



Importance of Lean Concepts and Its Need in Construction Projects

Prasanna Shetty, B Prakash Rao

Abstract: As we look through the lens of productivity, construction is extremely interesting industry. As researchers are coming up with various new techniques to transform the construction industry not all the efforts are completely used. Several technical and non-technical factors like poor work execution, congestion in the place of work, cleanliness issues, unavailability of resources, delay in the process, quality mismatch and lack of proper management affects the whole process. Hence there is a requirement for automation in several areas in the entire process to keep the non-value-added activities in check. The main cause for reduction in performance in this field is lack of waste management something that is least considered. Therefore, proper management of waste materials to produce a leaner and fitter organization plays a very important role in raising the profits. Lean construction requires involvement of lean manufacturing principles along with operations research and construction process. A case study is made based on the observations in the ongoing construction process of a 5-storeyed building "Shrisham Housing Association" in Udupi for a duration of 7 months. This involved activities like Masonry work such as Blockwork and Plastering, Flooring and Tiling. Lean process aims at raising the value of the product for the customers along with least wastage and increased productivity. There are several tools used by the industry to adopt to lean process such as the 5 Whys, The 5S System, Value Stream Mapping, Regression Analysis, Pareto Chart, Failure Modes and Effects Analysis, Continuous Improvement and Mistake Proofing. In this study "MUDA Walks" and "Value Stream Mapping" tools are used for detection, "Fishbone Diagram" and "5 Whys" for processing and "Last Planner System", "Daily Huddle Meeting", "5 S Principle" and "First Run Studies" for mitigation. It is observed that the percentage excess of materials over a period of six months of M. Sand and P. Sand has been reduced by 17% and 9.1% respectively whereas the percentage shortage of solid blocks has been reduced by 1%. The frequency of occurrence of types of wastage due to work delay is ranked 1 and wastage due to human resources is ranked the least among the five categories of wastes considered in this study. It is also observed that the average lead time of non-value added activities is 25.4% in tiling, plastering and block work.

Index Terms: Non Value added Activities, Lean Construction, Muda Walks, Value Stream Mapping, Fishbone Diagram

Revised Manuscript Received on 30 July 2019.

* Correspondence Author

Prasanna Shetty*, Former M.Tech(CEM) Student, Dept. of Civil Engineering, Manipal Institute of Technology, MAHE Manipal, India.

Prof. B Prakash Rao, Associate Professor (Senior Scale) Dept. of Civil Engineering, Manipal Institute of Technology, MAHE, Manipal, India.

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an [open access](https://creativecommons.org/licenses/by-nc-nd/4.0/) article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

I. INTRODUCTION

The contribution of systematic and conventional study in construction industry is particularly engaged on customary ideas and standards involved in management of development venture along with universal propensity towards independent learning. Latest improvements in construction industry get minimal recognition and hence perceived by research scholars during thesis and these scholars provide the results based on the observations made. But, this research observation being practically followed is almost negligible. A lot of efforts must be made to encourage such that the new techniques are put to practice. Therefore, it is expected that the current industrialists have lack of knowledge on the current research made in the management of construction projects. According to the researchers the non-value-added activities are high usually during the completion phase of the project. The initial phases are given more priority as there is rigorous check on the quality of the product than the final phases and the requirement for labor is more during the initial stages of the project. This drawback of not providing the required amount of attention to each phase leads to reduction in the performance and rise in the time required for the completion of the project[1]. The placement of the belongings the capacity as to how much work can be extracted out of it and at what levels one can provide customer satisfaction is what lean construction is all about. Lean development comprehends the weakness in stocks and consider cost as the key prospect and deploy construction with a need to proceed the work to the next group and after that it is brainstormed to come up with different opinions[2].

II. LITERATURE REVIEW

M.S. Bajjou, and A. Chafi (2018) have mentioned in the study that by proposing a unique information yield show that goes for clearing up the primary calculated premise of Lean Construction reasoning, just as setting up associations between the fundamental standards of this idea and all the sources of wastes that exist in the construction organization. The proposed model shows nine fundamental standards: customer focus, supply, continuous improvement, waste elimination, people involvement, planning and scheduling, quality, standardization and transparency. Likewise, the common-sense connections between those standards and nine sources of waste have been examined[2].



