



## PRODUCTIVITY ENHANCEMENT IN ENGINE CYLINDER HEAD INDUSTRY APPLYING VSM TECHNIQUE: A CASE STUDY

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### Abstract:

*Value Stream Mapping has the reputation of uncovering waste in manufacturing, production and business processes by identifying and removing or streamlining non-value-adding steps. Lean manufacturing is a methodology that focuses on minimizing waste within manufacturing systems while simultaneously maximizing productivity. The main role of lean manufacturing is to determine as well as to eliminate the waste. This research paper aim to apply one of the most significant lean manufacturing techniques called value stream mapping (VSM) to improve production line of a manufacture cylinder head recon business industry as a case study by using the value stream mapping technique for identify and eliminate of wastes. Based on future state map, final results showed that by implementing some lean thinking techniques, production lead time decreased from 170 minutes to 130 minutes (in KV Cylinder head line).*

**Keywords-** *Value stream mapping, Cycle time, Lean production, Current state map, Future state map.*

### INTRODUCTION

A value stream map gives a graphical overview of the flow of material and information in a production process. This is a good foundation for understanding how activities and operations are connected and forms an basis for analyses of the process. Value stream mapping is a lean management tool that helps visualize the steps needed to take from product creation to delivering it to the end-customer. Value Stream Mapping was first introduced by T. Ohno from Toyota Production in 1988 as 'Material and Information Flow Mapping', later it is named as Value Stream Mapping by John Shook and Mike Rother who co-authored the book 'Learning to See', published by the Lean Enterprise Institute in 1989. Value stream mapping is a tool that let us put all of the information in one place in a way that is not possible with process mapping or any other tools. A value stream is a collection of all actions value added as well as non-value added that are required to bring a product that use the same resources through the main flows, from raw material to the customers. In this study we selected an "old-cylinder-head" re-working industry **ABC RECON** (name withheld due propriety reasons) based at Pithampur area near Indore. The lean tool used for enhancing *productivity* of the industry, is *value stream mapping (VSM)* with setting *work standards*. The basic idea behind the system is eliminating *industrial wastes*. Waste may be defined as anything that does not added value to the end product from the customer's perspective. Nowadays, the continuous technological manufacturing, total productive maintenance, single-minute exchange of dies, and production smoothing are being consistently applied in different discrete part manufacturing systems involving automatic, electronics. Implementing VSM, not only removes wastes but also helps to understand the sources of the wastes so that they would never come back.

### LITERATURE REVIEW

VSM have been proven to be a greatly useful tool to eliminate some waste in a cycle and find there are more waste for us to eliminate in next cycle, during which lean becomes a habit or culture. The technique of lean tool can be applied to every situation in a company by finding out what customer wants and eliminating waste [1]. Both paint manufacturers and shops can more easily control stock inventory of finish good paint material because there is only one type of paint in the inventory, namely white paint / base. It is done by value stream map [2]. Implementation of VSM by SMED and KAIZEN technique. In assembly line have high change over time with bottleneck so he implemented VSM with the help of both lean manufacturing method. This study recommends that the insertion process might be converted from batch operation to continuous flow operation to reduce more wastes [3]. Value Stream Mapping (VSM) tool is implementation in a bearing industry. A Value stream is a collection of all actions (value added as well as non -value added) that are required to bring a product through the essential flows, starting with raw material and ending with the customer. For drawing current state value stream mapping, all relevant data has been collected and analyzed [5]. VSM process is analyzed for opportunity to drastically reduce and simplify it to the fewest actions necessary. By reducing wastefulness the proportion of value adding time in the whole process rises and the process throughput speed is increased. This makes the redesigned process more effective (the right things are being done) and more efficient (needing fewer resources) [6]. Find out hidden waste by value stream map. There is a significant amount of the time products spent on the production system usually was waiting and non-value added [7]. Fastener Company they used value stream map with 5S, for find out and eliminating waste. VSM help to identify demonstrate and decrease waste in the processes. Waste being

