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Study on Methods to Implement Lean Technology in Construction

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Abstract: ***Lean manufacturing is the tool widely used nowadays which involves mainly in waste minimization. As construction industry struggle with project delays and difficulties in resource utilization the lean concept will help to overcome these difficulties. Lean concept acts as an efficient management tool for eliminating waste and non-value added activities from construction projects thereby helping to complete the project within schedule and budget. This paper describes the lean concepts, its necessities in construction sector, studies various tools and techniques of lean and how it could be implemented along the various phases of construction. This paper explains the experimental study by implementing some of lean tools like Value Stream Mapping, 5 S, Kanban and the hurdles in implementing lean technology in construction have been discussed in the end.***
Keywords: Lean Design, VSM, POKA YOKE, JIT, Kanban, 5 S, Kaizen

I. INTRODUCTION

Lean is a technology or tools mainly found out for manufacturing industry in order to reduce waste and improve productivity based on value. With increase in globalization, need and advancement in technology the pressure on industries is increasing. Manufacturing industries are showing enormous and steady growth over years with the help of technology like 3D printing, robotics, internet facilities, computers, etc. Various tools like Just-In-Time, Value Stream Mapping; Poka Yoke helps in improving the productivity and reduces waste. Lean in one of such tool which is highly effective and efficient in reducing waste and improving growth when followed appropriately with effort. On the other side the construction sector lacks growth but the need for infrastructure and other building facilities are high. Construction industry encounter problems like delayed project delivery, less quality, excessive wastage of materials and improper resource utilization. The main prospect of lean management principle is -Drive more value by using less of everything.

II.TOOLS OF LEAN CONSTRUCTION

A. Target-Value Design

Collaborative design process involving designers, builders, suppliers, estimators, and owners to collaboratively produce a design that provides the best target value.

B. Last Planner System

Production control of design activities based on commitments through the consistent use of techniques such as pull planning, make-ready look-ahead planning with constraint analysis, weekly work planning based upon reliable promises, and learning based upon analysis of the planning system (plan percent complete and reasons for variance).

C. Pull Scheduling

Minimize design negative iterations by developing a plan using pull techniques – the work is planned based on the request of a downstream stakeholder.

D. 5 S: An approach to maintain order in the workplace. It includes:

1) *Sort:* Removing clutter and unused items
2) *Set in Order:* Arranging the work in a manner that makes jobs easier to do; defining a place for every thin
3) *Shine/Sweep:* Making it easy to keep the area clean.
4) *Standardize:* Making and maintaining the location designated with set in order.
5) *Self-Discipline/Sustain:* Keeping the 5 S's in place.

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E. 5 Whys

A problem solving technique that enables root cause analysis by asking repeatedly why an issue has occurred until it is not possible to identify another cause and the core of the problem.

F. Andon

A system to notify management, maintenance, and other workers that assistance is needed. First-run Study Trial execution of a process in order to determine the best way to perform the process.

G. Integrated Project Delivery (IPD)

A project delivery method that aims at aligning interests, objectives, and practices amongst the key project stakeholders. It strives to create a win-win situation to both the customer and builder.

H. Just-in-Time (JIT)

Producing or delivering the right amount of parts or product at the right time and the right place as needed for production.

I. Kaizen

A discrete, continuous improvement process usually most effective when integrated with an overall improvement strategy. It helps in achieving a lean culture by step by step improvements.

J. Kanban

A signal that gives instructions to pull materials or parts in a certain amount.

K. Poka yoke

A mistake proofing technique that keeps processes from producing errors.

L. Value Stream Mapping

A diagram that represents the steps involved for the material/equipment/workers and information flows needed to bring a product from request to delivery.

III.TYPES OF WASTE IN CONSTRUCTION PROJECT

A. Defects

It includes doing the wrong installation, defects in fabrication, punch lists and many kinds of change orders and not meeting the required code.

B. Overproduction of goods

Fabricating or ordering material too early and stockpiling material either in the shop, in a warehouse or at the job site. This waste causes other wastes, including inventory, transportation and motion.

C. Inventory

This includes un fabricated material, work-in-process and finished fabrications.

D. Motion

Workers looking for materials, tools, information, where to work, etc., is the waste of motion.