Importance of Lean Concepts and Its Need in Construction Projects

Bogdan Bahnariu(2018) has studied the hurdles and success factors which would permit to create and execute the Lean culture important to empower Lean management tools. The workplace at a Romanian construction organization was considered in the light of Lean administration devices and social requirements, so as to evaluate the organization's ability to adjust to Lean management. The outcomes appeared in the examination somewhat fulfilled a portion of the prerequisites vital for a Lean culture, the most significant being its attention on its employee's improvement, which has additionally made a decent workplace dependent on trust and regard [3].

Hamzah Abdul Rahman et.al., (2012) have conducted a survey in a construction industry which has been experiencing low profitability and poor execution contrasted with different industries. Industry experts and specialists have taken a gander at the manufacturing industry as a point of reference and a source of advancement. Past investigations have appeared gigantic profitability enhancements can be accomplished by essentially focusing at decreasing or disposing of those waste. A construction procedure waste management system is proposed as the early on lean guide for those specialists who wish to begin their lean adventures [4]. **Xiaoqi Li** (2014) has conducted a study on significant value stream mapping which gives a diagram of lean tool, which offers a structure for future examination in the utilization of significant value stream mapping in construction industry. The other goal is to play out this very own contextual analysis involvement in doing this exploration consider and the value stream mapping of his literature review process. The value stream mapping process pictures the work and target waste, which empowers future enhancement towards a superior state [5].

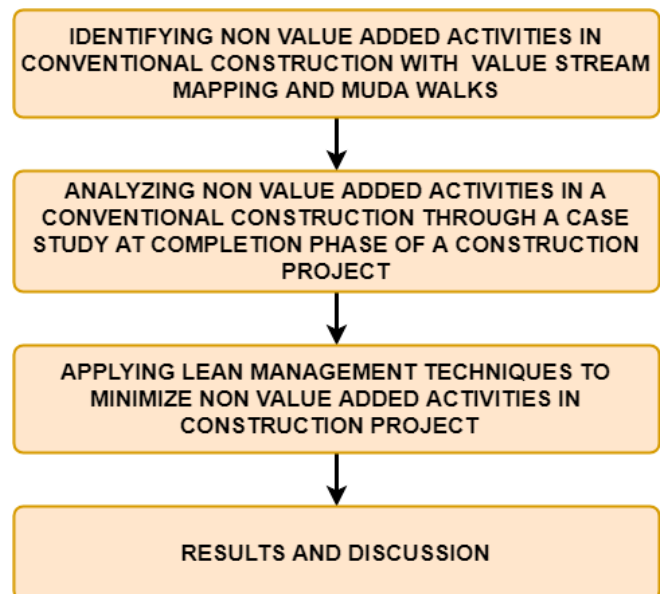
Lavina Susan Pothen, and Shobha Ramalingam (2017) have conducted a study which explains about poor efficiency and wasteful aspects in the production stage are disturbing issues in the construction field that additionally dissolve the offer of projects. Value Stream Mapping (VSM) and Work Sampling (WS) are two important strategies in the 'Lean' rationality that go for decreasing and limiting 'waste' in the existence cycle procedure of activities and in this manner associate in expanding efficiency. In this paper, they have studied about the usage difficulties and advantages of these two strategies in a mechanical task in India through an activity-based research system [6].

A. Findings from Literature

From the literature, the factors affecting the development of the construction projects were identified. The conventional techniques are the main issue and need modern techniques for improvement. This case study is all about implementing modern methods in construction industry.

III. METHODOLOGY

This study explains the techniques that need to be considered to adapt to lean construction and identify the non-value-added activities making use of lean tools. This study involves assessing the entire process mainly the completion phase of the project using the tools MUDA walks and Value Stream Mapping (VSM) and eliminate waste, improve the performance and profits, ensure safety and attain customer satisfaction. The entire observation is done in an ongoing construction of a 5-storeyed residential building, "Shrisham Housing Association" in Udipi for a duration of 6 months. The entire study is done in the completion phase of the project with an aim to understand the various activities involved and the connectivity between those activities. This involves interacting with the concerned engineers based on the current situation and identifying the wastes and coming up with plans to utilize the resources efficiently. The project methodology focuses on the completion phase activities like Masonry works such as Blockwork and Plastering, Flooring or Tiling and observing it with respect to the lean tools



MUDA walks and VSM. Fig. 1 describes the workflow.