any activity that does not add value to the final product. VSM can serve as a blue print for lean manufacturing. From this study we are focusing on SME on factory level or door-to-door VSM. This powerful tool not only highlights process inefficiencies, transactional and communication mismatches but also guides about the improvement areas [23]. For identifying root cause analysis they use value stream tool. In this case study firstly select product family, then create current state map, after that they create future state map and reduced lead time. Find out all value added and non value added activities and implement value stream map [27]. From 20 journals that considered on VSM for literature survey, their critical factor has identified. The most Common critical factors identified in journals are work in process, bottleneck, Takt time, lead-time, inventory, cycle time, cost, value added time, and waste. There are several research paper include in this literature network also work on Systematic literature network analysis. This methodology is also helpful in different application for benefits of research [28]. The implementation of the lean tool VSM in the company studied aimed at reducing waste and thus increasing both the quality and efficiency of a production process [29]. To eliminate non value added activity and waste for the procurement of endovascular stents use value stream map. Create current and future state map in hospital for improve the performance of processes. It represents the flow of both materials and information in an attempt to improve a process by finding sources of waste [30].

**RESEARCH METHODOLOGY**

The paper focused on VSM, which has been indicated as one of the best tools for Lean Production implementation in a facility. The time study Value stream method (VSM) Based on the case study, by re- assigning, regrouping, re-arranging the value and non-value added activities, the organization is able to improve productivity and operation costs. Observational method is used to collect data for this research. Time and activity observed for create Value stream map by stopwatch. There are several lean method for productivity enhance but we choose VSM for visualize the steps needed to take from product creation to delivering it to end customer.

A brief description of the available lean methods and techniques are as follow: **Cellular manufacturing**, the goal of Cellular manufacturing is to move as quickly as possible, make a wide variety of similar products, while making as little waste as possible. **Just in time**, The objective of Just-in-time is to increase the inventory turnover and reduce the holding cost and any other costs associated with it. **5S**, 5S is a system for organizing spaces so work can be performed efficiently, effectively, and safely, **SMED**, SMED is the term used to represent the Single Minute Exchange of Die or setup time that can be counted in a single digit of minutes. This all method is control by the shop floor. Now this method we used for project **VSM**, The main goal of VSM is to find different types of wastes and trying to eliminate them. The first step is to select the product or product family for increase productivity. The second step is that to develop a current step map for how to process begin done. The third step is to draw the future state map for how to production

process should be done after eliminating waste. In this method we observed, time and activity after analyzing basic time we calculate standard time. In industry find out seven wastes-

- Transportation – It mean moving parts and materials from one place to another place.
- Inventory – Overstocking with equipment that may be in need somewhere in the future. We can say undelivered part.
- Motion – unnecessary movement of employees or machinery.
- Waiting – waiting for goods to be delivered.
- Overproduction – Too many items produced “just in case”.
- Over-processing – Spending a lot of time on a given task.
- Defects – Broken parts or defected parts that need to be reworked.

We looked out those waste and work on it. Now, we discuss about **Value stream map symbols -**

Icons	Description
	Customer/Supplier Icon: represents the Supplier when in the upper left, customer when in the upper right, the usual end point for material.
	Dedicated Process flow Icon: a process, operation, machine or department, through which material flows. It represents one Department with a continuous, internal fixed flow.
	Shared Process Icon: a process, operation, department or work center that other value stream families share.
	Data Box Icon: it goes under other icons that have significant information/data required for analyzing and observing the system
	Work cell Icon: indicates that multiple processes are integrated in a manufacturing work cell.
	Push Arrow Icon: represents the “pushing” of material from one process to the next process.
	External Shipment Icon: shipments from suppliers or to customers using external transport.
	This box represents a central production scheduling or control department, person or operation.

