IMPLEMENTATION OF VALUE STREAM MAPPING AND KANBAN METHOD FOR IMPROVED AND SUSTAINABLE PRODUCTION IN PISTON MANUFACTURING INDUSTRY.

[1]Ashish Mishra, [2]Prof. M.S. Pardhi,
[1]Research Scholar, Dept. of Mechanical Engineering, SIRTE Bhopal
[2]Professor, Dept. of Mechanical Engineering, SIRTE Bhopal

ABSTRACT

Manufacturing industries are growing with rapid speed. Due to the reasons there are a lot of developments required in the manufacturing industry. Due to the production delays industry is facing a challenge of satisfying the customers demand on time. Due to insufficient production demand of product remains unmatched. This is the reason for the introduction of various lean manufacturing approaches. These approaches enable the industry to provide satisfaction to their consumers with increase in profits at the same time. In the present study Value stream mapping method is used for studying the manufacting process of piston manufacturing. As piston manufacturing involves various production processes which sometimes results in bottleneck formation at some stages. To consider this as a problem VSM with Kanban method is implemented for improving the current scenario of piston manufacturing industry. This study is the basic step to set an example for such industries which lacks quality and timely productions.

Keywords: Value Stream Mapping, Kanban, Piston, Manufacturing, Bottleneck etc.

INTRODUCTION

Lean manufacturing or lean production, often simply "lean", is a systematic method for waste minimization within a manufacturing system without sacrificing productivity. Lean also takes into account waste created through overburden and waste created through unevenness in workloads. Working from the perspective of the client who consumes a product or service, "value" is any action or process that a customer would be willing to pay for. “Lean manufacturing makes obvious what adds value, by reducing everything else (which is not adding value).”

Fig 1: Lean manufacturing principles

Value Stream Mapping:

Value Stream Mapping is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer with reduced lean wastes as compared to current map. A value stream focuses on areas of a firm that add value to a product or service, whereas a value chain refers to all of the activities within a company.

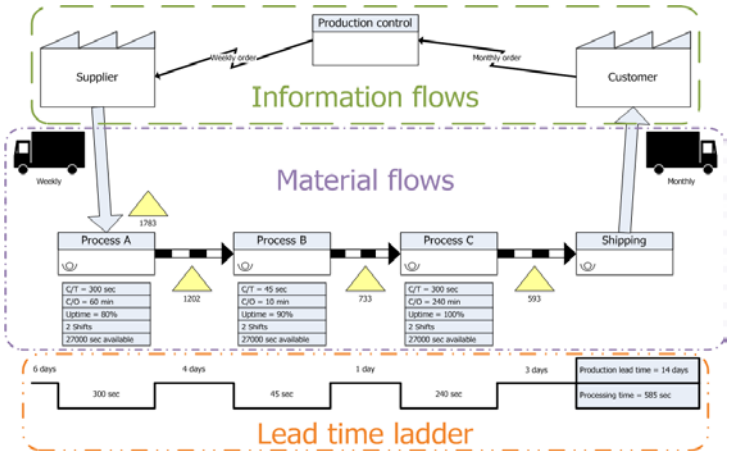

Fig 2: VSM Sample

Kanban Process:

Kanban is a visual signal that's used to trigger an action. The word kanban is Japanese and roughly translated means **"card you can see."** In manufacturing, Kanban starts with the customer's order and follows production downstream. At its simplest, kanban is a card with an inventory number that's attached to a part. Right before the part is installed, the kanban card is detached and sent up the supply chain as a request for another part. In a lean production environment, a part is only manufactured (or ordered) if there is a kanban card for it. Because all requests for parts are pulled from the order, kanban is sometimes referred to as a "pull system."