Fig. 1: Chart Representing the Work Flow

A. Recognizing Non Value Added Activities

The wastage observed in all the activities involved in the completion phase of the project were recorded. These observations were then classified as waste due to Repairs, Waste due to Waiting Time, Waste of Materials, Waste due to Man Power and Waste due to Operations. Lean construction tools like MUDA walks and Value Stream Mapping were considered for this process [2]. The waste management framework which involves the three major steps like

Waste Detection, Waste Processing and Waste Response is shown in Fig 2.

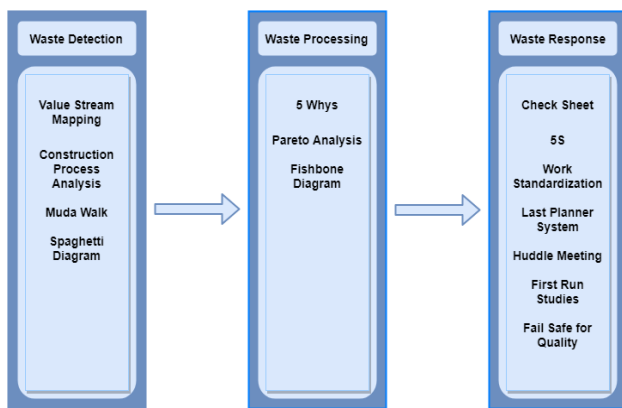


Fig. 2: Waste Management Framework

B. Waste Detection in Lean Construction

There are several tools in lean construction used for detection of waste like Value Stream Mapping (VSM), Construction Process Analysis, Muda Walks and Spaghetti Diagram. The tools used in this study are as follows:

1. MUDAwalks
2. Value Stream Mapping(VSM)

Muda signifies "waste" in Japanese. By walking a procedure, the workplace or passageway of an association, a site manager can become familiar with what's going on in the project site than by any other methods. The manager is expected to go through around one hour daily at different, random occasions walking around the site and watching employees working, communicating or interacting, and wandering. It involves figuring out how to identify waste and having the confidence and expertise to categorize it as waste. Taking a short trip around the building site helps one to identify the workflow whether the work is going on smoothly, a new sort of recycling that can be done, anything observed to be a waste, if the standards are being followed and use of equipment and its maintenance. It helps to understand what is right or wrong, what needs to be done, who should do the work, when the work needs to be done and check if any work is pending.

A Value Stream Map (VSM) is a tool that helps people observe and analyze a given procedure instead of just looking at the results. This sounds better because understanding the present condition of an activity also includes finding out and eradicating the waste. A VSM helps individuals to see the flow of value-Customer Value-Added versus Business Value-Added versus Non-Value-Added and its measure. Non-Value-Added activities lean into the process in few moments by understanding the procedure and is ready to provide a solution for that which enhances the performance and reduces wastage.

Thus, Value stream mapping is a type of a flowchart which utilizes symbols known as "the language of lean" to portray and enhance the flow of materials and instructions and its motivation is to give ideal product to the client through a total

value creation process with least waste. VSM helps as a diagnostic tool which helps to diagnose the cause for serious problems.

C. Waste Processing in Lean Construction

There are several waste processing techniques like 5 Whys, Pareto Analysis and Fishbone Diagram. The cause and effect diagram (Fishbone Diagram) are a simple yet incredible tool usually utilized in a cross functional setting to describe visually the potential underlying cause for an issue being referred to. The tool aims to organize the causes behind the issue into helpful groups, giving an opportunity to generate new ideas. The Fishbone Diagram then names the key causes visually represent the fish bone structure. The 5 Whys technique is an essential tool in the waste processing technique. It ensures effective root cause analysis in Lean Construction Management. The 5 Whys technique provides proper solution for any problem and make sure that the problems or failures do not repeat. An important factor that contributes to this technique is taking sound decision. This implies that the decision making process must be given to an experienced member who has clear knowledge and understanding of the project and its surroundings. The people who have good practical knowledge and can give the right information with respect to any problem in the project site.