A value stream map uses symbols to represent the flow of information and inventory within a system and to streamline those processes. It’s a tool for reducing waste and improving efficiency, with the goal of providing optimum value to customers in the form of products or services. Some symbols are there –

**Now, next step of value stream map current and future state map.**

**VSM: CURRENT STATE MAP**

Current state maps are the maps which help in identifying the various processes needed for the production of the component. It does not only show various processes but it also indicates the time associated with all kind of activities. Here are the some steps which are essential while drawing current state map for any product flow.

- The material and information flow is always collected while walking along the production pathway.
- It should always begin with a quick walk along the entire door to door value stream to get a sense of flow and sequence

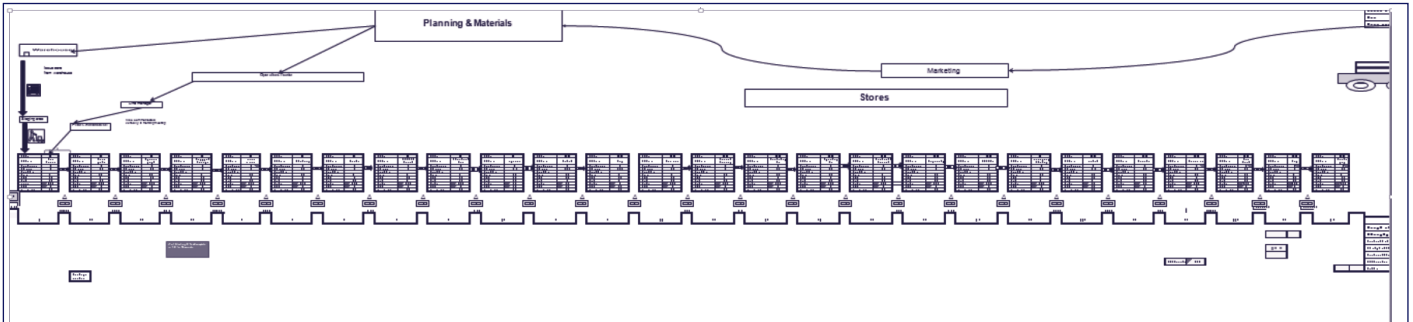
of processes. After the quick walk through, go back and gather information at each process.

- The start should begin at the shipping end and work upstream, instead of starting at the receiving dock walking down stream. By this way, one can get begin with the processes that are most directly to the customer, which should set the pace for other processes further upstream.

- The information regarding cycle time, changeover time etc. Should be collected with the stopwatch and never rely on the standard time.

Then map is drawn very easily on A3 sheet with the help of pencil.

Here, the current state maps for KV cylinder head section of plant are shown here.



To draw the future state map for KKV cylinder head it is necessary to calculate Takt time.

**VSM: TAKT TIME**

“Takt time” is how often one product or part should be produced, based on the rate of sales, to meet customer requirements. Takt is a German word which means peace.

Takt time is calculated by dividing customer demand rate per shift (in units), into the available working time per shift (in seconds).

Takt time= net available time per day/Customer demand per day

At ABCD Ltd. in a shift of 8 hours 2 tea breaks of 15 minutes are there and bathing break 30 minutes and lunch break of 30 minutes and 30 minutes breaks for other needs is there. So the available time is 6 hours. So the net available time per shift may be calculated as-

