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A Critical Literature Review on Implementing Lean Construction Concepts In infrastructure projects

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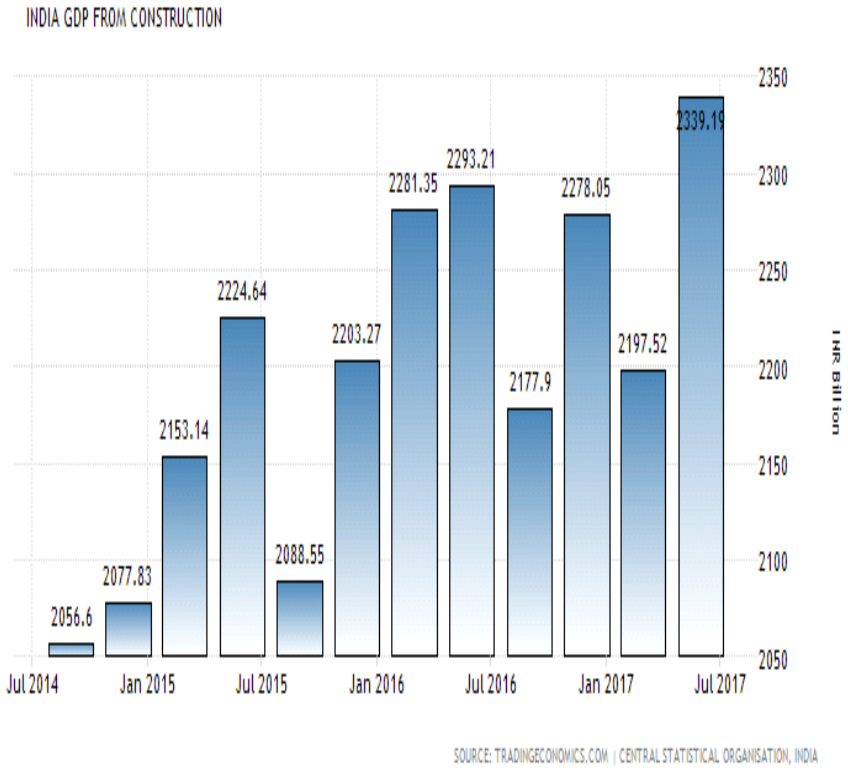
Abstract -*There are numbers of challenge and struggle face by the constructione industry in India. The major criteria for success of any construction project is to convey the project lacking time or cost overrun. This research illustrate the efficiency of lean thinking on the Indian construction industry and identify the factors required for lean construction.*

Keyword— *Lean Concepts, Lean Thinking, Construction Industry, infrastructure Projects*

i. INTRODUCTION

Lean approach is a new technique of project management in construction industry. It is more proficient on complex project. Lean philosophy are derived from, the Japanese manufacturing industry (TOYATO MOTOR). Lean construction is a technique to design production system to reduce waste of material time, time and effort in order to produce the greatest possible amount of value. Lean construction is a method forward that smoothening the construction work flow while getting better the overall value of a product to achieve the pre- determined goals. The result and benefits of apply lean production principles include been confirmed worthy whenever applied accurately. The Indian construction industry is a mainstay of the Indian economy, it is causal 10% to the GDP of India. Lean construction concept are not well-liked in India when we match up to country's like USA, Canada, Australia, Japan and Germany. According by a study inclusive by research firm liases foras, that the whole residential space underneath construction across 25 city approximately 3.2 billion sq ft and 34% of whole is delayed by over 12 months. This delayed space is esteemed at around rs 165,064 crore, which is approximately 1.32% of GDP, according to a report. After implementing RERA [real estate regulatory authority] now it is essential for contractors to terminate project in schedule in India.India is developing nation and the infrastructure in the country is not able to fulfill current demands. But from last 15 years a huge investment is made in the infrastructure is made in the infrastructure projects like roads, airports, bridge and ports etc. With such a great demand for infrastructure project in a country a huge number of investment of capital, natural resource and human resource are used. From previous few years it seen that project are getting delays due to many reason. And cost we are paying for this delays are that the wastage of resource and huge loss of public money is seen.The performance of construction industry is widely perceived as unsatisfactory when compared with many other industries. Lean construction is a production management strategy for achieving significant, continuous improvement in the performance of construction processes of a contractor through elimination of all waste of time and other resources that do not add value to the product or end product delivered to the customer. Lean concepts have resulted in dramatic performance improvements in manufacturing, and the principles behind lean have also been successfully applied to construction.The construction industry is the second major industry in India subsequent to agriculture. It accounts for about 11% of India as GDP. It makes considerable contribution to the national economy. Construction sector, which is the second largest service generator after agriculture, comprising road, ports, bridges, airports, and real estate.

