Value Stream Mapping Methodology for Lead Time Reduction: A Review

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Abstract: **In today's global competitive world, the era of mass production and pull 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. Thus, Value Stream Mapping (VSM) is one of the best and most common tools of lean manufacturing to identify and eliminate wastes. FVSM helps to reduce 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 production industries as well as in service sectors. This paper also represents a literature review to summarize various applications of VSM. The paper concludes with highlighting VSM's contribution to delight customers.**

Key words: Lean, 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).

I. 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.

Before giving definition of VSM we should 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 value 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 correct VSM is the most common and helpful tool to make entire stream valuable and to eliminate non-value adding activities.

Value Stream Mapping (VSM) is a set of methods to visually display the flow of materials and information. When ever there is a product for a customer, there is a value stream and the change lies in the 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 required a tough and tediouds work it requires just a paper, pencil and eareser to draw it and brainstorming for improvements and comments.

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 what is the actual proces 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 achived by making changes in current system. This achieved FVSM will become CVSM for next project and this cycle continously 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].

II. METHODOLOGY

The methodology applied to impliment Value Stream Mapping is basicaly having five steps. These all steps are overlaps to "DMAIC" (Define, Measure , Analyse, Impove, Control) approch. So we can say that VSM activies are an integral part of DMAIC approach. . Here, we can see similarities between them