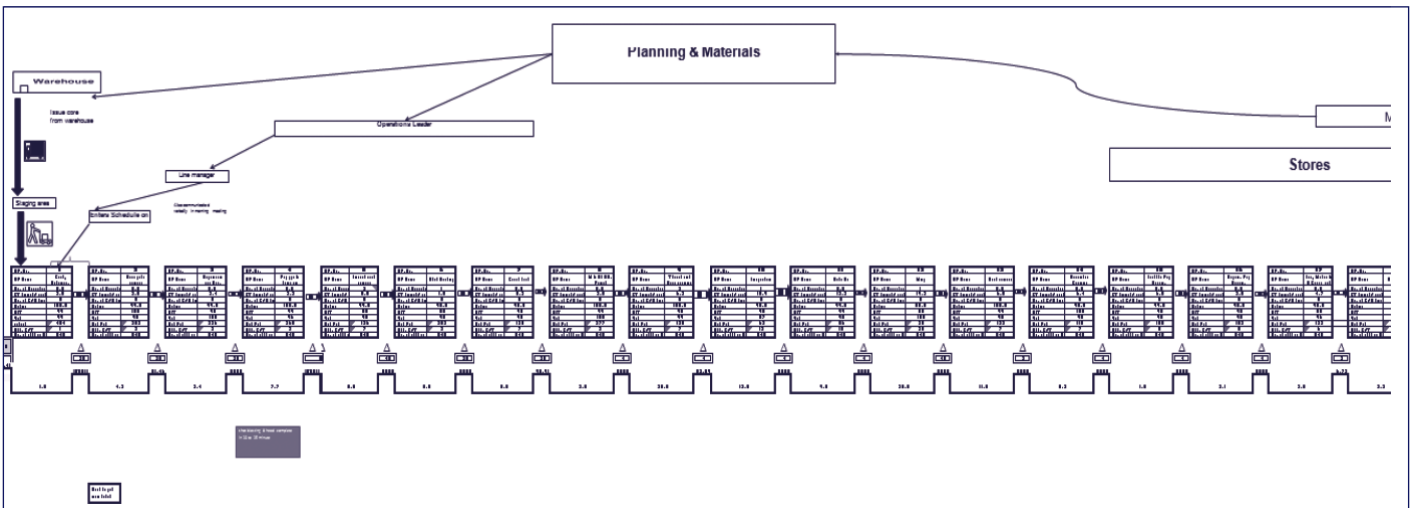
Shift Time	8 Hrs
Tea Breaks	15 x 2 = 30 Mins Other Need breaks
Lunch Break	30 Mins
	30 Mins

<b>TOTAL AVAILABLE TIME</b>	= 8 x 60 – (30 + 30 + 30) = 370 Minutes
<b>CUSTOMER DEMAND</b>	= 50 pieces per day

**TAKT TIME** = 370 / 50 minutes = **7.4 Minutes**

**VSM: FUTURE STATE MAP**

Future or to be state map shows how things to be done considering Takt time requirements. After the drawing of CSM the next is to draw FSM. FSM depicts how the value stream of a product should look like after eliminating all inefficiencies.