E. Transportation

This waste happens as material moves around the shop, is loaded on the truck or trailer, or is hauled to the job site and unloaded. It includes when the material is moved from inventory to the installation point, or moved to get out of another trade's area. Some research shows that material is moved on average about 2.5 times at the work site before being installed.

F. Waiting

This includes when a crew waits for instructions, inspections, change orders and materials at the job site; when a fabrication machine waits for material to be loaded; and when payroll waits for the late timesheets.

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G. Over processing

This includes over engineering, requiring additional signatures on a requisition, multiple handling of time sheets, duplicate entries on forms, completing reports no longer necessary, and getting double and triple estimates from suppliers. Any step in a process that is not value added is over processing.

H. Not utilizing talent

nsufficient training, assigning people to wrong task, wasteful admin tasks, poor communication, poor management, lack of team work and all other related things causes inefficient handling of human resources. Eliminating the causes of this waste will lead to more and efficient productivity.

IV.METHODS TO IMPLEMENT LEAN TECHNOLOGY IN CONSTRUCTION

A. Lean Design

Design phase is very important in construction project as a proper and good design will helps to eliminate all the unnecessary wastes involved. An efficient design would save cost eliminating rework.

The major three considerations for a lean design process are follows:

1) Transformation (transformation of inputs into outputs)
2) Flow (flow of material and information through time and space)
3) Value (the generation of value for customers

B. Value Stream Mapping (VSM)

Value stream mapping is an excellent tool to eliminate unwanted, non- value added activities from the project. It would help to reduce waste, save time and money. Every project involves number of processes and each process has several activities. Each process is represented by means of flowchart or a process flow diagram and every activity is categorized as values added, on-value added but necessary and non –value added. Then the non-value added activities are eliminated from the process. Application of the methodology generated improvements in the engineering process by reducing product errors, cycle times, and the share of non–value adding activities, thus increasing productivity.

1) Application of VSM in a Construction Office: The following VSM address issue on answering customer enquiry by a customer care personnel which involves clarification with the department head every time an enquiry arrives as the customer care personnel is not provided with sufficient information regarding quotations and other related preliminary data. The current process has many non value added activities which leads to an excessive processing time and customer dissatisfaction.

2) Previous Map

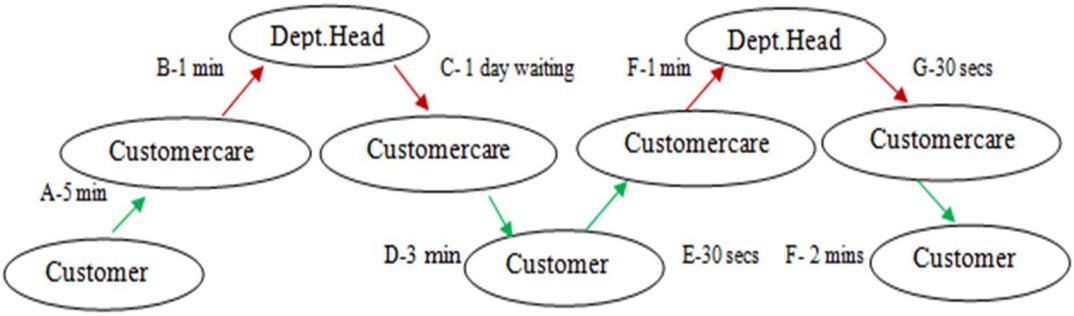

Fig. 1 VSM in construction office previous map

Total time required = 1 day and 13 minutes

→ Value added activity

Non-value added activity

In order to neglect the excessive processing time the customer care personnel was provided with a detailed catalogue with all the necessary information and a brochure for giving to the customer containing outline of the services provided. This helped in reducing the total time for addressing the customer enquiry.

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3) Current Map

Fig. 2 VSM in construction office current map

Total time required = 7 minutes

4) Benefits of VSM

a) Helps in improving quality and enhancing the value of process
b) Helps in eliminating unnecessary waste
c) Increase the reliability in schedule by decreasing schedule duration
d) Reduce cost thereby increasing profit

C. 5 S

It contributes to the reduction and elimination of the 8 wastes (overproduction, inventory, transportation, motion, waiting, defects, over-processing, and non-utilized creativity); it increases people's involvement, teamwork, morale, health and safety; it reduces costs, variability and uncertainty; and it help in setting the basis to implement Lean Construction in any company or project.