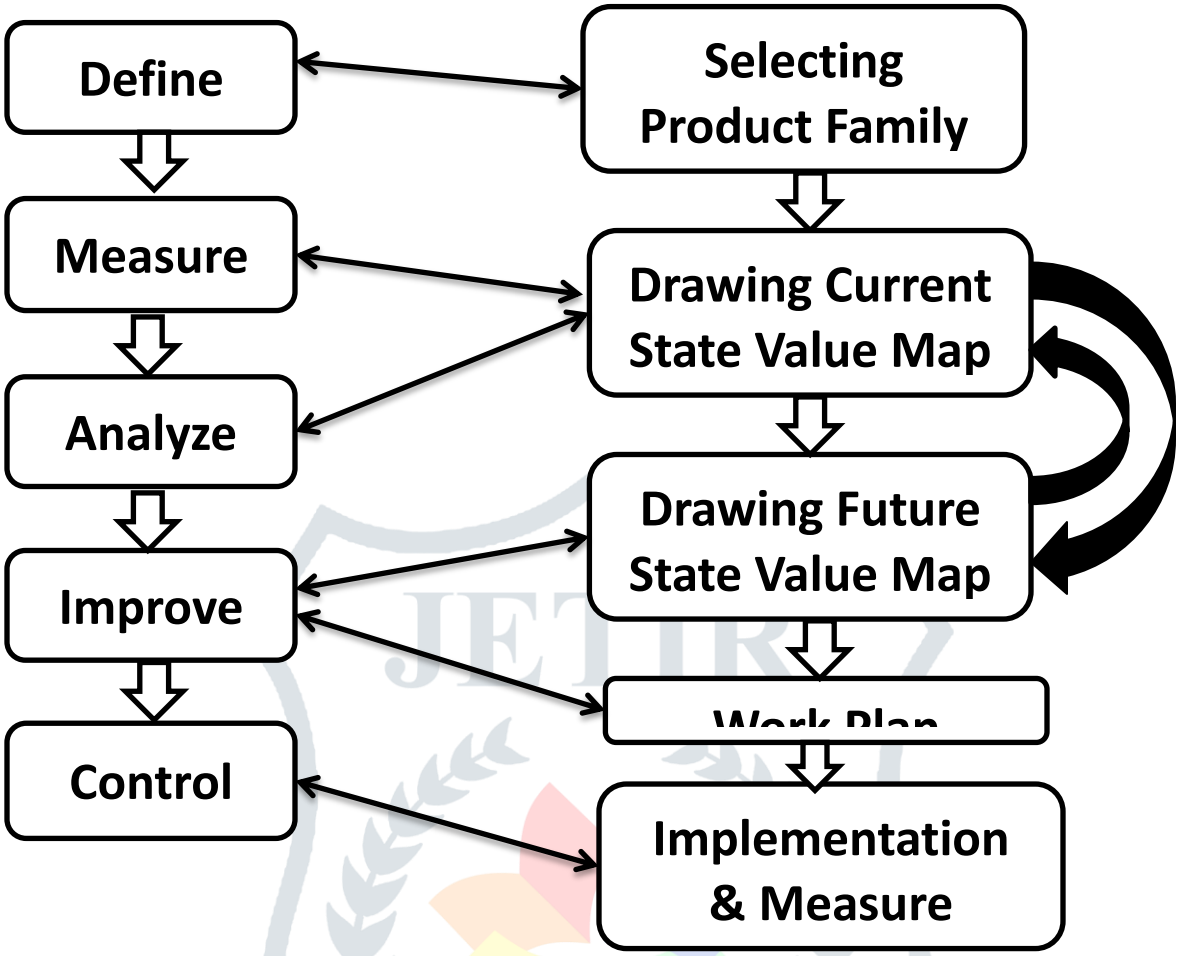

Fig.1Relation between DMAIC and VSM methodology

i. Identifying product family: To concentrate on one specific product for improvement.
ii. Drawng 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.
iii. Drawing future state value map(where we want to reach): By Continious analysing and brainstorming we can plote our targate VSM.
iv. 4.Work plan (route for sucess): Using lean tools (kanban, supply chain management, poka-yoke, MRP.etc) we have to plan best promicing way to achieve goal. There are some standerd symbols used in VSM drawing for easy understanding. Some basic symbols are shown in fig(2).
v. Implemetation and Measure benefits (tasks for goal achivement): Last stage is about implementation of new tecniques and measuring benefits achieved by them. This measurement helps us to conclude how much we succed 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 continious improvement process will be carried out.

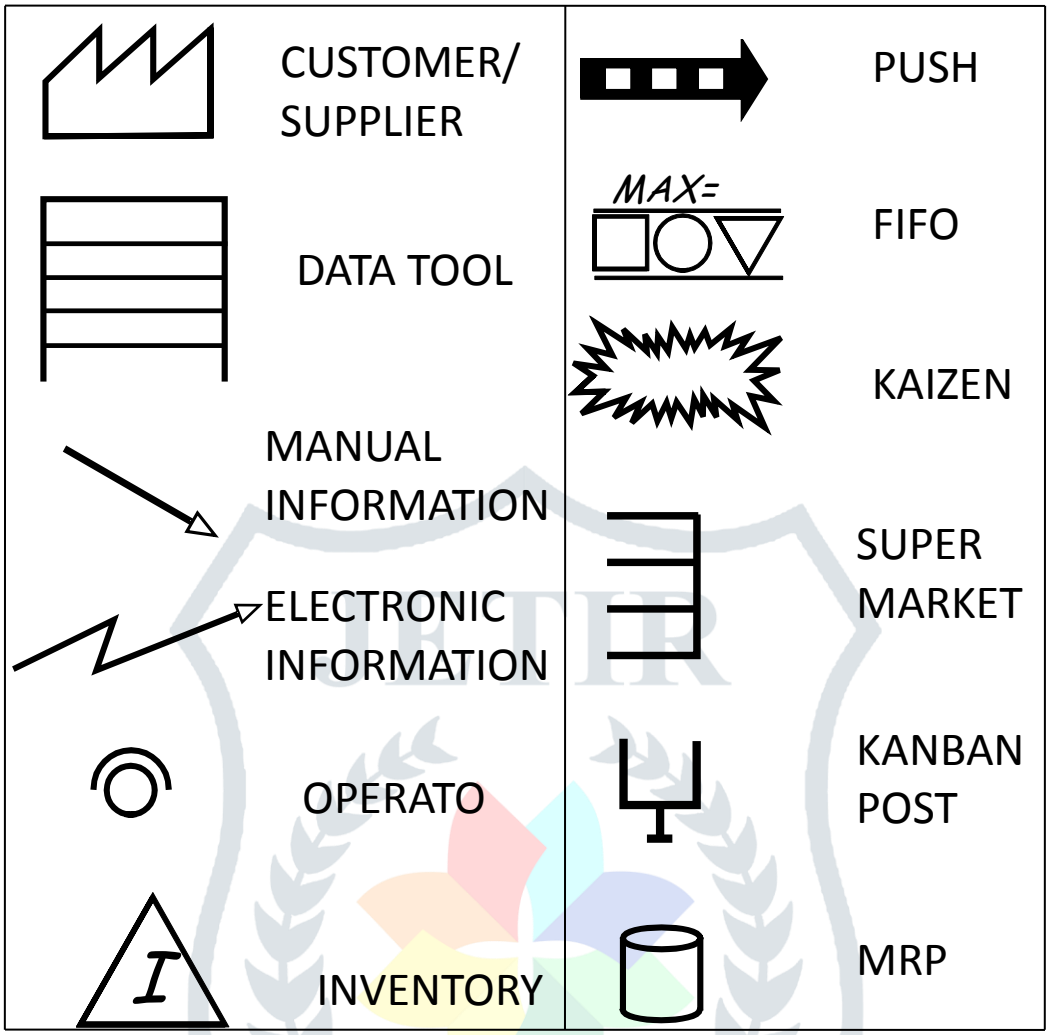

Fig. 2: Standard VSM symbols [4]

III. LITERATURE REVIEW

Traditionl view of VSM was only up to manufacturers end. Moreover it was limited to production industries only. But in recent trends scope of VSM has became wider with integration of various lean tools, supply chain involvement, concurrent engineering etc. Some new techniques are also introduced to improve effectiveness of VSM. In this paper some are discussed below.