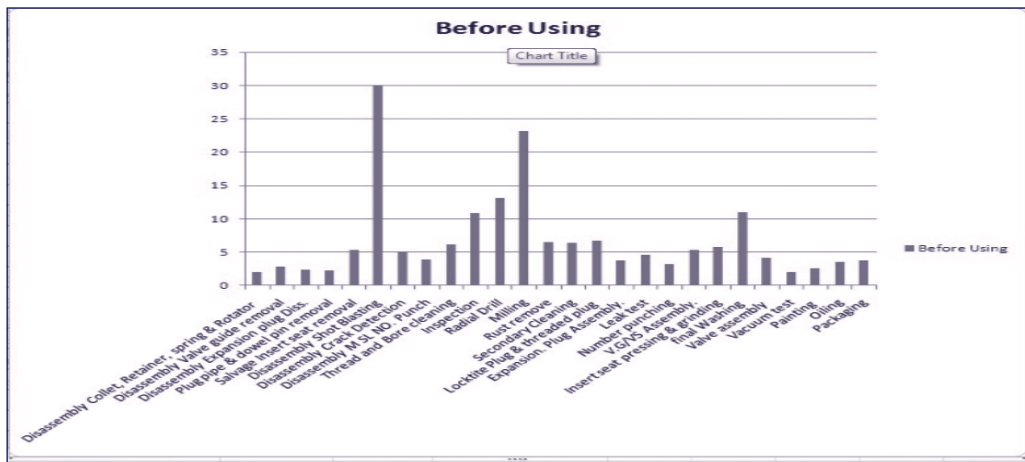


**RESULT AND DISCUSSION**

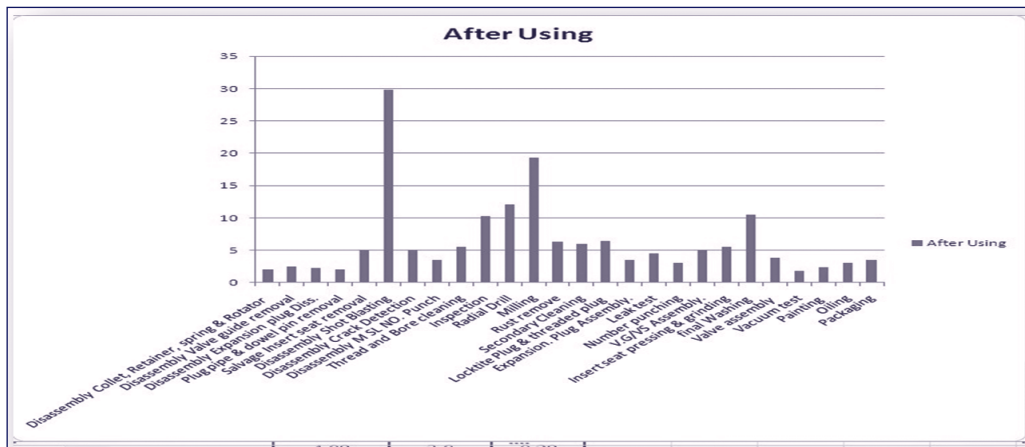
The technique of lean tool can be applied to every situation in a company by finding out what customer wants and eliminating waste. In KV Cylinder head line after my study or implementing

VSM (Value stream mapping) 40 minutes time are reduced. In this table showed difference between observed and standard time also represent view of implementation of value stream mapping.

S.no.	Workstation	Minutes	Observed time	Standard time	minutes
1	Disassembly Collet, Retainer, spring & Rotator	2	120	122.4	2.04
2	Disassembly Valve guide removal	2.5	150	167.4	2.79
3	Disassembly Expansion plug Diss.	2.3	138	145.2	2.42
4	Plug pipe & dowel pin removal	2.0	120	131.4	2.19
5	Salvage Insert seat removal	5	300	301.68	5.028
6	Disassembly Shot Blasting	30	1800	1790.88	29.83
7	Disassembly Crack Detection	5	300	309.6	5.16
8	Disassembly M SL NO. Punch	3.5	210	236.52	3.942
9	Thread and Bore cleaning	5.5	330	370.8	6.18
10	Inspection	10.3	618	654.72	10.912
11	Radial Drill	12.1	726	790.08	13.168
12	Milling	19.3	1158	1136.64	
13	Rust remove	6.3	378	389.88	6.498
14	Secondary Cleaning	6	360	386.52	6.442
15	Locktite Plug & threaded plug	6.4	384	406.6	6.77
16	Expansion. Plug Assembly.	3.5	210	225	3.75
17	Leak test	4.5	270	280.56	4.67
18	Number punching	3.0	180	189.6	3.16
19	V,G/VS Assembly.	5.0	300	319.6	5.32
20	Insert seat pressing & grinding	5.5	330	351.2	5.85
21	final Washing	10.5	630	658.8	10.98
22	Valve assembly	3.8	228	245.4	4.09
23	Vacuum test	1.8	108	118.8	1.98
24	Painting	2.5	150	156	2.6
25	Oiling	3.0	180	185.76	3.096
26	Packaging	3.5	210	219.36	3.656