D. Eliminating Non Value Added Activities in Lean Construction

There are several waste response techniques in lean construction such the "Check Sheet", "5S", "Work Standardization", "Just in Time", "A3 Problem Solving Report", "Last Planner System", "Visual Management", "Huddle Meetings", "First Run Studies", "Preventive Maintenance" and so on. For elimination of non-value-added activities where are considering tools like the Last Planner System, 5S, Daily Huddle Meetings, and First Run Studies.

IV. RESULTS AND DISCUSSION

The major goals of this project involved identifying conventional methods that influenced the time taken in the construction project. Hence, it is observed that projects required a process change to improve the quality and the profits. This led to identification of modern methods to ensure time optimization in the project. This eventually helped to determine the loss of "value" that is faced due to all the delay and unnecessary expenses specially in the completion phase of the project.

A. Waste Detection in Lean Construction

This project involves two techniques for waste detection, Muda Walks and Value Stream Mapping. Before going deep into the lean techniques, it is necessary to define certain parameters based on which value added and non-value-added activities can be classified.

Importance of Lean Concepts and Its Need in Construction Projects

An observation made during the project from “September 2018” to “February 2019” with respect to the different categories of materials purchased and the value shows how these materials were effectively used, percentage of materials that were excess, percentage of materials that fell short is shown in the Table 1.

Table 1: Percentage of shortage & excess material over a period of six months at site

Year	Month	Cement	M. Sand	P. Sand	Laterite Stone	Solid Blocks
2018	September	3.4	-22.4	-	1.2	3.8
2018	October	4.2	-19.3	-	1.8	4.3
2018	November	3.8	-21.7	-23.4	2.3	4.4
2018	December	3.3	-10.9	-18.4	1.4	3.9
2019	January	4.1	-8.3	-13.3	1.9	3.6
2019	February	3.9	-5.4	-14.3	-	2.8

(-) indicates excess.
(+) indicates shortage

Observing Non-Value-Added Activities

The observation was made using the MUDA Walk technique. This process involved the site management team which was aware of the site activities and followed suitable ways to perform supervision of site where it was ensured that the workers were comfortable and were able to get the work done efficiently. It found working conditions, materials quantity and quality, finishing of work and many other parameters. This process helped in identifying problems and deciding the best solution for the site at that point of time. One hour per day observations were made i.e. perform a MUDA walk at random time. The focus was on observing the work process, ensuring proper safety measures are implemented, checking the progress of the work, checking for possible environment risk. Identifying waste due to materials and resources. Communicating with the laborers identifying issues faced during implementation. Observing the work break taken by workers or not and breakdown of machines leading to delay in work.

Table 2 gives a detailed report of all the observation made during MUDA walks mainly considering the non-value-added activities, what category does it belong and the cause for such activities. Study reveals that during Laterite and blockwork phase, Cement Plastering Phase and Tiling and Flooring Phase. Overall, 38 different observations were made out of which 16 belonged to Laterite and Blockwork, 11 belonged to Cement Plastering and another 11 belonged to Tiling and Flooring Process.

Table 2: Categorization of non-value-added activities observed during "MUDA Walks"

Sl.no	Observed Non-Value Added Activities	Categories of Waste	Cause Category
a) Laterite & Blockwork			
1	Improper dressing of laterite stone	Operations	Method
2	Delay in shifting of materials	Delays	People
3	Delay in supplying materials to site by vendor	Delays	Material
4	Damaged blocks during transit	Materials	Material
5	Uneven size of laterite blocks	Materials	Material
6	Improper cutting of blocks	Materials	Material
7	Improper conducting by electrical & plumbing services	Operations	Method
8	Uneven thickness of mortar joints b/w blockwork	Operations	Method
9	Insufficient Curing	Operations	Method
10	Undulations in structural members	Human resources	Method
11	Rework for bad quality of work	Rework	People
12	Delay in installation of lintels	Delays	People
13	Rework for design changes	Rework	Management
14	Delay in requesting client inspection	Delays	Management
15	Rework for Damage by falling debris	Rework	Equipment
16	Delay in Providing diamond mesh at RCC joints	Delays	People
b) Cement Plastering			
17	Spillage of M. Sand during Transit	Materials	Material
18	Improper mortar mix ratio	Operations	Method
19	Excessive thickness of plastering	Materials	Method
20	Rework for cracks in plastering	Rework	Method
21	Insufficient Curing	Operations	Method
22	Inadequate mixing of mortar	Operations	Method
23	Improper storage of cement bags near work area	Materials	People
24	Improper fixing of diamond mesh for conduits	Operations	Method
25	Work clearance delays by client	Delays	Management
26	Delayed fixing of electrical pipes and junction boxes	Delays	People
27	Delayed fixing of door frames & window grills	Delays	People
c) Tiling & Flooring			
28	Breakage of tiles during transit	Materials	Material
29	Bad quality tiles received from supplier	Materials	Material
30	Rework for poor quality of tiling and flooring	Rework	Method
31	Excessive thickness of tile adhesive	Materials	Method
32	Inadequate curing of ceramic tiles	Operations	Method
33	Damage of tiles while cutting	Materials	People
34	Work Permission delays by client	Delays	Management
35	Delays in fixing plumbing & electrical fixtures	Delays	People
36	Delays and waiting time due to inadequate utilities	Delays	Management
37	Waiting time for shifting of tiles and other materials	Delays	People
38	Delayed work progress due to inadequate machinery	Delays	Equipment

