journal (2013) 52, 697-704].

EXPERIMENTAL

Research methodology

This study aims at creating a framework for the organization to work in a systematic way. Hence, the reason for loss of system in the present environment should be analyzed by collecting data. Techniques also need to analyze completely before creating a framework. The methods used for collecting data were direct observation, interviews with authorities, documentary analysis and questionnaire for complete analysis of all issues. Among these data collection methods, interviews and questionnaire are the most important means for obtaining results of analysis. Hence,

- First approach is to understand the lean construction principles, techniques and governing factors through literature survey.
- Then the present environment of Indian society needs to be analyzed by collecting data through direct observation and interviews. Interviews were taken from site engineers, safety engineers, managing directors, project managers and sales managers. They were interviewed in a manner suitable to the objective of the study.
- Questionnaires were also distributed to obtain systematic and structured data. The first part of the questionnaire contains, demographic questions and second part contains structured questions. The response was given by the project managers, supervisors, site engineers, contractors and labours. The rate of respondents are on a 5 point Likert scale where 1-strongly disagree, 2-disagree, 3-neutral, 4-agree, 5-disagree.
- From this, the respondents were asked to give their opinion for the questionnaire. Through which various waste, factors and ideas about lean technique prevailing was gathered.
- Finally, the obtained data are analyzed using SPSS software and manual method to determine the existing environment scenario and lean technique status.
- This analyzed result was used to create a conceptual framework suitable to present environment eliminating waste and involving lean technique. Initially skeletal framework was prepared to facilitate the proposed framework.

Lean construction principles

Lean construction is a way to design production systems to minimize waste of

materials, time, and effort in order to generate the maximum possible amount of value. The most important determinants of construction are supposed to be workflow reliability and labour flow but lean construction has changed the traditional views of the project as transformation and embraces the concept of flow and value generation. There are five fundamental principles for lean thinking which are to be followed step by step:

- Specify value
- Identify the value stream
- Flow
- Pull
- Perfection

Lean construction is carried based these principles, which aims at incorporating important factors into the construction field, which are:

- Flow variability
- Process variability
- Transparency
- Continuous improvement

Some of the important objective such as cycle time reduction, elimination of waste and variability reduction are achieved by incorporating these factors into the project. Continuous improvement, pull production control and continuous flow have been the direction for implementation of lean construction.

Lean construction techniques

There are various lean techniques that have analysed and adopted throughout the construction research field. Process mapping technique, 5s techniques, last planner technique, increased visualization, fail for safe quality, daily huddle meeting first run studies and many more lean techniques are available. This project is focused on developing a framework for organization survival in any economic condition, therefore, this study deals with main four lean techniques that can monitor an organization completely from site work to office work. The important four technique adopted for this study are: the 5S technique, the last planner technique, increased visualization, and daily huddle meeting technique.

The 5S technique

5S is a systematic technique used by organizations comes from five Japanese words; Seiri (sort), Seiton (set in order), Seiso (shine), Seiketsu (standardize), and Shitsuke (sustain). This system helps to organize a workplace for efficiency and decrease wasting and optimize quality and productivity via monitoring an organized environment. It also provides useful visual evidences to obtain more firm results. There is a real need for empirical studies in field of new management systems and their impact on company's performance. This technique mainly aims standardizing the site work in terms of construction industry, thereby, in order to reduce wastage through rework and time consumption. This helps in improving the production of construction industry efficiently sustaining the systematic manner developed. Fig. 1 illustrates the each element of 5s technique.

