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Identifying and Eliminating Barriers in Indian Construction Industry with the Help of LEAN Techniques

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***Abstract*— The building sector has adopted the lean construction technique by attempting to adapt the Japanese lean manufacturing mindset. Recently, there has been a lot of study done and there is still work being done to apply lean principles to the construction industry in order to improve waste and increase efficiency. The lean methodology is clearly successful; however several significant reports have suggested that mis-conceptualizing lean thinking is a key difficulty. Additionally, certain case studies have found that the lean methodology was either used incorrectly or just partially. The study aims to identify the obstacles that stand in the way of the successful use of lean construction in the Indian construction industry, as well as to explore the usefulness of lean methodology in project management. A questionnaire survey of senior consultants from architectural and project management firms as well as project managers from building construction organizations was used to gather data. After ranking the primary obstacles using the data gathered, lean principles are recommended as a means of removing these obstacles. A case study of a construction project was selected, wherein the lean value stream mapping tool was utilized and potential productivity gains were noted.**

Keywords*— *Lean Construction, Barriers, Value Stream Mapping, Waste, Productivity, Cycle Time, Waste Generation.

I. INTRODUCTION

Lean technology, rooted in the principles of efficiency, waste reduction, and continuous improvement, has gained prominence in diverse industries, including construction. In the context of the Indian construction sector, Lean practices offer a strategic approach to address challenges such as project delays, resource inefficiencies, and cost overruns [6]. Fundamentally, Lean prioritizes providing value to the client by streamlining operations, getting rid of waste, and encouraging a continual improvement mindset. Lean technology adoption in the construction sector requires the adoption of procedures and tools that streamline operations, enhance project management, and ultimately contribute to the successful completion of construction projects.

A. Key Principles of Lean Technology:

Central to Lean technology are several key principles that guide its application in construction. These include customer-centricity, value stream analysis, flow optimization, pull-based systems, and a commitment to continuous improvement. By aligning construction processes with these principles, the industry can achieve better project outcomes, minimize resource wastage, and enhance overall productivity. Lean's emphasis on identifying and eliminating non-value-added activities ensures that every step in the construction process contributes directly to the project's value proposition.

B. Role of Value Stream Mapping (VSM) Tool:

Value Stream Mapping (VSM) is an essential Lean tool with special application in the Indian construction industry. Through the use of a visual depiction of the whole building process, value stream mapping (VSM) enables stakeholders to easily identify and evaluate each phase in the process. In the construction industry, VSM helps in mapping the flow of materials and information, enabling a comprehensive understanding of the project's current state. This tool facilitates the identification of bottlenecks, inefficiencies, and areas for improvement, ultimately leading to the creation of a more streamlined and optimized construction process [13].

II. NEED OF THE STUDY:

The purpose of this study is to investigate and address the barriers that stand in the way of the successful implementation of Lean principles and practices in the Indian construction industry. By identifying and analyzing specific challenges such as cultural factors, regulatory constraints, and resistance to change, the study aims to propose tailored strategies to overcome these barriers. The research aims to present the business case for Lean adoption by closely examining the effects of current barriers on construction projects. This includes highlighting potential cost savings, better project schedules, and improved overall project quality. The study further endeavors to provide a comprehensive roadmap for the effective integration of Lean tools, promoting a culture of continuous improvement and contributing valuable insights to elevate the efficiency and competitiveness of the Indian construction sector.

III. LITERATURE REVIEW:

We gathered the information that was already available on lean concepts and how they were being used globally in the construction sector. Additionally, obstacles to applying the lean methodology were looked into.

According to Vinaya D. More et al. (2016), a communication breakdown between the owner-designer team and the contractor is one of the challenges in putting the lean technique into practice. In addition, the project used the lean methodology, which led to a decrease of 13% in process operations and a 25% overall time savings.

In his study, Ogunbiyi (2018) identified the main obstacles to lean implementation in sustainable building in the United Kingdom. These obstacles were categorized as follows: low awareness and comprehension of lean principles; employee attitude problems; resistance to change and culture; lack of management support; lack of customer-focused and process-based performance measurement systems; and lack of implementation concepts and

understanding. These are a some of the biggest obstacles to implementing lean.