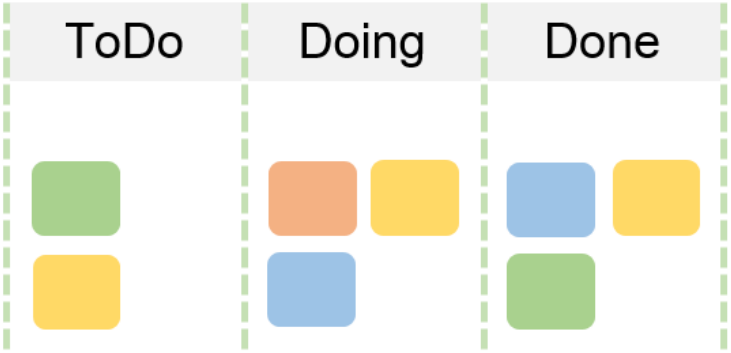

Fig 3: Kanban procedure

LITERATURE REVIEW

Neha Verma et.al. (2016) [1] in her research presented a model of implementation of lean manufacturing for improving productivity and quality, by conducting a case study in a small scale industry at Ranchi, Jharkhand. The purposes of this paper are to identify waste related problems, cause of equipment failure, bottleneck problems and rectify them. The problems associated in the study are analyzed in concern with rejection control, inventory control, waiting time, set time and eliminating non value added time / activities. The complete problem is identified and depicted by value stream mapping. This paper conclude with discussing improvements and it proposes Value stream mapping lean tools can be applied in small scale industries and calculation of takt time for reduction of wastage and increasing productivity.

Gleison Hidalgo Martins et. al. 2016 [2] Studied the approach for the application of the Value Stream Mapping and Earned Value analysis methods in a Pinch Bottom with Simple Fold (PBSF) paper bag production line in an industrial packaging enterprise of multiwall paper bags located in Brazil. From the joint application of the mentioned methods, a better diagnosis of the situation was obtained, and the opportunities of eliminating wastes, of operation enhancement, and of a better monitoring of the involved costs appeared, bringing potential production gains and quality to the enterprise. As a contribution of this work, it can be highlighted the presentation and discussion about the complimentarily of a Lean

Manufacturing tool with a Project Management Methodology.

Santosh B. Dighe et. al. (2015) [3] explained Value stream mapping is a lean manufacturing tool to plan a production process involving lean initiatives through systematic data capture and analysis. This tool has been used 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 of value stream mapping is 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 improved value flow. 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.

Korakot Yuvamitra et.al. (2014) [4] Explained the one way of achieving constant process improvement is through value stream mapping. Value stream mapping is used to visualize the current processes for easier understanding and problem identification. A well-defined problem statement will ensure a successful outcome of a project improvement process. This research provides a case study performed on a rope manufacturing process. A current state value stream map is created, and the possible improvements are suggested. The implemented results are shown in the form of future state map. The results show that, after waste elimination and structural revision, a manufacturing process becomes more efficient, enabling the customer to receive an order significantly faster.

METHODOLOGY

For the present Study a Piston manufacturing industry is considered for performing the study based procedure. In the Methodology of this project various steps were taken to finalize this work. Below are the few steps considered in the project execution:

1. Selecting the suitable industry for implementing the lean manufacturing procedure.
2. Study the different procedures of machining and manufacturing adopted in the industry.
3. Calculate the machining time and other time based operations which can contribute in the improvement of production process of current study.
4. Apply value stream mapping on the current scenario to calculate the complete procedure time and to suggest future state changes.
5. Applying Kanban to have the record of each and every ongoing and required activity.
6. Finally comparing both the states that is present and future state with incorporated benefits

For the Process study various parameters were considered to have the actual idea of ongoing process and for suggesting the ways to eradicate the associate problems in the process. Initial Capabilities – Piston Design, Equipment/Machine used – CNC lathe, Operations- turning, boring, drilling, Piston form- round, Material – aluminium, cast iron, steel.

VSM Software tool used in the Project

For the execution of present work a open source software name Creatley was utilized. Creatley offers vast flexibility in designing the Flowcharts and diagrams for Value Stream Mapping cases. Several templates and symbols of VSM can be used, changed and modified as per the requirement of the map.