There are many areas we found for improvement but to implement and work in all that areas simultaneously is not possible. At one time one focus is required, to make this task easy and efficient one new methodology is introduced. It is a relation matrix between 7 wastes and 7 stream mapping tools. This tool works as pareto chart for finding critical wastes.

Peter Hines, Nick Rich outlined a new typology and decision-making matrices for selecting most promising waste for improvement [5]. They define all seven wastes (overproduction; waiting; transport; inappropriate processing; unnecessary inventory; unnecessary motion; defects) and correlate them with seven value stream mapping tools(faster-than-necessary pace; waiting; conveyance; processing; excess stock; unnecessary motion; and correction of mistakes). This correlation helps to identify most promising waste in production line.

Here one example manufacturing industry is given where they were in trouble to choose correct value stream mapping tool. They plot matrix and found that key prior improvement required in firm's supplier lead-time reduction. When the data from the quality filter mapping studied it was found that the real issue was on-time delivery rather than lead-time reduction. They focus on suppliers and work on titration of suppliers, co-ordination between suppliers, supplier association, awareness-raising program, vendor-managed inventory, self certification, stabilized scheduling and EDI. As an outcome conservative estimate of the savings of £10m per year was achieved.

The same technique of seven mapping tools for stream mapping is used by William M. Goriwondo, Samson Mhlanga and Alphonce Marecha in order to manage their supply chain [6]. This new metrics helps them to identify flaws in the system that requires redesigning and to prioritize improvements. By analyzing metrics they found that major waste is due to defects, inventory and unnecessary motion. For that they implement "kaizen blitz"* approach. To reduce defects they modified their production system and achieved reduction in defects by 20%, for excessive inventory they introduce FIFO system and reduced unnecessary inventory by 18% and to reduce unnecessary motion reduce by 37% after implementation of on line storage system.

In traditional view the thought for supply chain was only a duty of distributors. But now days to the scope of supply chain is increased to reduce supply costs and time, attaining operational excellence and to focus on innovation in product development and marketing. This all scopes are directly or indirectly related to customer satisfaction and value paid by them. So there should be some relation between value chain (from customers to producers) and supply chain (from producers to customers). Here, Andrew Feller, Dr. Dan Shunk, and Dr. Tom Callarman focused on integration of supply chain and value chain [8]. In third generation supply chain management as being focused on customer intimacy, and being a synchronized supply chain where consumers have the power to pull value [9] thus, chain as a value to the end users. Supply chain works as a demand chain from customers to manufacturers. This reduces excessive inventory at manufacturers end and on time delivery and serve value at optimum price at customers end. Thus this integration makes balanced flow at both the nodes.

Ritesh R. Bhat, Prof. S. Shivakumar reported a noticeable reduction in cycle time and increase in cycle efficiency with an application of Kanban- "pull" system in value stream map [10]. The premise of Kanban is that material will not be produced or moved until a customer sends the signal to do so. In GHPL they introduce Make – to – Order inventory policy, for reduction in production lead time and to increase productivity. Hence, they improved value to the customer. After implementing kanban system approx 80% reduction in lead time was achieved as an outcome of the project.

Roberto J. Arbulu, Iris D.Tommelein, Kenneth D.Walsh and James C. Hershauer introduce value stream mapping (VSM) as a methodology for modeling and analyzing supply chains to improve value in construction site by shortening supply chain lead times [11]. This paper focused on the supply chain of a specific Engineered-to-order product, namely pipe supports, the methodology used applies to supply chain re designing. Like, I) Buddy with a supplier and involving a supplier early on in design, so no later conversion will be needed and rework may be avoided, ii) Standardize products and processes and iii) Use electronic data interchange (EDI). They achieved 96% of the time in this supply chain is non-value-added time, is to reduce order to- delivery lead time for this engineered-to-order product.