Approvals, acquisition, lack of finance and carrying the cases of badly execute public-private-partnership (PPP) models that are crippling growth of construction in India.



According to the study which is completed with the associated chambers of commerce and industry of India (ASSOCHAM) together with thought arbitrage research institute (TARI). Over 75% of real estate projects of the whole investments valued over rs 14 lakh crore remain non starter as of economic year 15. Due to issue like beginning delays in environmental clearances, plan secretary general, Mr. d s rawat whereas addressing a journalists conference beside with m k shama, director, TARI and Mr. babulal jain, senior member, ASSOCHAM supervision committee in Noida. Infrastructure sector is a key driver for the Indian economy. The sector is highly responsible for propelling India's overall development and enjoys intense focus from government for initiating policies that would ensure time-bound creation of world class infrastructure in the country. Infrastructure sector includes power, bridges, dams, roads and urban infrastructure development. In 2016, India jumped 19 places in world bank's logistics performance index (LPI) 2016, to rank 35th amongst 160 countries.

Foreign direct investment received in construction development sector (townships, housing, built up infrastructure and construction development projects) from april 2000 to march 2017 stood at us$ 24.3 billion, according to the department of industrial policy and promotion (DIPP).

- The government of India has planned an investment worth rs 45,000 crore (us$ 7.07 billion) for the development of India's north-eastern regions bordering china, Bhutan, Bangladesh and Myanmar.
- The ministry of road transport and highways, government of India, invested rs 14,916 crore (us$ 2.32 billion) for the special accelerated road development programmed for north east and rs 4,095 crore (us$ 635.6 million) for the national highway (original) over the past two years to improve the road infrastructure in India's north eastern region.
- The infrastructure sector in India witnessed 33 deals in fy 2016-17 involving us$ 3.49 billion as against us$ 2.98 billion raised across 31 deals in fy 2015-16, with the majority of deals led by the power, roads and renewable sectors, as per investment bank requires capital.
- Meinhardt group, an engineering company based in Singapore, plans to establish its position in India as it targets the next wave of India's urban development to meet the country's development needs.
- UAE based firm, dp world, having previously invested us$ 1 billion in India, is planning to invest another us$ 1 billion in India's infrastructure sector along with logistics and container terminals, stated Mr. sultan ahmed bin sulayem, chief executive officer (Ceo), dp world.

- I squared capital, a global infrastructure investment company, plans to raise up to us$ 4 billion through its second infrastructure fund, which will be invested in infrastructure assets in India and across the globe.
- Abertis infrastructures is a Spanish infrastructure firm, has agreed to buy two toll road assets in operation in south India from Macquarie group for rs 1,000 crore (us$ 151 million) to scale up its presence in India.
- Gvk power & infrastructure ltd won the bid to develop Mumbai's second airport in navi Mumbai for rs 16,000 crore (us$ 2.39 billion).
- UAE based gamma group, outlined plans of investing around rs 3,000 crore (us$ 453 million) in the infrastructure, health and education sectors of Kerala.
- Skytran inc., a nasa technology partner specializing in developing pod car systems for urban transport, plans to build a one-kilometer pilot track in India at its own cost as per the requirement of the government, which has shortlisted skytran as one of the three companies chosen to build pod cars on trial basis.

Lean approach is a innovative method of project management in construction industry. It is more proficient on complex projects. Lean principles are imitative from the Japanese manufacturing industry (TOYATO MOTOR). Lean construction is a method to design production system to minimize waste of material, time and effort in order to generate the maximum possible amount of value. Lean construction is a way forward that smoothening the construction work flow although improving the overall value of a product to achieve the pre- determined goals. The results and benefits of applying lean production principles have been proven worthy whenever applied correctly.

ii. AIM & OBJECTIVE

The aim of this research paper is to advance knowledge on Lean methodology in construction projects. The objective of this paper is to identify the affecting factors for implementing lean technology in construction projects.

iii. LITERATURE REVIEW

Bruno pontes mota et al.(2008) has analyzed that after applying lean construction concepts they noticed that productivity has been enhanced and duration of project concentrated. Construction phase of a residential project in the town area of brazil. The project comprise the construction of 18 houses finance by a private investor and it was constructed and managed by a small achieve a more stable flow of work and the number of emergency request for resource decreased radically. Also, the project was completed a month move ahead when compared to its original timetable thus allowing the investor to sell the units sooner than expected. Finally after, analyzing the reimbursement achieve in this pilots project the company's upper management has decided to use lean concepts in other projects, and the private investors wants to make certain lean is used in other projects finance by this company.