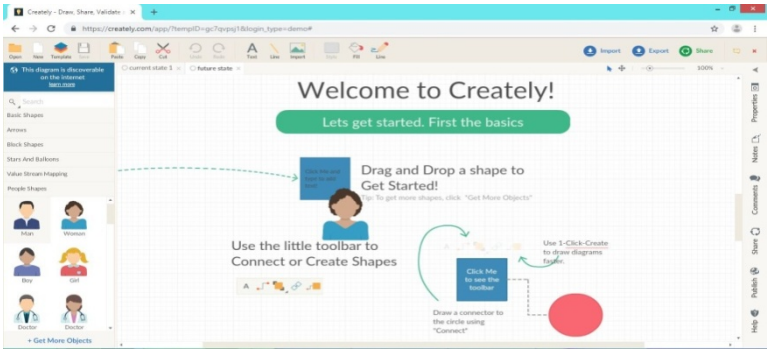

Fig 4: Creatley user interface for creating VSM Model

In the initial stage first the current state map of VSM Prevailing in the industry was designed to find the root cause and bottle neck phenomenon in the project work. After the study of Current state takt time and other parameters further the VSM for implementation was prepared. In the initial stage various operation performed in the industry were studied and different ways for their improvements were listed for further implementation. Details different processes included in the manufacturing are shown below with the help of various photos.

Fig 5: Various Processes involved in the manufacturing of Piston

CALCULATION: Available time =9*60*60 - 1*60*60 =28,800 sec.
Customer order = 18000/month
Dispatch = 3000 weekly
Production/day = 600
(1). TAKT Time
= Net available time/production/day
=28800/600(per shift)
=48seconds
(2). No. of work station required
= line cycle time/TAKT Time
=398/48 =7.96≈ 8
(3). Lead time = LCT+Σ IT +TT
= 398+3600/600 + 7*24*60*60/4000
= 555sec.
Where, LCT= Total Line cycle Time
IT = Idle time
TT = Transportation Time

Analysis of Future Stream Map:

In Future State Map for assembly process two processes are gathered to reduce non value added time during processes. Supermarkets are placed between processes to reduce inventory wastages during process and to turn process from build to stock to make to order. Make to order process lead to assembly of parts when order placed by customers. It results reduction in inventories. The information and communication flow between processing lines improved by scheduling pacemaker in the process as well process turned from push to pull by Kanban system. On this research we have made some sizeable improvements.
Lead Time = LCT + ΣIT +TT
= 226 +6 + 151
=383sec.
Where, LCT= Total Line cycle Time
IT = Idle time
TT = Transportation Time
Mean cycle time = Sum of No.of cycle times/ total entities

RESULTS

VSM Data for Current State

Creating Future State Map:

S. No.	Operation	WIP	Cycle time (sec)	Changeover time (sec)
1	Cutting	200	18	18
2	CNC	500	60	12
3	Turning	250	22	15
4	Boring	200	28	20
5	Drilling	600	60	25
6	Assembly	150	130	23
7	Packaging	220	25	5

To create future state map these are following findings- Product Lead Time (PLT) and Product Cycle Efficiency (PCE). These four wastes need to be reduced or eliminated first in order to move the system closer to the one proposed in the future value-stream map. They are Defects detection, waiting time, Inventory and Material handling respectively.

VSM Data for future state

S.No.	Operation	WIP	Cycle time (sec)	Changeover time (sec)
1	Cutting	200	18	18
2	CNC	500	60	12
3	Turning	250	22	15
4	Boring & Drilling	110	44	22
5	Assembly & Packaging	150	77	13

Comparison of future and current state maps

On comparing the maps of current state and future state, it can be clearly seen that there were 7 process carried out in the current state having their prescribed cycle time and change over time. Further, in the future state after applying the VSM the processes are reduced to 5 since boring and drilling has become single process and assembly & packaging has become a single process. The map shows the no variation in the number of man power required as in both the state maps the man power is 14.