Value stream mapping, according to [3], is a technique for mapping the information flow that occurs during the creation of a single kind of good or service as well as the flow of information overall. Identifying value-added and non-value-added operations, as well as producing at the general level as well as in each work area.

Sam Spata (2018) gave a case study to his class using two similar projects that had the same time, city, architect, bid amount, but different contractors and delivery techniques. Because it had to make major adjustments and went over its bid cost, the project with the traditional delivery approach ended up costing about 1.38 million dollars (15%) more than the project with the lean delivery system.

IV. Methodology:

A. *For Barriers in Implementation of LEAN Tools:-*

Questionnaires are the primary means of data collecting. Project managers from companies involved in building construction are among the target group for the data gathering. To enable online collection of survey data, the questionnaire was posted as a Google Doc to Google Drive. Through emails, the questionnaire was distributed to project managers, architects, and civil engineers working for construction companies. The reps were required to complete the survey and upload the information online. The most likely obstacles are presented in the outcome after the responses were analyzed by the SPSS software for likelihood of occurrence. The questionnaire responses were collated to provide us with a clear picture of the most likely obstacles.

B. *For Implementation of Value Sream Mapping (VSM) Tool:-*

After that, four weeks of intensive site observation and an analysis of the actual work being done there were used to gather data from the project site. We decided to apply VSM Tool for one cycle of RCC Slab (from starters to slab casting). This was accomplished by physically observing every action at the project site, collecting statistics on activity durations, and interviewing the engineers. The average of the data is used to determine how long each activity takes. After identifying the tasks involved in the activity and documenting observations, the process's Current State Map and Future State Map were created.

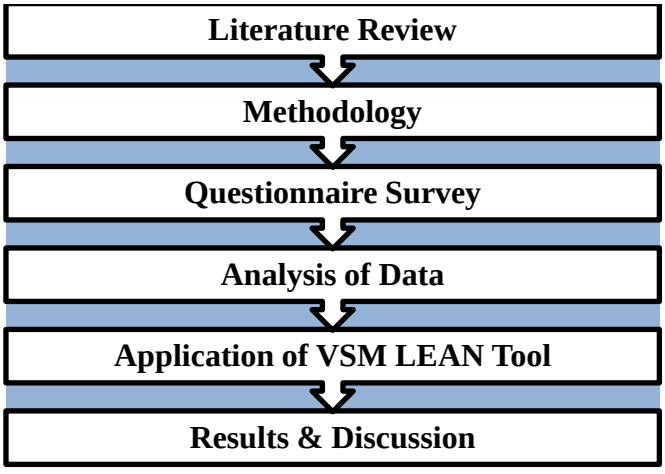

Fig. 1. Research Methodology

V. Results and Discussion:-

A. *Regarding obstacles When using LEAN Construction:*

The Questionnaire was distributed to 110 employees of significant construction companies in India; however, several employees were unable to respond due to their hectic schedules, and only 70 replies were gathered. The first section of the questionnaire recorded the respondent's details including their profession, credentials, and years of expertise in the field, the company name.