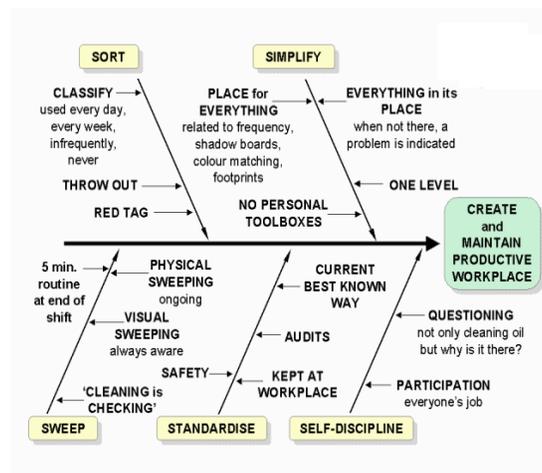


Fig. 1: Representation of 5S technique

Last planner system technique

The Last Planner is the empowered site foreman or other professional who is in direct contact with the work to plan and schedule detailed tasks. Since traditional work planning establishes time frames but cannot effectively establish the tasks that are necessary for project completion or handle works starts or stops, it is the decentralized decision making of the Last Planner who can match labour and material resources to accomplish assignments in response to future demands. The LPS is based on at least three levels of schedules and planning tools: 1) the master pull schedule which identifies major project phases and document milestones; 2) the look-ahead schedule which uses items pulled from the master schedule and is used for work flow control; and 3) the weekly work plan (WWP) provides a

detailed work plan that specifies handoffs at each phase between trades. Fig. 2 illustrates the sequence of last planner system to be adopted in a project.

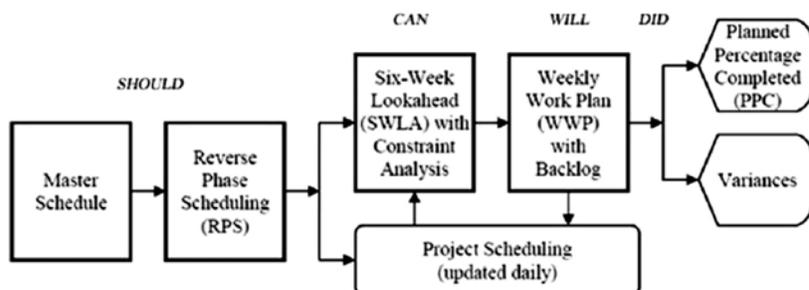


Fig. 2: Sequence of last planner system

Increased visualization technique

Increased visualization is a technique that is adopted to combine the last planner and 5S techniques together. Increased visualization is mainly carried out in order to transfer the information visually more effectively than any other means of communication. There are many ways of communicating visually, which involves charts, boards, kanban cards, software in case of large scale companies- 4D, 5D software are available, this will help to reduce the rework or other problems at site by incorporating everything that has been formulated at the office level.

Daily huddle meeting

The daily huddle requires another change in culture; a culture where the project manager has the discipline to prepare and implement a plan versus the typical culture of waiting for a problem to occur and then reacting to the problem. This planning change is implemented during the execution phase of the project by holding daily meetings to coordinate work activities. The huddle-up meeting is a great communication tool and can be used to address other project issues such as weather, environment, security, quality, or schedule. The huddle-up meeting provides a format to communicate coordination, quality, security, and schedule issues that must be addressed and, like safety, critical issues may require a work pause or stop work order until they are remedied; a warning may be issued for lesser events.

Data analysis

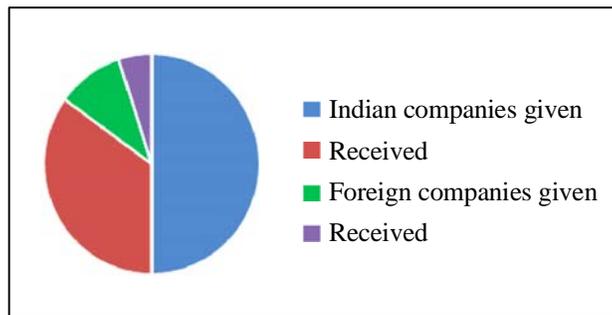
Questionnaire responses

All the respondents are from Chennai city and 5 of them were collected from foreign company namely belonging to Qatar. Approximately fifty questionnaire responses were

collected. The answer were collected mainly from those belonging to middle management level like project engineers, site engineers, contractors, safety engineers, and also sales managers. These respondents were also questioned that is interviewed regarding use of new technologies and wastes occurring in their site experiences. The questionnaire was analyzed in order to understand the need of technique, the type and intensity of waste occurring and mentality of people towards the construction production system. The questionnaire was analyzed using SPSS software to mainly determine the waste in construction production system.

Table 1: Number of respondents

Organization	Questionnaire given	Data collected
Indian companies	50	35
Foreign companies	10	5



Hence, from the Fig. 2 we can infer that most of the questionnaires namely about 70 percentages of them were collected and can be analyzed using SPSS software and other methods of analysis also.