Schonemann, M. Thiede, S. Herrmann have discussed relation of value stream mapping with concurrent engineering, involving customers in design and manufacturing process. [12] Increasing complexity of products leads to the involvement of suppliers early in product development projects [13]. Errors made in early product development can cause up to 70 % of manufacturing costs [14]. This indicates the importance of considering available manufacturing capabilities and constrains as early as possible during product development and motivates the integrated development of products, manufacturing systems, and processes [15]. But in actual practices manufacturers and users are different there is no communication between them excepting a feedback section. Customers pay for thing what they needed, so it is required to involve suppliers in design stage because only suppliers are the mediator between producer and consumers. Traditional VSM does not allow considering the impact of different product characteristics since a value stream map is created specifically for one product or one product family. Additionally, it does not include the constraints for parameters of processes and resources. The extended VSM concept proposed in seems to be the first considering the impact of different product characteristics on the value streams under survey [16].

Rhonda R. Lummus, Robert J. Vokurka & Brad Rodeghiero use value stream concept in clinic which is non production sector [17]. Initially there was a haphazard flow of patients and due to this patients have to wait for service and sometimes they can't proper service. These all were NVAs for patients and the time and money required to manage them was NVAs for doctors. To manage this flow researcher design a flow pattern and the result was a 25% increase in capacity without additional capital or hospital staff. By diverting patients as per their priority for service, time required for service and allocating right patient to right doctor they achieve balanced value stream.

A case study is described by Md. Shakhawat Hossain and Abdullah Al Masud to prepare value stream analysis of dried fish's produced in Kuakata [18]. In the previous supply chain of marine dried fish, three intermediary stakeholders are involved between fisherman and consumers. They are processor, aratdar and wholesaler/ retailer. As market demand changes aratdar fixes the price of dried fishes. Thus, Processor, middle man and other gets the price of the product according to aratdar's fixation. This situation hampered the fisherman and local aratdar's financial condition and they losses their capital and profit. The wholesaler or retailer in city market secure as high as 40% profit while primary producers secure, only 10% to 15% profit. This case study recommends appropriate policy for fish producers and to overcome barriers in the supply chain of dry fish. For that they measure upstream and downstream value flow and bifurcate procedure in VA, NVA and NNVA. To manage this situation they recommended reducing the no. of intermediaries in supply chain, Modern credit system, quickest transportation facilities and support from government and NGOs.

R.M. Belokar, Vikas Kumar and Sandeep Singh Kharb represent a case study of automobile industry for improving quality and delivery with decreasing cost associated with NVAs [19]. The problem they discussed was machine shops are facing delayed deliveries, long queues, and high work in process inventories, improper utilization. This problem increases overall cost of production. But the need for customized products/parts with reduced lead requires that products/parts to be produced in small batch sizes as per customer's requirement. So they arrange process flow according to their operation time and frequency of operation. They measuring cycle time and comparing it with takt time and as per difference measured between cycle time and takt time they tries to manage layout, introduce new machines and arrange operational flow. Thus, traditional manufacturing system changes in to machine shop manufacturing system to adopt lean environment. By changing this they saved 67% of operation time. Here, the team focused on three lean manufacturing techniques of which productions leveling through minimizing process WIP, improvement of takt time and minimizing handling to eliminate or at least reduce changeover/handling time of a front disc assembly which is component of brake. Palak Sheth and Vivek Deshpande also described a case study of VSM implementation in automobile sector. They introduce a pull type production system. Using time study and inventory management system they reduced total lead time by 61% [20].

IV. SUMMURY

By studying all this cases we can say that VSM technique is having wide scope of application. It is not only limited to production company. It can be used to reduce production time, satisfying customer's requirements on time, manage supply chain quantitative quality improvement.

But VSM is having a fundamental limitation that it is a manual method for mapping and analysis of the flows of products, materials, people, information, etc. in manufacturing facilities. The manual method of VSM only produces a static model within a system that makes the observation and evaluation processes of the map difficult. Due to manual plotting grater variability results in to higher error. Moreover VSM just gives a snap shot of process at particular time it is not a detailed data map. To plot VSM requires extra time and money, sometime top management did not get agree to provide it and if they agree, they did not accept required changes and stick with old methods. VSM lacks capability for rapid development and evaluation of different alternatives in improving Current State Map when time and budget constraint exists. It does not give a predictable outcome from the changes made on it.

V. CONCLUSION

We can say that VSM is nothing but an effective integration of manpower, materials and machinery, and methods. Simplicity in terms of understanding and utilization of this tool makes is more valuable. But VSM should not end with one improvement, is should continue with a habit of continuous improvement.

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