

# Lean Construction – Application of Value Stream Mapping on Infra Structure Project

Khaja Layeequddin<sup>#1</sup>, Suebha Khatoon<sup>\*2</sup>

<sup>1</sup>Student, M Tech (Construction Management), Lords Institute of Engineering and Technology, Hyderabad, India

<sup>2</sup>Assistant Professor, M Tech (Construction Management), Lords Institute of Engineering and Technology, Hyderabad, India

**Abstract** — Value Stream Mapping (VSM) is a tool for depicting the flow of material in a manufacturing process. This study demonstrates that value stream mapping can also be applied to the movement and processing of information in Infra structure projects. Currently it takes about 40 days to cast a single slab. The value stream map shows that 7 days of this time consists of non-value added activity such as backlogs and waiting. Using Lean tools both value-added and non-value added activities on the value stream map can be identified. The future state map shows how the process might be improved after changes are made to the process. The challenge lies in organizing the information in the VSM to remove or reduce the non-value added steps. There are some distinct differences between the office processes and manufacturing processes. Unlike production systems, information flows can be loosely structured and use informal scheduling, making it difficult to identify and map their values streams. However, companies can apply value stream mapping tool to office processes in the same way they use it in manufacturing.

**Keywords** — Lean Construction, Value Stream Mapping

## I. INTRODUCTION

This chapter explores the history of Lean Manufacturing and how Lean can be implemented outside manufacturing. It will show how Lean is used in service and present relevant case studies. Finally, it will introduce value stream mapping. The term Lean thinking, or Lean production, was first used in the book by James P. Womack and Daniel T. Jones, “*The Machine that Changed the World*”. Lean Manufacturing is a philosophical way of thinking, and has a basic goal of satisfying the customer through on time delivery and high quality products by simply eliminating waste. The entire lean philosophy is not as simple to implement as the definition might suggest. There are a number elements involved to make the philosophy work as a system. Perhaps a more understandable is the definition given by “John Shook:” “*A manufacturing philosophy that shortens the time line between the customer order and the shipment by eliminating waste*”. This means that one builds what the

customer orders as soon as possible after the order, and that the total lead time between order and delivery is as short as possible.

## II. HISTORY OF LEAN MANUFACTURING

Many people understand that lean manufacturing concepts and practices were developed for the Toyota manufacturing system. While this is correct, Lean manufacturing history goes beyond this. Lean manufacturing concepts were used in other manufacturing systems before Toyota. In

1104, the Venetian navy standardized the design for building warships using interchangeable parts. By 1574, the Venetian practices were so advanced that King Henry III of France was invited to watch the construction of a warship in a continuous flow. In 1765, French general Jean-Béptiste De Gribeauval had grasped the significance of standardized designs and interchangeable parts to facilitate battlefield repairs. By 1807 Marc Brunel in England had devised equipment for making simple wooden items like rope blocks for the Royal Navy. Twenty-two machines produced identical items in process sequence one at a time. By the 1822, Thomas Blanchard at the Springfield Armoury in the U.S had devised a set of a 14 machines and laid them out in a cellular arrangement.

The Ford motor company used Lean manufacturing concepts to manufacture the Model T automobile in early 1914.

## III. LEAN OUTSIDE MANUFACTURING

Lean manufacturing is a management philosophy focusing on reduction of the seven wastes in manufactured products-overproduction, waiting time, transportation, processing, inventory, motion and scrap. By eliminating waste, quality is improved, and production time and costs are reduced. Lean has reduced inventories for manufacturers, improved knowledge management and decreased lead times for customers in an automotive industry. Some of the cases where Lean techniques used are in ASMC in Dresden, Germany where they used it in the chip making operations. The Lean implementation reduced the lot travel distance from 925 to 363 meters; lead time variability from 2.86 to .83 days, and; lead time from 4.21 to 2.64 days. Vibco Vibrators Inc. in Wyoming used Lean techniques

and decreased their setup time for machines from 2 hours to 10 min. Many companies have considered a Lean transformation to be limited to the manufacturing floor. One simple reason for such belief is an inability to differentiate value from waste, and difficulty in implementing improvements, in administrative areas. In the initial stages of the implementation of Lean, many companies achieved remarkable improvement on the shop floor, but they neglected important office processes from the value stream map. By not including office processes, companies failed to see the total picture of the enterprise and thus could not effectively eliminate the waste present in the non-production areas. Sometimes many companies neglect to look the actual causes of waste that are present in support processes for the shop floor. If the support processes are not considered, then opportunities for improvement remain, both on and off the shop floor. The ignorance of people in capturing the information typically creates twice the waste in the office than on the shop floor. Moreover the waste produced by office processes hamper the growth of companies.

#### **IV. VALUE STREAM MAPPING**

This research study uses value stream mapping (VSM). VSM is the discipline of mapping the material and information flows that are required to coordinate the activities performed by manufacturers, suppliers, and distributors, to deliver products to the customers. Sometimes, it is defined as a collection of all actions value-added and non-value added that are required to bring a product or a group of similar products from the raw material to the customer. Value Stream Mapping is a powerful tool to eliminate waste and make the supply chain of any organization Lean and responsive. VSM can be done in the same way for practically any business activity, and can be expanded upstream and downstream to encompass the entire supply chain. This powerful tool not only highlights process inefficiencies and transactional and communication mismatches, but also guides the organization in improving these areas. This thesis considers the flow of information.

1) The information is generally transferred by paper or electronically. These processes often vary in scope. For example, requirement of shuttering material does not require much time for the contractor to review and approval. Companies often view administrative departments such as human resources, finance, engineering, and purchasing, as independent contributors to its success. They do not see the interaction and integration of the work activities involving multiple functions and departments. It is no wonder then that companies have difficulty in grasping the concepts of a new value stream design for the office. A company can overcome the inherent challenges of value stream management in the office by identifying and

redesigning one or two value streams to begin with, then adding more as it continues its Lean transformation.