1) Implantation of 5S in Construction Office and Site:

TABLE 1
5 S IMPLEMENTATION PROCESS

5 S	PLACE	PROCESS
SORT	In office	a) Keeping necessary documents and discards unwanted bills and papers. b) Reducing files by using computer
	In site	a) Keep the materials& equipments needed on site as per schedule. b) Discard unwanted materials, metals, scrap and wastage from previous work.
SIMPLIFY	In office	a) Arrange all the documents in appropriate places b) Everything is kept in its place and labeled in away such that anyone can find the required document easily without unwanted motion c) All the stakeholders, vendors, customer care numbers are displayed clearly. d) Each department is allocated with a definite space and a clear tag.
	In site	a) All the materials are arranged well in its place with clear indication of its specifications like dimension, supplier name, etc b) Color coding may be done for easy identification by labors. c) No unwanted material should allow to rest in unwanted place at any time.
SWEEP/SHINE	In office	a) Assigning people for sweeping. b) Every area should be kept clean
	In site	a) After completing a day's work the site should be made clean by respective workers b) Cleanliness should be followed by every person in site

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		c) Site should be clean of scrap, metals, screws ,broken glass, nails, etc d) Supervisor should check for cleanliness in site
STANDARDISE	In office and site	a) Deciding who is in charge of maintaining the needed conditions to maintain the first 3S. b) Avoid setbacks by means of integrating daily maintenance. c) Checking the level of maintenance periodically
	In site	a) Specifying certain location for tools, equipments and materials b) Clearly displaying the specific location for tools by pictures for easy understanding
SUSTAIN	In office and site	a) Training b) Periodical review and kaizen

2) Benefits of implementing 5 S

a) Helps in improving quality of construction and customer satisfaction
b) Prevents re-work and non-value added activities
c) Improves safety and productivity
d) Reduces wastage of time and unwanted motion
e) Helps in completing work within scheduling by reducing unwanted motion.
f) Helps in better material management