Chien-ho ko et al.(2002) identified that lean building design model (Lbdm) by lean concepts to develop design quality. Hidden waste in conventional design workflow is primary identified using value streaming mapping (Vsm). Vsm is used for visualization and recognized by visiting gemba. Present design process is separated into three stages, namely initial design, essential design, and detailed design. In building projects, designers and engineers involve professionals from different fields. In addition, traditional designs are tend to be completed by individual designers and engineers without interactive partnership. As a result, constructability and hidden design problems break absent during construction phase, resultant in schedule delays and financial statement overruns. In this study, an managerial learning environment is build to assist project stakeholders to learn from faulty designs. The design quality can be improved through iterative communications. Consensus can therefore be converged from the collaborative design workflows. The proposed method that allow project stakeholders to validate their design needs can achieve feasible design artifacts, thus enhancing project performances. In the future, researchers may consider other lean tools and technique to supplementary improve design quality.

David herranz limon et al.(2015) analyzed that construction industry in Norway has passed out during the last decade a number of efforts in the implementation of lean practices. The practices in which the organizations are focused vary as well as the altitude of implementation and results obtained, but with the omission of certain companies the implementation is still limited.

Jay shankar et al.(2013) is analyses decrease in the overall cost of the activity, decrease in overall time of the activity and just in time (jit) be able to implemented, easy to recognize from the top to bottom of the construction pyramid and we can put an end to 'just do it' policy of implement activities. They analyze the general perception of construction industry and how the lean construction tools can be used to advance the implementation of these activities particularly in supervision construction wastes. As mentioned in there paper, they developed a process improvement tool using lean construction which are executed it in different sites. They received an irresistible response from the construction team and they establish it very effective tool that can be implemented in the site. Very simple and easy to use, better way to convey the information about a crisis to the top management, easy to understand from the top to bottom of the construction pyramid, decline in the overall cost of the activity, fall in overall time of the activity .

Fhivio augusto picchi et al.(2009) have noticed a lack of awareness on the following research issues: using value stream mapping for the understanding of waste generation on construction sites, in addition to correct actions for implementing accessible tools broadening the considerate of standardized work within construction processes, continuous learning, and systematic improvements.

Mohd arif marhani et al. (2014) believed that based on the literature review, it can be over and done with the current application and implementation of lean construction into the malaysian construction industry is still in its formative years or in a very early stage even though it is known to present a good platform for the stakeholders to accomplish value for money for their projects. Its full execution in the malaysian construction industry in particular is not an easy task as it will need more effort from all associated parties such as the education organization and for the practitioners.

Harsha n et al. (2008) identify by lean construction tool a company can gain a superior understanding of the kinds of waste that exist in their construction process. Furthermore, the tool can help companies to decide where change needs to begin by getting to the root cause of the problem thus facilitating prioritization of problem and avoiding sub-optimization. This could lead to improved efficiency of construction activities resulting in lower operational costs, greater than before profit margin and reduced environmental damages.

Rishav sarma bardalai and arunima jayakumar et al. (2014) identified the last planner is a methods that can be implement in the site for the successful execution of the work. The last planner process begin with the reverse phase schedule, a detailed work plan specify handoffs amid trades for every phase. Base on the rps, a "look ahead" schedule provide the activities to be finished during the coming weeks and the backlog of ready work.

Xavier brioso et al. (2014) analysed expanding the reach of the lean construction thinking. The success of the training course is reflected in the opportunities for improvement recognized between editing and publishing, made promising through the feedback collected from participant. The school of sciences and engineering of Peru resolve carry on to inform this training course incorporate world community lean practices, particularly simulations and workshops, despite the fact that trying to balance the benefit-cost ratio.

Mohammed almanei et al. (2005) identified that implementation of lean manufacturing in any type of organizations can bring many benefits, such as tumbling waste and getting better functioning efficiency. Though, lean implementation is not a straightforward procedure. Although a number of frameworks have been obtainable, still many company find it difficult to apply lean. Furthermore, most of these roadmaps are for great manufacturing companies, and not for small and medium enterprise. Regrettably, there is not a recipe that if used can guarantee a successful implementation. Furthermore, ineffective implementation can have a great impact on organization's resources, but even more significantly, affect employees and their confidence in lean philosophy. In their paper they said, the most outstanding lean implementation frameworks will be discussed, under the prism of the needs of sees. .

Remon fayek aziz et al. (2014) identified that three critical fundamentals: time spent on enhancement, improvement skills and mechanisms, and improvement viewpoint and goals. And said future research also needs to develop and validate a more complete model of performance improvement and further examine the behavior of improvement process over time and use the model as a initial point for system reshape by adding loops and breaking links.