Before the applying value stream map with time and method study



After the applying Value stream map with time and method Study

## CONCLUSION

It is rightly argue that whenever there is a product for a customer, there is a value stream. From the analysis and results it could be seen that the VSM can be of a great help to understand the current system, to analyses the whole process not only showing its presence but also letting one know where exactly is the problem and helps to improve upon it to increase the productivity. In the future state map of value stream, the lead time and Process time is reduced and the efficiency of this process is increased. VSM have been proven to be a greatly useful tool to eliminate some waste in a cycle and find there are more waste for us to eliminate in next cycle, during which lean becomes a habit or culture. The technique of lean tool can be applied to every situation in a company by finding out what customer wants and eliminating waste. The idea is to create culture in which people at various levels of an organization are continuously improving their production every day & in every way.

## REFERENCES

- 1) Pradip Gunaki1\*, S.N. Teli2\*, Fauzia Siddiqui3, A Review Paper on Productivity Improvement by Value Stream Mapping, *Journal of Emerging Technologies and Innovative Research (JETIR)*
- 2) Gun Nanda Tian Purnama, Gunanto, Humiras Hardi Purba, Siti Aisyah, *Analysis of Increasing the Productivity of Using Tinting Machines Based on the VSM Method in the Paint Industry, International Journal of Research in Engineering, Science and Management Volume-1, Issue-12, December-2018*
- 3) R.M. Belokar, Sandeep Singh Kharb, Vikas Kumar "An Application Of Value Stream Mapping In Automobile Industry: A Case Study", *International Journal Of Innovative Technology An Exploring Engineering (IJITEE) ISSN: 2278-3075, Vol.-1(2), July 2012.*
- 4) Amir Azizia, Thulasi a/p Manoharanb, *Designing a Future Value Stream Mapping to Reduce Lead Time using SMED-A Case Study, 2nd International Materials, Industrial, and Manufacturing Engineering Conference, MIMEC2015, 4-6 February 2015, Bali Indonesia*
- 5) S. Santhosh Kumar, & M. Pradeep Kumar, "Cycle Time Reduction Of Truck Body Assembly In An Automobile Industry By Lean Principles", *Procedia Materials Science 5 (2014), Pp.1853-1862.*
- 6) Hugh L. Mcmanus And Richard L. Millard "Value Stream Analysis And Mapping For Product Development", *Proceedings Of The International Council Of The Aeronautical Sciences 23rd ICAS Congress, 8-13 September, (2002), Toronto Canada.*
- 7) Hines Peter, Jones Daniel T., Rich Nick, "Lean Logistics", *International Journal Of Physical Distribution & Logistics Management, (1997 A) 27-3/4 153-173.*
- 8) Hines Peter, Rich Nick, "The Seven Value Stream Mapping Tools", *International Journal Of Operations & Production Management, (1997 B) 17 1 46-64.*
- 9) Rahani AR\*, Muhammad al-Ashraf, *Production Flow Analysis through Value Stream Mapping: A Lean Manufacturing Process Case Study International Symposium on Robotics and Intelligent Sensors 2012 (IRIS 2012)*
- 10) Dr. Cemil Ceylan, "Value Chain Analysis Using Value Stream Mapping: White Good Industry Application", *Proceedings Of The 2011 International Conference On Industrial Engineering And Operations Management Kuala Lumpur, Malaysia, January (2011), Pp.22 – 24..*
- 11) Mahmoud Al-Odeh Et.Al, "Value Stream Mapping: Recreating An Industrial Environment In An Educational Setting", *Proceedings Of The (2014) Iajc/Isam Joint International Conference Isbn, Pp.978-1-60643-379-9.*
- 12) Johan Tingström Et.Al, "Implementing Value Stream Mapping – Vsm In A R&D Organization", *Norddesign (2010), Pp.25-27.*
- 13) Muhammad Abdussamadet.Al, "Value Stream Mapping To Reduce Manufacturing Lead Time In A Semi-Automated Factory", *Asian Transactions On Engineering (Ate Issn: 2221-4267) Volume 02 Issue 06.*
- 14) Palak P. Sheth1 Et.Al, "Value Stream Mapping: A Case Study Of Automotive Industry", *Ijret (2014), Pp..2321-7308.*
- 15) Abu Md. Saifuddoha Et.Al, "Minimization Of Waste By Applying Value Stream Mapping In The Supply Chain Of Cement Industry", *Iosr Journal Of Business And Management (Iosr-Jbm), (2013), Pp.79- 84.*
- 16) Hurt, U.; Tomba, A. & Koppel, O. *Value Stream Mapping As A Tool In Optimising Production Logistics. Case: He Teletechnics, 10th International Daaam Baltic Conference "Industrial Engineering" - 12-13 May 2015, Tallinn, Estonia*
- 17) K.C.Ng1, C.P.Lim, K.E.Chong, G.G.G.Goh "Elimination Of Waste Through Value Add/Non Value Add Process Analysis To Improve Cost Productivity In Manufacturing - A Case Study" *Proceedings Of The Ieee Ieem 2013.*
- 18) P. Kuhlant1,2, T. Edtmayr2, A. Sunk2, T. Mühlbradt, *Enhancing Work System Design And Improvement By Further Developments Of Value Stream Mapping, Institute Of Management Science, Vienna University Of Technology, Vienna, Austria, Proceedings Of The IEEE IEEM 2014.*
- 19) Subodh B. Patil, S.S. Kuber, "Productivity Improvement In Plant By Using Systematic Layout Planning" *IJERT, Vol. 3, Issue 04, April 2014, Pp 770 775, ISSN 2321-7308.*
- 20) Parthiban P., Raju. R, "Productivity Improvement In Shoe Making Industry By Using Method Study, ISOR- JMCE, PP 01 08, ISSN 2320 334X.
- 21) Clifford S. Barber & Brian C. Tietje, *A Research Agenda For Value Stream Mapping The Sales Process, Published Online: 23 Sep 2013.*
- 22) Matthias Thürera, Ivan Tomaševićb And Mark Stevensonc, *On The Meaning Of 'Waste': Review And Definition,*

