Value Stream Mapping in Manufacturing Industry: A Review

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Abstract – In today's global competitive world, the era of mass production and push system is over. Now customer satisfaction is prime objective as they compare value of the money and the value they received from that money. They will not pay for any waste. Moreover, their demands vary and that needs to be tapped at the earliest to enjoy the first mover experience in the competitive market. Hence, Value Stream Mapping (VSM) is one of the best and most common tools of lean manufacturing to identify and eliminate wastes. Future State Value Stream Map (FVSM) helps to reduce Non-value added activity (NVAs) in a process and make a production flow efficient, effective and economic. This paper discusses methodology to implement value stream mapping and its benefits to various manufacturing industries. This paper also represents a literature review to summarize various applications of VSM. The paper concludes with highlighting VSM's contribution to delight customers.

Keywords: Lean manufacturing, VSM (Value stream map), CVSM (Current state value stream map), FVSM (Future state value stream map), VA (Value added activity), NVA (Non-value added activity), NNVA (Necessary non-value added activity).

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INTRODUCTION

To sustain in this changing and developing Market adoption of lean tool is must. Lean manufacturing is comprehensive set of techniques for waste identification and its elimination from processes in order to increase system flexibility, effectiveness and reduce costs [1]. One of the most common and easy way to find lean wastes is VSM technique.

Now let us first understand what is value? Value of the product is measured at end users. Value of the product for customer is in terms of money, satisfaction, performance, service or elegance. To serve the best cost to benefit to the customers company needs a customer requirement data. This data become helpful to make a right product for right customer with right specification at right time with right price. To make this entire system optimised and to match up with the organizational goals VSM is the most common and helpful tool to make entire stream valuable and to eliminate non-value adding activities. It helps to plot each sub activities within the processes to eliminate the lead time & thus reduce the cycle time significantly.

Value Stream Mapping (VSM) is a set of methods which is used to visually display the flow of materials and information. Whenever there is a product for a customer, there is a value stream and the change lies in seeing it. Value Stream map is also known as "Material and information flow mapping" in Toyota [2]. It is developed as a outcome of the work done by Taiichi Ohno at Toyota in the 1960's -70's. VSM doesn't require a tough and tedious work rather it requires just a paper, pencil and eraser to draw it and brainstorming for improvements and comments.

A value stream includes all the operations and processes to transform raw materials into finished goods or services, including non-value adding activities. Value stream management is a management tool for planning a production process involving lean initiatives through systematic data capture and analysis (Tapping, 2002). It is a proven process for planning the improvements that will allow companies to develop lean practices.

In one project there are two value stream maps. A current state map (CVSM) and a future state map (FVSM). A current state value stream map shows the actual process at the beginning of a project. It identifies wastes and NVAs. The future state map shows what the process should look like at the end of the project? After that improvements are defined and are achieved by making changes in current system. This achieved FVSM will become CVSM for next project and this cycle continuously runs.

We can use VSM as a Lean method to identify the opportunities of improvements for future. VSM method is associated with production as well as with service sectors. It can be used for:

- Development of new product;

- Logistics and supply chain activities;

- Improving productivity hence profitability;

- Reduction in production and service time;

- Customer satisfaction;

- Developing efficient production technique.

- Layout/ equipment modification.

VSM is an analytical method and it is based on details, depending on the level of details, the VSM can address a process step, to one or to the production lines, or to the entire factory [3]. Value stream mapping has supporting methods that are often used in Lean environments to analyse and design flows at the system level (across multiple processes).

PURPOSE OF STUDY

The purpose of this study is to develop a value stream map for a manufacturing company. This particular tool allows the company to document current lead time, inventory levels and cycle times to determine the ratio of value added to total lead time of the product line being analysed. The first step will be to create a current state map to make a picture of the production flow and understand the company's current cycle times, process communications, and machine equipment capacity. This provides the information needed to produce a future state map by creating a vision of an ideal value flow, although that will not be done in this study. The goal is to identify and eliminate the waste, which is any activity that does not add value to the final product, in the production process.

Thus ultimately value stream mapping will help the capacity planners in capacity planning & verification to meet the customer's expectation in terms of quantity & quality by optimising the resources and thus reducing the input operational costs.