After analyzing all the activities documented in the report the conclusion made is shown in Table 3 which is based on the frequency of occurrence of each activity and understanding the major non-value-added activities in the environment and ensuring such activities are controlled.

Table 3: Frequency of occurrence of types of wastages

Types of Wastage	Frequency	Ranking
Delays	13	1
Materials	10	2
Operations	9	3
Repairs	5	4
Human Resources	1	5

The frequency table is for all



Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

the commonly occurring activities observed during MUDA walks and are arranged in the order of the highest frequency to the lowest. The major cause for non-value-added activities being Delay in work with a frequency of 13 out of 38 observations which can have happened due to lack of resources or due to improper management. The second major problem was due to materials which can be due to transit problems or measurement issues or the way the materials were handled, with an occurrence rate of 10. The third major issue was operation that did not add to value of the project. The remaining cause for such activities were due to repairs or human resources which rarely occurred.

Applying Value Stream Mapping Technique

Value Stream Mapping was used for mapping all the process to the individual activities in the final phase of this building project. This process helps us identify the steps involved in each activity, it also helps us observe the possible subtasks in each activity. By listing all the steps, it is possible to differentiate between the tasks that added value to the project and tasks that were non-value-added activities. By performing a deep dive into each stage from the beginning till the completion. After performing a complete study, the activities that did not add any value to the project is observed. The observations are represented in a flow diagram with time cycles between value added and non-value-added activities. Value stream mapping flow diagram were designed for Blockwork, Cement Plastering and tiling or flooring of the building. Beginning with Blockwork, the following activities were observed during the project:

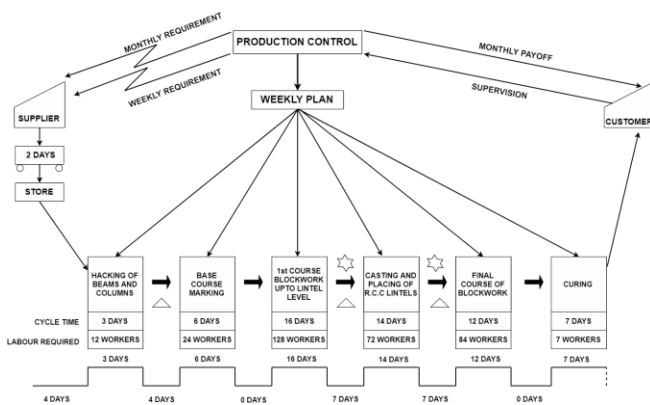


Fig.3: Flow chart representing Value Stream Mapping of Blockwork

In Fig. 3 there are 6 major steps involved in Blockwork. It involves hacking of beams and columns, base course making, 1st course blockwork upto lintel level, casting and placing of R.C.C lintels, final course of blockwork and curing. It is observed that a 58 days cycle time added value to the project. The total time taken to complete the blockwork of 5 storeyed building with 4 two-bedroom apartments on each floor is 80 days which is around 11 to 12 weeks. Non-value-added activities were highest after 1st course blockwork and after casting and placing of lintels.