Usama hamed issa et al. (2012) indicated that the use of lean construction technique in construction projects has significant effects on the decrease in pet[percent expected time-overrun] values and the enlarge in Ppc values[percent plan completed]. Sepani senaratne identified that lean construction is a idea still new to lots of construction industries in the world. Lean construction can be argued as a strategic option when implement in a new setting, where certain test such as its suitability and

acceptability desires to be done prior to its execution. Hence, they aimed to explore the suitability and acceptability of lean thinking in Sri-lanka. The learning adopt an opinion survey using Delphi method to bring together empirical data. The result reveal frequent flow activities that generate waste and their causes in the sri lankan construction industry. The investigate further finds that the domestic construction industry workforce is unaware of these flow activities that create waste and their cause. When experienced majority believe the core principles of lean construction and are having a kaizen mentality, which is middle to lean thinking. Therefore, the learning concludes that lean construction is suitable and acceptable in the Sri-lankan context. Overall, the study offers an move towards to test lean construction in a new construction industry using an opinion survey

iv. MAJOR FINDINGS

From the literature review it is identified that if we will use lean concept in the place of traditional method it will be beneficial. In the planning lean method we are using master plan, phase plan, look ahead plan, weekly work plan and in traditional method we are using master plan and contingency plan. Lean concept using pull technique where in the traditional method we are using push technique. For the constraints in the lean we analysis during the planning stage and in traditional method we are doing constraints analysis during execution. In the lean method responsibility of work is given before execution starts and that is very clear and in traditional it is not very clear.Various researcher have used various method for achieving the success of lean production and few of them have also tried to brief it out. Salem et al. (2006) worked on the various tool for achieving lean process.

Scope	Technique	Requirements
Flow variability	Last planner	Phase scheduling
		Six week look ahead
		Weekly work plan
		PPC chart
Process variability	Fail safe for quality	Check for quality
		Check for safety
Transparency	Five S's	Sort
		Straighten
		Standardize
		Shine
		Sustain
	Increased visualization	Commitment charts
		Safety sign
		Mobile sign
		Project milestones
Continuous improvement	Huddle meetings	All foreman meeting
		Start of the day meeting
	First run studies	Plan
		Do
		Check, Act

Followings are the most common factors that are identified from the literature review:

1) causes associated with flows

A) resources

- Materials: lack of materials at the work place; materials are not well distributed; inadequate transportation means
- Equipment: non-availability; inefficient utilization; inadequate equipment for work needs
- Labor: personal attitudes of workers; rebellion of workers

B) information

- Lack of information
- Poor information quality

- Timing of delivery is inadequate

2) causes associated with conversions

A) method

- Deficient design of work crews
- Inadequate procedures
- Inadequate support to work activities

B) planning

- Lack of work space
- Too much people working in reduced space
- Poor work conditions

C) quality

- Poor execution of work
- Damages to work already finished

3) causes associated with management activities

A) decision-making

- Poor allocation of work to labors
- Poor distribution of personnel

B) ineffective supervision/control

- Poor or lack of supervision

v. CONCLUSION

In the construction projects, designers and engineers require professionals from diverse fields. In addition, traditional designs are tend to be concluded by individual designers and engineers devoid of interactive collaboration. Consequently, constructability and hidden design problems break out during construction phase, resulting in schedule delays and budget overruns. It is derives relationship between lean construction and performance improvement programs in construction organizations Knowledge about lean methodology is limited in Indian construction industry. To improve the productivity we can use tool like last planner, huddle meeting & first run studies. Thus outcome of this analysis is that there is frequently delay in the planning stage itself like site clear, frequent change in requirement from client and change in drawing occurs frequently. Following are the most crucial factors which are affecting construction projects at various phases while applying lean concept.

I. Planning Stage

i. lack of knowledge
ii. funding issues
iii. site clearance
iv. objections from nearby organization
v. change in drawing occurs
vi. unclear information regarding the projects
vii. frequent change in client requirement
viii. inappropriate attitude from client

II. Management Stage

i. frequent design change
ii. lack of design information
iii. poor layout of site
iv. lack of trust
v. slow decision making
vi. poor planning
vii. waiting for material
viii. waiting for equipment
ix. waiting for workers
x. lack of control
xi. poor coordination
xii. too few supervisor and foreman
xiii. over allocation of workers
xiv. over allocation of material

III. Execution Stage

i. waiting for labors
ii. lack of supervision
iii. lack of knowledge of work
iv. rework and repair in defective work
v. error done by labor
vi. unnecessary resting
vii. unnecessary chaos
viii. unnecessary leave
ix. theft
x. waiting for equipment
xi. time taken for maintenance
xii. use of outdated equipment

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