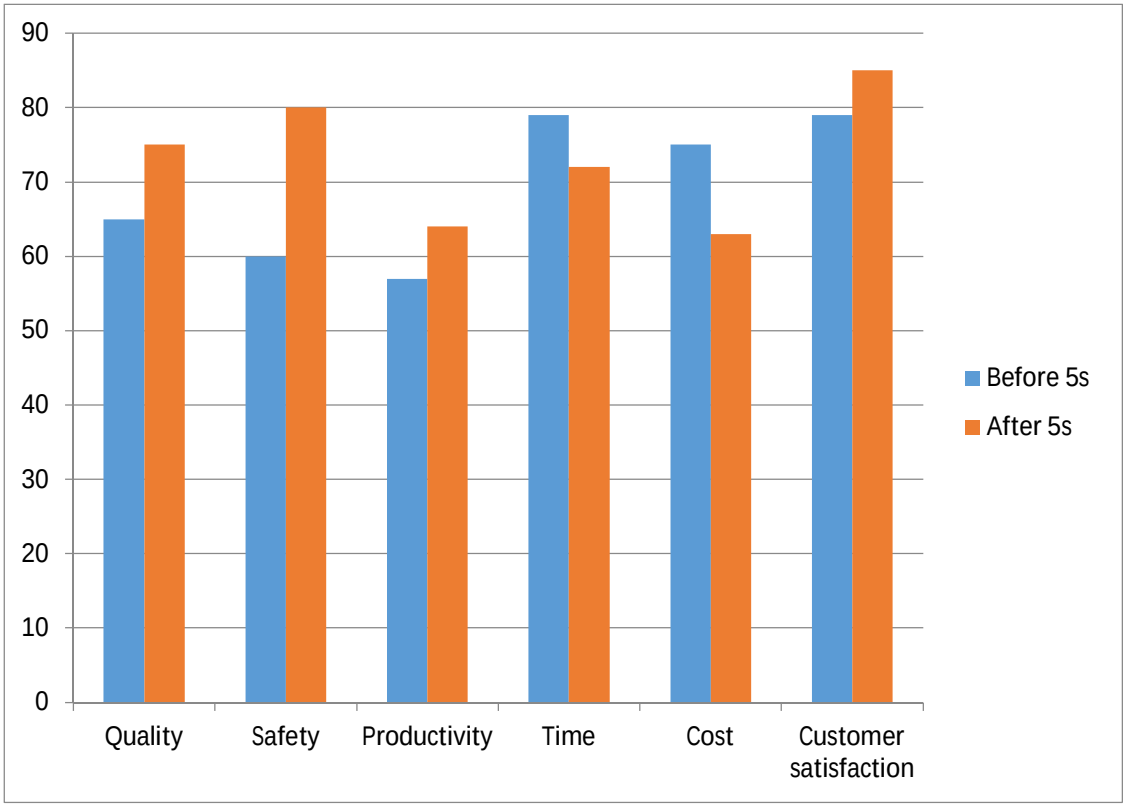

Fig. 3 Result of 5 S implementation

D. Kanban

Kanban is a visual method for controlling production as a part of JIT (Just in Time) and Lean manufacturing. Kanban introduces the pull method which ensures that it controls what is produced, in what quantity, and when to produce it. This ensures that the production is per the client's desire and not more. Kanban means "a signal to replace or refill."

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1) Application of KANBAN in Various Places :

TABLE 2
APPLICATION OF KANBAN TECHNIQUE

PLACE	BENEFITS	KANBAN
Overall organization	a) Reduce the communication overhead of the organization by making the work processes transparent b) Eliminate unnecessary meetings c) Develop a level of stability to the system that enables standardization and learning d) Have clear visibility into the state of the operation	-By displaying Kanban board
Company/office	a) keep track of customer inquiries so that they can be answer correctly and quickly	-By displaying Kanban board
Construction site	a) Measure how long it takes to complete a task b) Have clear visibility into the status of work c) Keeping the workflow smooth d) Improving the production system e) Helps to keep track on or before schedule	-By displaying Kanban board
Inventory	a) Keep the right amount of stock in the warehouse b) Helps to follow JIT c) Prevent excess inventory d) Save cost	-By re-filling things required when it is 60% empty or certain limits -By purchasing material as per kanban card from respective department

2) Benefits of KANBAN

a) Bottlenecks become clearly visible in real-time.
b) Tends to naturally spread throughout the organization to other departments such as HR and sales, thereby increasing visibility of everything that is going on at the company.
c) Kanban will reduce inventory, on average, by 25 to 75%. This saves any company significantly in terms of rent, electricity, and storage space.
d) Improves workflow - The speed of moving from one task to another is significantly reduced by the creation of clearly marked flow lanes, kanban cards, and clearly marked labels.
e) Prevent Overproduction -Because parts are only created at the visual signal by the kanban label (link), inventory is much less likely to be overproduced. Resulting in significant savings in the holding of stock.
f) Minimize risk of obsolete inventory, because inventory is only created as it is needed**.**
g) Increased responsiveness- Unlike a predictive system, kanban immediately reacts to the environment. By responding to clearly and easily read kanban cards the lag time between a shift in demand and a shift in process is almost non-existent.

V.HURDLES IN IMPLEMENTATING LEAN TECHNOLOGY IN CONSTRUCTION

Although lean is an effective and efficient culture for management and the manufacturing sector shows a good and clearly visible result implementing lean technology, it is not widely applied in construction sector. The following are neither the various reasons for not implementing lean in construction:

A. Lack of exposure to Lean technology
B. Nature of the construction sector involving wide variation in working site , type of people and project nature
C. Tendency of the people to apply traditional construction practices
D. Attitude of the labors

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E. Lack of client and stakeholder involvement
F. Lack of training

VI.CONCLUSION

Construction sector being one of the largest sectors contributing to country's 11% GDP frequently suffers from project delays and budget overruns. The sector mainly depends on labor, equipment and material. The entire process from design to delivery of a project involves much waste. It accounts for series of activities out of which only 10 % is value added activities and 57 % is waste. Lean construction methodology proves itself efficient in eliminating this waste. Lean construction is not a tool but a culture that have to be implemented step by step in order to get a fruitful result .it involves removal of waste in all possible ways, improves the work flow and increases the value of each process by means of continuous improvement .. Thus, some of the tools in lean technology have been studied and the method to apply them in project has been identified. The results show the effectiveness of each tool and practice. Finally the hurdles in implementing lean in construction have been discussed. Overall lean technology helps in achieving better construction management reducing unnecessary waste, improving quality, prevent project delays and budget overruns. It also helps in achieving better customer satisfaction.