The activities observed during Cement Plastering Phase

are:

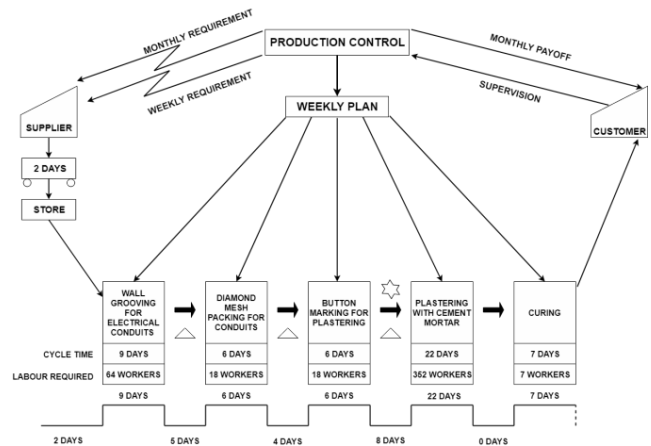


Fig.4: Flow chart representing Value Stream Mapping of Cement Plastering

Fig. 4 shows the 5 major steps involved in Cement plastering stage. It involves wall grooving for electrical conduits, diamond mesh packing for conduits, button marking for plastering, plastering with cement mortar and curing. In the process it is observed that a 50 days cycle time added value to the project. The total time taken to complete the Cement Plastering of 5 storeyed building with 4 two-bedroom apartments on each floor is 69 days which is around 10 weeks. Non-value-added activities were highest after button marking for plastering. Hence, the marking of a Rapid process improvement that helps in reducing the non-value-added time.

The activities observed during Tiling and Flooring Phase are:

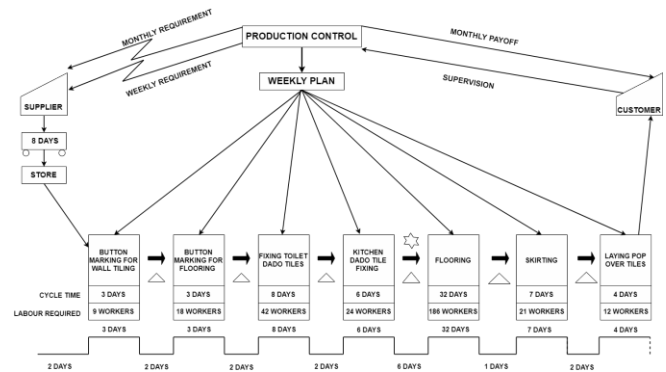


Fig.5: Flow chart representing Value Stream Mapping of Tiling and Flooring

The 7 major steps involved in Tiling and Flooring are shown in Fig. 5. It consists of button marking for wall tiling, button marking for flooring, fixing toilet dado tiles, dado tile fixing of kitchen, flooring, skirting and finally laying POP over tiles. In the process it is observed that 63 days cycle time added value to the project. The total time taken to complete the Cement Plastering of 5 storeyed building with 4 two-bedroom apartments on each floor is 80 days which is around 11 weeks. Non-value-added activities were highest after kitchen dado tile fixing.



Importance of Lean Concepts and Its Need in Construction Projects

Hence, the marking of a Rapid process improvement that helps in reducing the non-value-added time.

Value stream mapping for blockwork, Cement plastering and Tiling needs a production control which is the department involved in project planning. The thunder shaped arrow represents the internet or other communication facilities. Planning department is responsible to contact the supplier and specify the weekly and monthly amount of material required for each activity in the project. An arrow with a straight line shows normal flow of data from receipts, documents or conversation. The customer provides pay offs on monthly basis, all of this is submitted by the contractor in the form of Running Accounting Bills. Cycle time is the time required for completion of each step in every activity of final phase. The triangle icon represents the delay that occurred in each step of an activity. Rapid process improvement if required to reduce activities that added no value was represented with a star symbol or Kaizen burst icon. The total time taken by an activity from beginning till the end is called the Lead Time. The Lead time is the sum of time taken for activities that add value and time taken for activities that do not add value. With the help of all the non-value-added time and value-added time along with Lead time it is possible to determine the percentage of non-value-added activities as shown in Table 4.