RELATED CONCEPTUAL WORK

Value stream mapping is a recognised method used as part of Six Sigma methodologies. Value stream refers to those specifics of the firms that add value to the product or service under consideration and it is necessary to map both inter- and intra-company value-adding streams [18]. The rate at which value is added to a single product from the raw material stage through dispatch and delivery to the customer and changing view of organizations towards improvement to

processes is discussed [4]. A new scheme of classifying operations into three generic categories as non-value adding (NVA), necessary but non-value adding and value adding is suggested. This scheme proved to be more generic and was extended to different areas [12]. Individual tools to understand different value streams maps and regarding their overlapping nature and use were developed [8]. The five tenets of lean manufacturing were enumerated and it was emphasized that VSM has to be carried out as the first step towards lean implementation [17]. A classification scheme about seven new mapping tools (namely, process activity mapping, supply chain response matrix, production variety funnel, quality filter mapping, demand amplification mapping, decision point analysis and physical structure mapping) and their applications areas were suggested [7]. It was shown that unnecessary inventory, defects, inappropriate processing and transportation were the most serious wastes in the system, further suggested to adopt five of the VSM tools: process activity mapping, supply chain response matrix, quality filter mapping, demand amplification mapping, and decision point analysis [9]. A new approach for VSM in detail including a summary of the previous VSM approach and its weaknesses was described.

The new approach involves a strategic review of a business or supply chain's activities, the delimitation of key processes and the mapping of these processes. It also highlighted limitations of VSM and categorized them under main heads such as: limitations related to VSM method: VSM did not take care about other wastes such as wasted energy or wasted human potential, areas of overlap between value streams were not covered such as finite capacity planning. Limitations of VSM related to general environment use: lack of understanding of what becoming lean means, lack of formal education step in the process at either senior level or operational levels, lack of understanding of a particular firm's position in a supply chain and the implications of their actions, lack of linkage to corporate strategy and wider market environment, lack of review of other key processes in different business and supply chain environment such as new product development and in order to avoid "shop floor myopia", lack of understanding about human resource issues such as the appropriate internal or external culture, language, and relationships required by organizations [6]. It was noted that VSM may not serve the purpose when it is used to map a production line which produces different types of product families that are having different processing times and set-up times for each processing step apart from different number of shifts [11]. It was rightly argued that whenever there is a product for a customer, there is a value stream. The challenge lies in seeing and working on it. VSM can be done in the same way for practically any business activity and expanded upstream or downstream. This powerful tool not only highlights process inefficiencies,

transactional and communication mismatches but also guides about the improvement [14]. Anything other than the minimum amount of equipment, effort, materials, parts, space, and time that are essential to add value to the product was defined as waste. They also told that waste takes many forms and can be found at any time and in any place. It may be found hidden in policies, procedures, process and product designs, and in operations [15]. The use of value stream mapping to the field of accounting to determine the process costs of a value stream was extended. The information contained in value stream maps can be used to calculate current and future state process costs and create value stream profit-and-loss statements [10]. A classification scheme to serve as a link between manufacturing waste problems and lean manufacturing tools was proposed. A manufacturing organization can match its manufacturing wastes with the appropriate lean manufacturing tools. This classification scheme systematically organizes lean manufacturing tools and metrics according to their level of abstraction, appropriate location of application of the tool in the organization, whether it addresses management waste or activity waste, the type of resource waste it addresses, and whether it identifies waste, measures waste, eliminates waste, or a combination of the three [13]. Value stream maps for determining the beliefs, behaviours, and competencies possessed by business leaders were described and with the help of current and future states map, the ineffectiveness of most senior managers as well as traditional leadership development programs were highlighted [5]. They also proposed an alternative and innovative framework for a structured application of VSM to products requiring nonlinear value streams, based on the preliminary analysis to identify the longer critical production path using the temporized bill of material. After identification of the critical path, possible improvements were searched and then all sharing with secondary paths were considered as further constraints. Finally, when the main value stream got improved, a new path became the critical one. Thus, the analysis proceeded iteratively until the optimum is reached or the WIP level has decreased under the desired level [19]. Singh et al. suggested industries to apply VSM techniques to find money drain points in their balance sheets and also apply these techniques to cut down operational cost to save business during recessionary times [16].

METHODOLOGY

The methodology applied to implement Value Stream Mapping is basically having five steps. These all step overlap with "DMAIC" (Define, Measure, Analyse, Improve and Control) approach. So we can say that VSM activities are an integral part of DMAIC approach.

1) **Identifying product family:** To concentrate on one specific product for improvement.

2) **Drawing current state value map (where we are):** It includes all VA, NVA, NNVA activities. We can draw CVSM by using past data and customer feedback.

3) **Drawing future state value map (where we want to reach):** By Continuous analysing and brainstorming we can plot our targeted VSM.

4) **Work plan (route for success):** Using lean tools (Kanban, supply chain management, poka-yoke, MRP, etc.) we have to plan best promising way to achieve goal. There are some standard symbols used in VSM drawing for easy understanding.

5) **Implementation and Measure benefits (tasks for goal achievement):** Last stage is about implementation of new techniques and measuring benefits achieved by them. This measurement helps us to conclude how much we succeed towards our target. Lagging in target achievement will be always there and it should be improved in next VSM.

Thus cycle of VSM will not stop after implementation of FVSM, it will become CVSM for next project and continuous improvement process will be carried out.