Informa Uk Limited, Trading As Taylor & Francis Group 2016.

- 23) Mastan Singh, Er. Gurjinder Singh, Er. Jonny Garg, Value Stream Mapping: A Case Study of Fastener Industry, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) <https://kanbanize.com/lean-management/value-waste/7-wastes-of-lean>
- 24) Shubham Ghushe, Shubham Deshmukh, Vrushabhsingh Basgoti, Yogesh Yawale, Pratik Gangasagar, Prof. N. S. Duryodhan, Implementation of Value stream mapping (VSM) in a coir product manufacturing industry, 2017, International Research Journal of Engineering and Technology (IRJET). [https://courses.washington.edu/ie337/Value\\_Stream\\_Mapping.pdf](https://courses.washington.edu/ie337/Value_Stream_Mapping.pdf)
- 25) Anup P. Chaple, Balkrishna E. Narkhede, Value stream mapping in a discrete manufacturing: A case study, Int. J. Sup. Chain. Mgt, Vol. 6, No. 1, March 2017
- 26) Z. Z. Inamdar, V. S. Narwane, R. D. Raut and B. E. Narkhede, Literature Review on 'Value Stream Mapping' Using Bibliometric Tool, Industrial Engineering Journal Volume 12 Issue 3 \* March 2019
- 27) António Pedro Lacerda, Ana Raquel Xambre, and Helena Maria Alvelos, Applying Value Stream Mapping to eliminate waste: a case study of an original equipment manufacturer for the automotive industry, International Journal of Production Research, 2015
- 28) Ulf K. Teichgräber, Maximilian de Bucourt, Applying value stream mapping techniques to eliminate non-value-added waste for the procurement of endovascular stents, European Journal of Radiology 81 (2012) e47– e52

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