Table 4: Percentage of Non-Value-added

Sl.no	Activity	VAT	Non-VAT	Lead Time	% Lead Time
1	Laterite & Blockwork	58	22	80	27.50
2	Cement Plastering	50	19	69	27.54
3	Tiling / Flooring	63	17	80	21.25
	Total	171	58	229	Avg:25.43

Waste Processing in Lean Construction Waste processing is used in identification of waste. This process focuses on processing the observations made during the identification phase. This requires the presence of site and planning managers who have knowledge of all the activities taking place in the site. This process requires two procedures one is the “Cause and Effect Technique” also called as the “Fishbone Diagram” and the second technique is the “5 Whys” Tool. These techniques involved discussions or brainstorming sessions among the managers and the experts from each field to find out the cause and the effect that each non-value-added activity did on the entire project. Fig. 6 represents the fishbone diagram for non-value-added activities in construction.

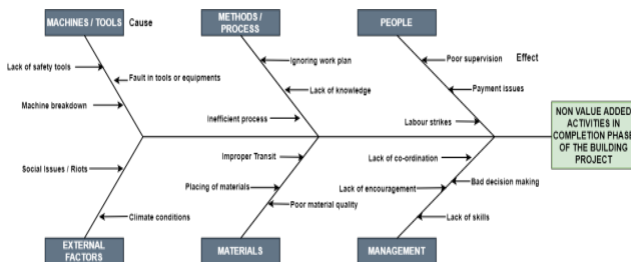


Fig. 6: Fishbone diagram for non-value-added activities in construction

This second technique was the “5 Whys” in which a Team is formed, of experts from each field and ensure that all the members in the team are aware of the activities on the site and have experience in such investigations. Studies suggest forming a cross-functional team, as ideas and opinions from different fields would help make effective decisions. This involves Team Work where not just a single person, but the entire team takes the decisions. The next step would be Defining the Problem Statement, with clear definition help to understand the issue and the impact that it can have on the project. The major part of this process is Asking Why, the team leader begins asking “why” 5 times or more with all the members and expects each member to provide true answers. This is continued until the root cause is identified. The team leader further analyses the problems and Take appropriate actions. The responsibility of taking the action is assigned to one of the members. The team needs to conduct regular meeting and keep a check on the Impact of the action taken whether it is positive and preventing repetition of the problems. The steps taken for the problems faced the decisions made need to be Documented. The document can be used for future reference and help saving a lot of time during similar problems.

B. Waste Mitigation in Lean

Construction Last Planner System

This process is required to make certain improvisation to the flow of all the activities in the finishing phase. This helps us to have a plan that helps us to avoid conflicts in the work. A 4-week pre planned schedule is designed that helps us to easily identify all the activities that need to be performed within the period of 4 weeks. This process required pre planning and all the required materials need to be arranged before beginning any process. A weekly work plan is designed to ensure all the important activities that need to be performed within that week is taken care of. Planned percent complete (PPC) is a tool that helps us identify the root cause for failure and rectifying the mistakes. To improve the quality of work the people working closely with the laborer needs to provide some inputs or specify if something is necessary to help the workers work efficiently.

Daily Huddle Meetings

Daily huddle meetings or Daily pass downs are conducted along with the last planner system which helps in sharing the daily work and updates between sub-contractors, Site engineers, Supervisors and foreman for effective working. This helps in prioritizing the work and taking effective decisions and reduces confusion and disagreements between team members. Planning daily work eventually helps us to complete the weekly targets.

“5 S” Principle

After completion of each tasks by the team it was ensured that there was reduction in non-value-added activities between each activity. Cleaning of workplace and proper placement of materials after each activity such as blockwork and Cement plastering can play a part in reducing non-



value-added activities. Assigning people to ensure the neatness of the site. Conducting regular audits and meetings and taking customer reviews. Maintaining the frequency of all that work and to realize the amount of waste to reduce it and enhance the performance. Understanding and realizing the wastage and enhancing the overall performance.

First Run Studies

The first run of a selected operations should be observed carefully, with an intention to improvise the work it is necessary keep making changes to the work after each run. A Plan, Do, Check and Act is followed to serve the purpose. This process includes creating a flowchart that helps to plan the work, implement it, test the impact and act. It helps to identify the errors and make the necessary changes in the sequence of activities. The data that is collected during observation is used to improve the process. Therefore, PDCA cycle ensures continuous development by reducing the non-value-added activities.