2) VSM helps to identify all types of waste in the value stream and target specific areas for improvement. It helps to see the big picture and improve the whole flow. Some firms that followed different Lean tools like JIT, 5S, and TPM, felt that there is a need to understand the entire system in order to gain maximum benefits from lean. VSM is a pencil-and-paper tool, which is created using a standard set of icons.

3) Generally a VSM tool contains both a current state map and, one or more future state maps that represent progressive improvements to the current state map. Before drawing a current state map, a particular product or product family must be chosen as the target for improvement. The current state map is the beginning point of the enterprise transformation it represents the baseline condition of how the company organizes and progresses work. The map itself solves no problems rather its purpose is to point to problems in the company work streams. The current state map is essentially a snapshot capturing how things are currently being done. This is accomplished by following the selected product from beginning to end, observing every process. The second aspect of the current state map is the information flow that shows how each process knows what, and how much, to make. The information flow is drawn on the upper portion of the map, left to right. Travel time is the time taken for the information to reach from one process step to another, and is shown on the information arrows. Every process box there will display both value-added time and non-value added time for the given step. The value-added time represents the sum of the processing times for each process, while non-value-added time is the time that is taken for waiting and backlogs.

**Step 1:** Clearly identify the objective of the process.

**Step 2:** Identify all the positions (or people) involved in the process of achieving that objective. Cross-functional team members from all parties involved in the project should be included in all mapping sessions.

**Step 3:** Write a step by step outline of each action in the process as information or materials is passed through each position.

**Step 4:** Draw a “current state” value stream map, which shows a step by step process flow. This is a flow chart diagram and must include all the steps as the process is currently conducted (not how it “should be” or “can be” conducted.) Show the good, the bad and the ugly. This is real world, as it happens today.

**Step 5:** Once the “current state” is mapped out, identify process times and delay times on actual steps or actions, as well as between actual steps and actions where no activity may be taking place. (This may be waiting times.) Make sure you have input from every position (or person) involved in the process.

**Step 6:** Next identify steps in the process that are non-value added. Another term for non-value added is waste. Waste is any activity that is not adding value to the end product or service. Target the wastes specifically. (Often in construction, non-value added is anything that the customer would be unwilling to pay for, but depending on the process, it can be anything that doesn't directly help you achieve the process objective.)

It has been observed that lack of proper planning has resulted in wasted effort of project team members, sub optimal results due to conflicts in the field and continuous in consistent performance.

Some issues which arose due to lack of proper planning by the management at site are listed below.

- Problems in sequencing as no instructions were given on time and absence of supervisor.
- Non availability of labor at site for various reasons.
- Slab Reinforcement not ready on time.
- Non availability of materials like steel which delayed the reinforcement activity. v. Checking by the client representative can be done in day shift only.
- Proper planning was not carried out in the beginning this can be observed in the removal of high tension cable line that was passing through the project.



**Fig 1: Lean Construction**

## V. ANALYSIS

The current state map for casting of the slab is shown in Figure 4.3. Based on this map waste identification and categorization is done. During the site visits lack of proper planning at the site was clearly observed. One particular contributor to wait time is time taken for checking and approvals. This is common where several participants interact, playing different roles for different organizations. Due to the lack of decision making, information was awaiting proceeding for days. Therefore, identifying and eliminating this wait time is essential to compress the throughput time of one cycle. A number of instances were observed at site when rework had to be done after inspection by the client representative. This was attributed to the absence of one of the client representative during the alignment or the fixing was carried out. As it can be seen in the

current state map that client checking is carried out twice in one cycle of casting. Most of the delays were from the client side in checking which leads to the stretching of the entire process cycle. Another particular contributor to wait time was supply of ready mix concrete by the batching plant. The whole system is following a push system which is against the principles of Lean production methodology. One process is pushing and calling for the second activity to happen. After the reinforcement is laid down for the columns and casting has been done the form work for erecting the slab has to be carried out but there was severe shortage of formwork for erecting the slab which was not properly planned by the contractor. Concreting for the slab has to be carried out immediately after laying the reinforcement but there were series of waiting time and break down of batching plant. This situation occurs because of lack of coordination between different sub contracts working at the same place. There are numerous

causes that are delaying the casting cycle. Coordination issues were the most prominent one. Revision of drawing hampered the progress of work at times. An attempt to classify the identified problems was done and highlighted the present scenario in various dimensions – viz Material flow issues, information or communication issues, manpower issues.

It has been observed that lack of proper planning has resulted in wasted effort of project team members, sub optimal results due to conflicts in the field and continuous inconsistent performance. Some issues which arose due to lack of proper planning by the management at site are listed below.

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## VI.CONCLUSION

The case study has looked upon the applicability of Value stream mapping in casting of slab activity where work is carried out in a repetitive manner.

Regarding elimination of waste leading to cost efficiency value stream mapping seems to have at least the possibility to identify waste for administrative purposes. Value stream mapping tools only gives as much information as the data put into it. By establishing a batching plant at the site there would have been cost reduction in ready mix concrete of a margin about 15-20% to the client.

Proper planning must be adopted from the contractor side in making the materials readily available at the site thereby not delaying the activities as per planned. By increasing the duration of activities there had been increase of about 28 percent in the total wage payment given to the crew. The model is dependent of quantitative information – transforming input to output. For projects which are in starting stages this tool might not be that useful because of unavailability of complete information.

## ACKNOWLEDGMENT

We wish to acknowledge Mohammed Shaffiuddin, Professor and HOD, Department of Civil Engineering, Lords Institute of Engineering and Technology, Hyderabad for his valued support throughout the project phase.

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