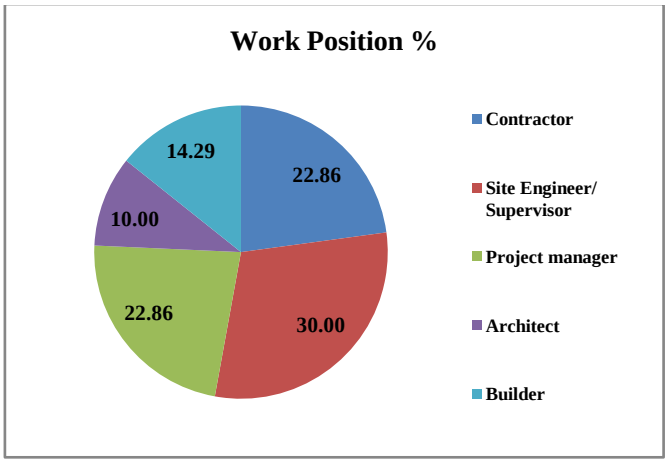

Fig. 2. Work Position of Respondents

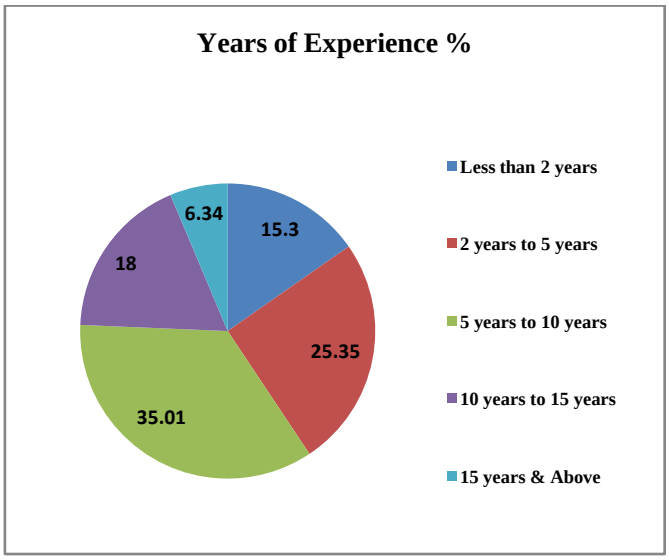

Fig. 3. Years of Experience of Respondents

This paper includes a prepared questionnaire as well as a list of the hurdles as previously described. Thirty construction companies provided questionnaire surveys, which were used to collect the data. The survey was conducted using a 5-point Likert scale, which goes from Very high (1) to Very low (5).

The collected data was examined using the statistical package for social sciences (SPSS) application, version 23. The reliability of the data obtained from this question was assessed using Cronbach's Alpha coefficients by entering it into the SPSS 23.0 software. With a value of 0.747, the coefficient was found to be more reliable than the acceptable threshold of 0.7, indicating the quality of the results.

TABLE I. OUTPUT AS PER SPSS SOFTWARE WITH KEY BARRIERS

ID	List of Key Barriers Identified	Mean	Standard Deviation
B1	Absence of managerial commitment and support for the use of LC approaches	3.22	0.806
B2	Lack of adaption of change	3.52	0.730
B3	Lack of leadership guide and support in applying Lean Practices	4.11	0.709
B4	Lack of financial resources allocated in implementing LEAN Techniques	3.97	0.661
B5	Lack of level of awareness regarding Lean practices in Construction Industry	3.71	0.881
B6	Absence of government support for building projects to use any creative approaches	3.89	0.661
B7	Absence of knowledge and experience required to use LC techniques	3.77	0.740
B8	Inadequate communication between the managers, administrators, foremen, and other project partners	3.44	0.586
B9	Insufficient comprehension of the LC concepts	3.61	0.732
B10	Insufficient technical expertise to use LC techniques	4.05	0.774

As per Table No. 01, it appears clearly that Leadership & Support Issues (B3), Technical Expertise issue (B10) and Financial Issues (B4) are the top three main barriers in India in order to use LEAN Tools in Indian Construction Sector. Hence, it is required to apply LEAN Tools in a proper and in effective way to remove obstacles regarding their implementation from Indian Construction Industry.

B. For implementation of VSM Tool:

The site officials were informed of the wastes and their consequences found by the examination of the Current State and Future State Maps. In the project's location, the suggested improvement measures were immediately put into practice, and the productivity increase was examined.

Fig. 4. Steel Waste on Site (Current State)

Fig. 5. Off-Site Column Fixing (Future State)

1) Current State Map:-

In the current state map, the slab requires cycle to complete in 10 Days, because of steel waste, unused workforce and labours, inadequate material storage which causes lot of wastage of time.

A chart is made using the data and information gathered from the engineers, contractors, managers, and staff. The necessary steel for reinforcing the slab is ordered eight days before the construction begins, according to the current status map. The supplier of raw steel delivers the steel in three days. The steel yard receives it on the sixth day of indent. Here, 2.5 T of steel are required for the 165 SQMT third floor slab (Part-1). Using the bar bending schedule (BBS), five workers can cut and bend steel in a single day.