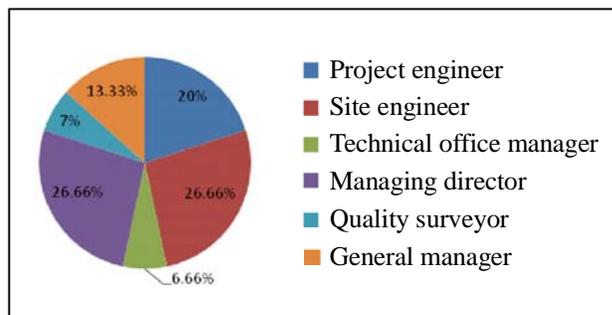


Fig. 4: Respondent's designation

Analysis of data

Data obtained through questionnaires can be summed up based the governing factors and tools such as flow variability, transparency, process variability and continuous improvement each of which has their own impact on lean techniques. Hence data are analysed in terms of lean construction tools. The data obtained where analyzed in:

- Average mean method
- Arithmetic mean method
- SPSS software

Table 2: Summary of average mean method analysis

Problems-category	Observed questions	Mean	Rank
5S Techniques	Arranging tools, equipments and materials according to usage and importance	2.5	3
Increased visualisation	Inserting safety signs in all required and critical spots at site, warning about equipments and accidents	2.9	2
Last planner	Phase-wise planning gives more preferred results than complete future planning	3	1
Huddle meeting	Meetings with site in-charge at start of work on daily basis will sustain the work flow	2.6	4

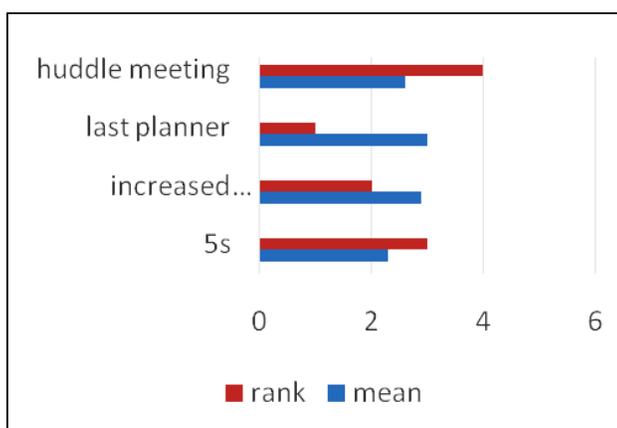


Fig. 5: Bar chart result for arithmetic mean method analysis

Table 3: Summary of SPSS data analysis

Problems-category	Observed Questions	Mean	Rank
5S Techniques	Arranging tools , equipments and materials according to usage and importance	2.5	3.5
Increased visualisation	Inserting safety signs in all required and critical spots at site, warning about equipments and accidents	2.9	2
Last planner	Phase-wise planning gives more preferred results than complete future planning	3	1
Huddle meeting	Meetings with site in-charge at start of work on daily basis will sustain the work flow	2.6	3.5

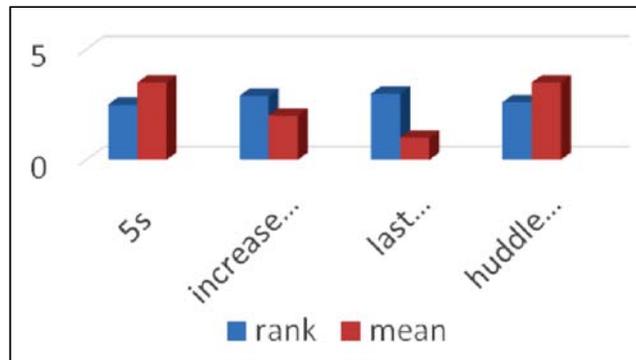


Fig. 6: Bar chart for analyzed result from SPSS

Need for framework of lean techniques

Based on the analysis carried out, we derive out the actual need for lean technique in the analysed area.

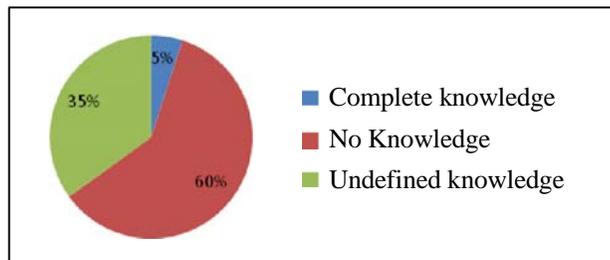


Fig. 7: Knowledge about lean technique

The need are in terms of eliminating waste that involve cost, time, and money whose data were also obtained from the organizations themselves. Initially number of people having idea, having no idea and having confused idea about lean techniques were analyzed.