A) **Five Primary Elements for Value Stream Mapping (VSM)**

The five primary elements to consider when implementing VSM are manufacturing flow, organization, process, metrics, and logistics. These elements represent the variety of aspects needed to sustain a successful VSM implementation program. Manufacturing flow addresses physical changes and design standards. Organization identifies people's roles/functions, training in new ways of working, and communication. Process control is directed at monitoring, controlling, stabilizing, and pursuing ways to improve the process. Metrics addresses visible results-based performance measures, targeted improvement, and team rewards/recognition. Logistics provide the definition for operating rules and mechanisms for planning and controlling the flow of material.
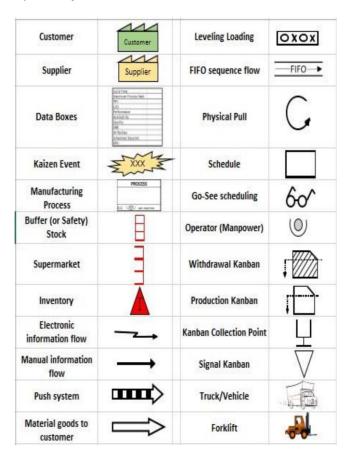
B) **Key Elements of Value Stream Map**

• Process Flow

• Material Flow

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- Information Flow

- Process Metrics Data

- Customer Requirements

- In-Process Inventory (WIP)

- Lead Times for Each Process Step

C)   **Process Metrics Data for VSM**

- Cycle Time (C/T)

- Changeover Time (C/O) & Frequency

- First Time through (FTT)

- No. of Product Variations

- No. of Operators

- Uptime or Availability

- Overall Equipment Effectiveness

- Operating Pattern

D)   **Symbols used in VSM are shown below**

Customer	Customer	Leveling Loading	OXOX
Supplier	Supplier	FIFO sequence flow	—FIFO→
Data Boxes		Physical Pull	
Kaizen Event	XXX	Schedule	
Manufacturing Process	PROCESS	Go-See scheduling	
Buffer (or Safety) Stock		Operator (Manpower)	
Supermarket		Withdrawal Kanban	
Inventory		Production Kanban	
Electronic information flow		Kanban Collection Point	
Manual information flow		Signal Kanban	
Push system		Truck/Vehicle	
Material goods to customer		Forklift	

E)   **Ten Steps to create a VSM Model**

1. Draw customer & supplier icons.

2. Draw customer & supplier information flow.

3. Draw & label production processes.

4. Draw inventory triangles for raw/WIP/finished goods.

5. Draw customer delivery icons.

6. Draw supplier delivery icon.

7. Draw production scheduling information flows.

8. Draw material flows.

9. Calculate total lead time & process time.

10. Calculate TAKT time for the process.

CONCLUSIONS

From the literature review and my gradual learning about VSM, I realized that value stream mapping is a powerful lean tool that can provide an overall view of how work flows. Visualizing non-visible work is the first step in knowing how work gets done, thus the work can be further analysed to see where waste exists. The benefit of value stream mapping is summarized as follows:

(1)   Value stream mapping helps in identifying waste.

(2)   By providing a full-cycle view, value stream mapping deepens the understanding of processes required in delivering value.

(3)   Value stream mapping shows the information flow through the processes.

(4)   Value stream maps offer a direction for improvement.

(5)   The quantitative nature of value stream mapping makes improvement quantifiable.

(6)   The visual unification tool can help in visualizing non-visible work, such as information exchanges. Visualizing non-visible work is a key step in understanding how work gets done.

(7)   Value stream maps can create connections to the customer, which helps an organization focus more on the customer's perspective and deliver more value to the customer.

(8)   Value stream maps can provide a holistic system view by connecting disparate parts into a more collaborative organization, with

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the objective of providing higher value to customers.

(9) Value stream mapping can help in visualizing and simplifying the work process at a macro level, which may help in making strategic decisions for improvements better and faster.

(10) Value stream maps are effective means to orient newcomers by helping them understand a holistic view and where they fit in an organization.

To sum up, value stream maps provide a visual, full-cycle macro view of how work progresses from a customer request to the final fulfilment of that request. The mapping process deepens the understanding of work systems that deliver value to customers and reflect the work flow from a customer's perspective. As a result, the process of value stream mapping provides effective ways to establish strategic directions for better decision making and work design.

FUTURE WORK

The following research points maybe suggested for future work:

1. This research work focused on the exploration of VSM at a broad base of observation and in one industry only. Further analysis of this topic may find benefit in the more in-depth study of VSM examples, using this research as background.

2. This research work is focused on lean implementation using VSM only. The research may further be explored in deployment of other lean tools namely 5S, Kaizen, TPM, SMED, Kanban etc.

3. Verification studies of the proposed VSM method are necessary to determine the efficacy of the method, and how it may be advanced.

4. In order to avoid unplanned machinery downtime, Total Productive Maintenance (TPM) techniques can me implement because it increases the efficiency and useful life of the equipment.

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