After being cut, the steel needs to be brought to the area where it will be fixed. Two laborers carry 2.5 tons of steel to the area in a single day. The steel that is used for the starters, columns, and beam bottom is presumably in the safety stock (Inventory). Slab concreting can be finished in a single day with ready-mix concrete. 5 laborers need 2 days to fix and shutter 16 starters; 9 laborers need 4 days to fix and shutter 16 columns; 10 laborers need 2 days to fix and shutter the beam bottom and the slab shuttering of area 165 SQMT; 12 laborers need 2 days to fix the 2.5-ton slab reinforcement. Slab casting requires 10 laborers. To finish the 165 SQMT slab area, Total 46 laborers are required.

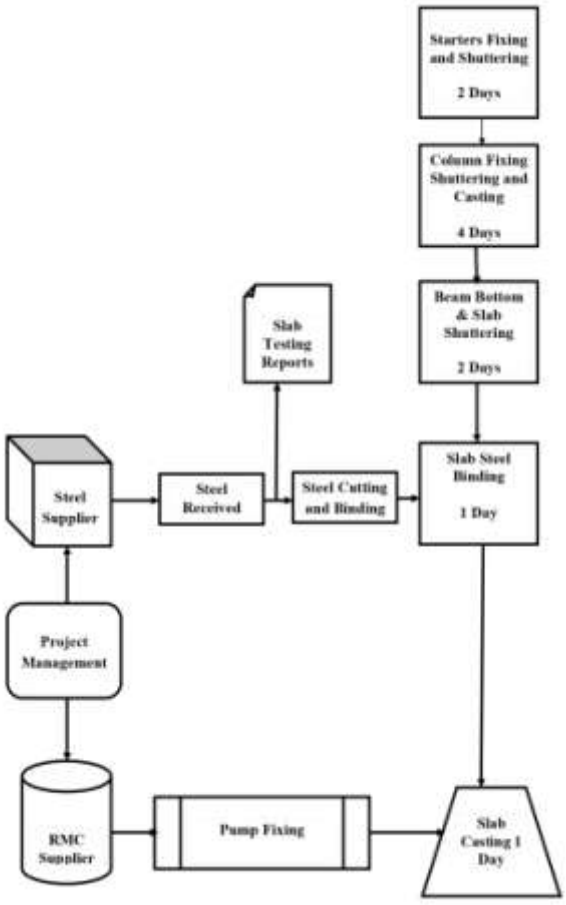

Fig. 6. Current state map of VSM of Construction of RCC Slab.

Thus, Rs. 4000 was spent on cutting, bending, and moving steel, and Rs. 3500 was spent on security over a period of 10 days.

The total amount spent is equal to 4000 + 3500 = 7500 rupees.

Ten days were needed to complete the process.

TABLE II. TYPE OF TIME WASTES AT THE CONSTRUCTION SITE

Waste	Example
Over production	cutting steel for a longer period of time than necessary
Waiting	Steel is not available on the website.
Transportation	Material movement that is not required
Extra processing	Excessive compaction
Inventory	Unused steel expecting steel reports
Motion	Insufficient storage of materials results in excess movement during placement.
Defects	Spare movement on the positioning results from inadequate material storage.
Not utilizing resources	Labour and personnel that are not being employed

Suggestions for enhancing the present procedure of Current State Mapping (CSM):

The author recommended ordering Ready-Made Steel on site in order to save costs associated with cutting, bending, and storing steel. Ready-Made Steel is produced by a company and prepared according to the specifications and bar bending schedule provided by the client. The use of ready-made steel in construction projects has numerous advantages.

Future State Map:-

In the future state map, slab requires cycle to complete in 8 days to complete. As the steel waste and waiting time reduced and readymade steel is used, material storage properly done, work is properly assigned to labour and personnel. Apart from that, steel, labour, time delay reduced.