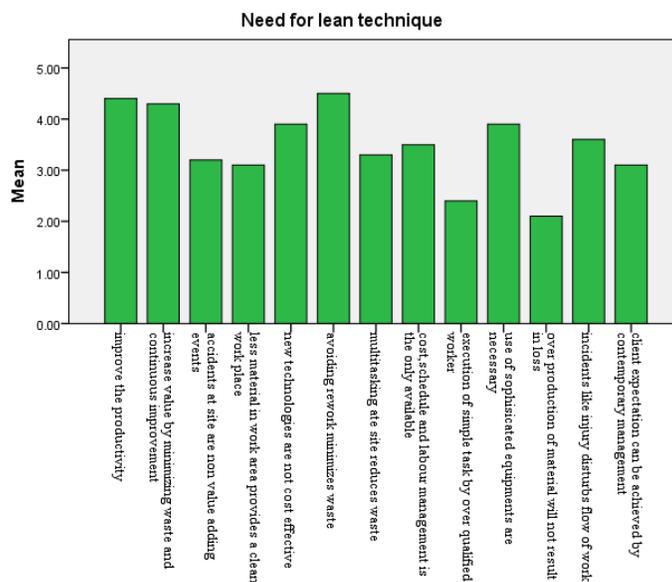


Fig. 8: Need for lean technique

Framework representation

Framework is developed in order provide guidelines for the application of lean construction in accordance with present construction scenario. With help of data obtained through questionnaire and interviews, the important factors and causes for loss, delays, and reduced production have been analyzed thoroughly. The various techniques have been designed in order to eliminate and overcome such waste to provide effective construction production system. Hence these techniques need to applied in field in an organized and systematic manner for which a framework is being proposed (Fig. 4).

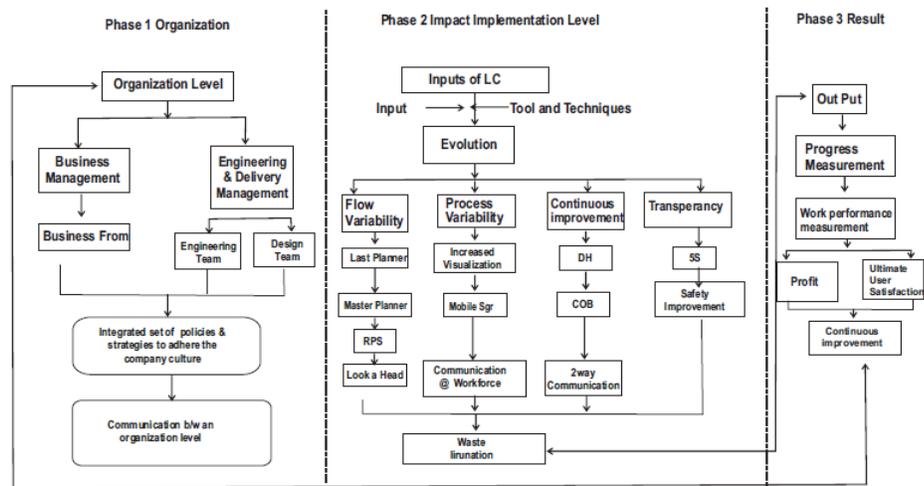
RESULTS AND DISCUSSION

This proposed framework is provided in such a manner that wastes causing the loss in productivity are overcome by incorporating the right technique at right point of construction process. This study emphasises that construction should be carried out in a coordinated transparent manner to avoid all the loss and failure. Hence this proved the

guidelines to be carried out in a contractor's point of view for executing a project. Therefore project manager should keep the site engineer involved and site engineer should keep the labours involved for an efficient system. This study can be further carried out by implementing this framework in any organization and bringing out the profitable result.

CONCLUSION

Lean construction comprises of many techniques but this study focuses only on four main techniques that is increased visualization, 5S technique, last planner technique and daily huddle meeting which are the required technique to modify the present Indian society. These study aims at introducing a system into Indian construction production department to avoid confusion, commotion, delays, waits and loss in productivity. This framework is mainly focused on residential project, it can enhanced to suit any type of projects.



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