V. CONCLUSION AND FUTURE SCOPE

Researchers have said that in construction industry the need for lean practice is more than any other industry. The non-value-added activities observed like poor work implementation, congestion on the site, lack of neatness, lack of resources, delay and rework, quality issues and other external factors affected the work process. It is observed that there is a need for improvisation of the process to reduce non-value-added activities; the main reason being poor waste management on site. Therefore, the objective in this project was to incorporate lean construction process and eradicate conventional techniques. This helped us to improvise in terms of time in the current project. The observations, the changes made, and the action taken in each phase has been documented. Wastage of

materials was a common problem faced when conventional techniques were followed. Due to adaptation to lean practice it is observed to have a significant reduction in the percentage of waste in the following materials:

- M. Sand from 22.4% on September 2018 to 5.4% in February 2019
- P. Sand from 23.4% on November 2018 to 14.3% in February 2019
- Solid Blocks from 3.8% on September 2018 to 2.8% in February 2019

Wastage in Cement and Laterite stone could not be reduced due to lot of fluctuations of rates in the market and due to lack of availability of materials. Further it is observed that the impact of lean practice in this project resulted in reduction of non-value-added activities. In frequency of occurrence of types of wastages, it is observed that wastage due to delay in work ranked 1 with a frequency of 13 and the lowest being the wastage due to human resources with a frequency of 1 among the five categories of wastes considered in this study. The project was a case study based on the observations made during the construction process of a 5-storeyed building "Shrisham Housing Association" in Udupi for a duration of 7

months. This involved activities like Masonry work such as Blockwork and Plastering, Flooring and Tiling.

Tools of lean constructions like MUDA walks and Value Stream Mapping are used to detect the activities that did not add value. It is observed that the percentage of these activities with respect to Lead Time were,

- 27.50% for Blockworks,
- 21.25% for Tiling and Flooring
- 27.54% for plastering process

These results are processed using fishbone diagram to perform root cause analysis and 5 Whys techniques to arrive at conclusion and take right decisions. Few mitigation steps with techniques like last planner system, daily huddle meetings, 5 S principles and first run studies were adopted. This process involved preparing the work plan on weekly basis and conducting daily pass downs that helped prioritize the work and ensure the success of weekly plans. The neatness of the site was taken care which was an added advantage. After this study it is noticed that there is a scope for improvement in future. In this study comparison between each technique present for detection, processing and mitigation is not made.

A deep study on each of the tools of lean construction can be made to draw conclusions on the advantages and disadvantages of each of them. Combination of tools from each section i.e. detection, processing and mitigation can be considered for better outcomes.

REFERENCES

1. Mohammed S, and Hashem M, "Lean Construction Principles Past and Present – A Business Model Consistency," In Proc. ASC Annual International Conference, 2015.
2. Bajjou M.S, and Chafi A, "The potential effectiveness of lean construction principles in reducing construction process waste: an input-output model," Journal of Mechanical Engineering and Sciences, vol. 12, no. 4, pp. 4141-4160, 2018.
3. Bogdan Bahariu, "Barriers and Success Factors for a Lean Culture," In Proc. Int'l. Group for Lean Construction, 2018, pp. 631-641.
4. Hamzah A, Chen W, and Irene Y, "Waste Processing Framework for Non-Value Adding Activities Using Lean Construction," Journal of Frontiers in Construction Engineering, pp. 8-13, 2012.
5. Xiaoqi Li, "A Literature Review on Value Stream Mapping with a Case Study of Applying Value Stream Mapping on Research Process," M. S. thesis, 2014.
6. Lavina P, and Shobha R, "Applicability of Value Stream Mapping and Work Sampling in An Industrial Project in India," In Proc. 26th Annual Conference of the International Group for Lean Construction. Chennai, India, 2017, pp. 516-526.

AUTHOR PROFILE



Prasanna Shetty, Former M.Tech (CEM) Student, Dept. of Civil Engineering, Manipal Institute of Technology, Manipal Academy of Higher Education Manipal, India

Importance of Lean Concepts and Its Need in Construction Projects



Prof. B Prakash Rao Associate Professor (Senior Scale) Dept. of Civil Engineering, Manipal Institute of Technology, Manipal Academy of Higher Education,,Manipal,India. Has published 19 papers in International Journals,5 papers in National Journals,11 papers in International Conferences and 21 papers in National(Indian) Conferences till date. He has visited 27 Countries till date of which 9 are for presenting papers in International Conferences.