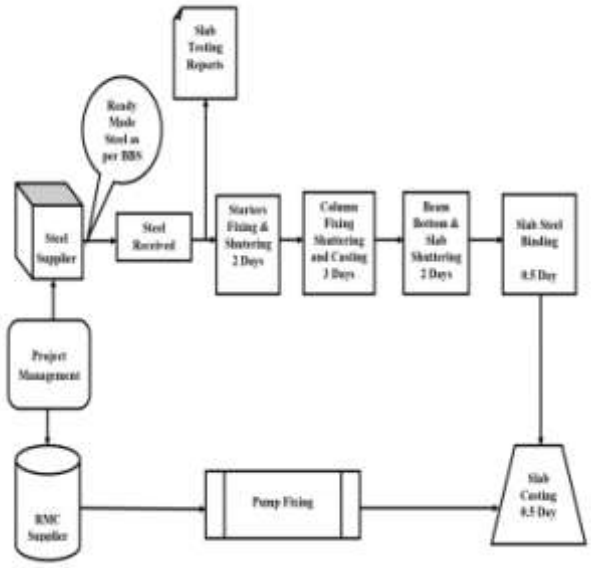

Fig. 7 Future State Map of VSM of Construction of RCC Slab

Suppliers of Ready-Made Steel offer quicker final product delivery. The 4th day of the indent is when it can be received at the location.

The advantages of using VSM Tool & Ready-Made Steel for this case study are as follows:

- It is possible to save the Rs. 4000 that was paid to the laborers for cutting, bending, and moving steel.
- There is a lesser quantity in the steel inventory. So, It can be used for other purposes.
- The steel yard is no longer needed to maintain security. It saves Rs. 3500.
- Very Less waste is produced by the steel pieces that are cut.
- Planning for procurement can be made better.
- Ten days were cut down to eight. Two days are spared.
- 46 Labours were cut down to 40. Six Labours are spared. (for one slab)

TABLE NO. III COMPARISON BETWEEN CURRENT STATE & FUTURE STATE RESOURCES REQD. (FOR ONE SLAB)

	Current State Map			Future State Map		
Activity	***Qty.***	***Total Labour***	***Days***	***Qty.***	***Total Labour***	***Days***
Starter fixing and shuttering	16 no.	5	2	16 no.	5	2
Column binding and shuttering	16 no.	9	4	16 no.	6	3
Beam bottom and slab shuttering	32 no.	10	2	32 no.	10	2
Slab steel binding	2.5 ton	12	1	2.5 ton	9	0.5
Slab Casting	28 cum.	10	1	28 cum.	10	0.5
Total		**46**	**10**		**40**	**8**

VI. CONCLUSIONS:

By educating construction professionals via seminars & conferences about the benefits of lean construction, it is feasible to overcome a lack of awareness regarding the crucial significance of its implementation. Furthermore, the government ought to implement measures that recognize and reward companies who implement lean concepts. It is advised that the entire organization take the initiative to implement Lean concepts; sending a small group of managers or staff members to workshops and seminars is insufficient.

It is imperative that suppliers and subcontractors participate in these workshops and take the initiative to apply the concepts of lean management. Problematic situations can be reduced by forming strategic alliances and adopting a participative project management approach in close collaboration with suppliers and subcontractors. If one consistently works with the same source, this can be accomplished successfully.

Construction managers will be able to effectively identify and measure waste sources according to the VSM approach. It will make it easier for managers to identify areas for improvement and provide concrete plans for putting them into action. As a result, they will be able to lower expenses while also using less energy and materials, manage human resources better, adhere to timetables and quality standards, and lessen process unpredictability. This study has clarified the primary drawbacks of conventional VSM and offered a workable strategy for applying VSM in the building sector. In this case study, by using the VSM Tools, slab cycle reduced by 10 days to 8 days, the labour reduced by 46 to 40 labours per slab cycle, Rs. 11000/- reduced per slab cycle. The future state map shows a notable increase in overall performance when compared to the current state map. In this manner, the construction project can be completed more quickly, with higher quality, and at a lower cost, all while meeting the client's requirements for timeliness, quality, and affordability. Overall, the application of the Value Stream Mapping (VSM) tool in lean construction represents a transformative approach to enhancing project efficiency and reducing waste.

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