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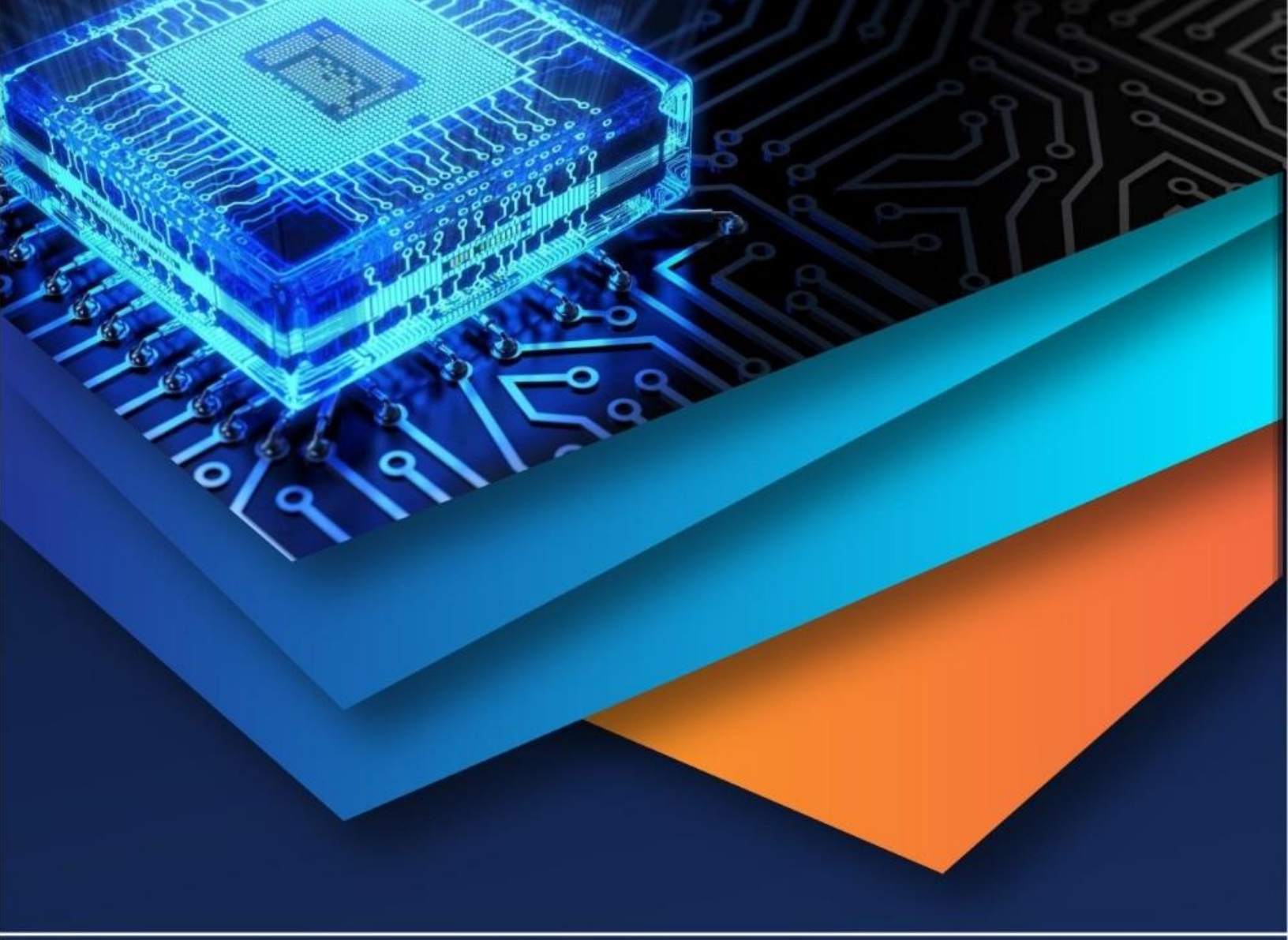

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