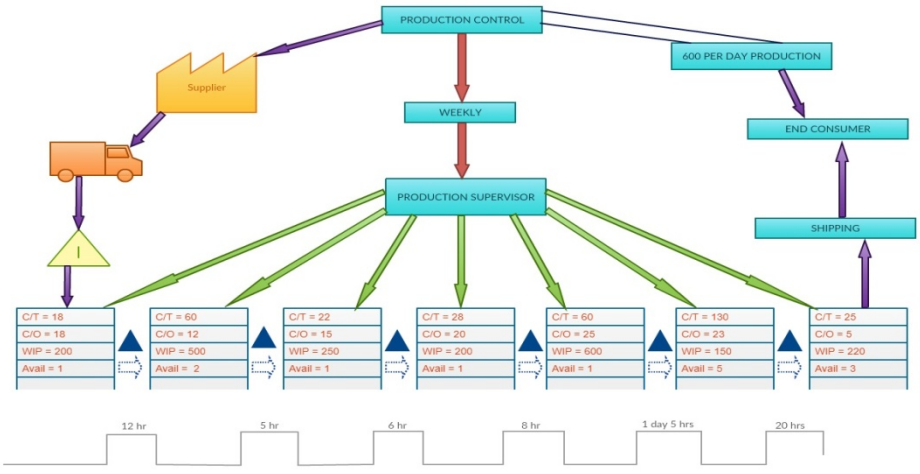

Fig 5 VSM For Current State

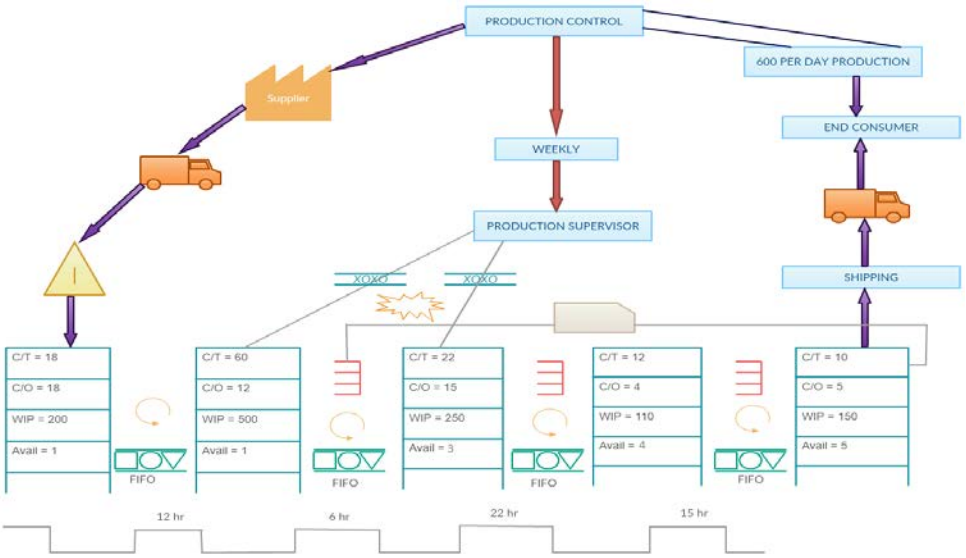

Fig 5: VSM for Future State

Process optimized in future state

- Boring & drilling:

Total time = 8+4= 12hrs

Optimized lead time = takt time x 4/total time x (3600) = 48x4/(12x60x60)= 0.0044x3600≈16

- Assembly & Packaging:

Total time = 29+20=40 hrs

Optimized lead time = 48x4/(49x60x60)= 0.00133x3600≈5

Here, 4 is number of weeks in a month

On applying of Kanban process in the following results were obtained.

PROCESS	CURRENT STATE (HR)	FUTURE STATE (HR)
CUTTING	12	12
CNC	8	6
TURNING	6	5
BORING	8	16
DRILLING	4	
ASSEMBLY	28	5
PACKAGING	20	
TOTAL	**86**	**44**

CONCLUSION

By the following proposed implementation path of the improvements, the performance of the production process can be improved. From the comparison table it can be clearly seen that the proposed VSM model reduced the overall time of the manufacturing unit from 86 hrs to 44 hrs. Combining the processes also helped in reducing the manufacturing cost and recyclable waste material. There is a reduction in the number of operators required for each operation in the future state model as compared to the current VSM map, thus reducing the labor cost.

REFERENCES

1. **Neha Verma1, Vinay Sharma-** "Sustainable competitive advantage by implementing lean manufacturing "A Case study for Indian SME" Available online at www.sciencedirect.com ScienceDirect Materials Today: Proceedings 4 (2017) 9210–9217 www.materialstoday.com/proceedings
2. **Korakot Yuvamitra, Jim Lee, and Kanjicai Dong-**"Value Stream Mapping of Rope Manufacturing: A Case Study" Hindawi International Journal of Manufacturing Engineering Volume 2017, Article ID 8674187, 11 pages

3. **Santosh B. Dighe1, Abhay Kakirde-** "Lean Manufacturing Implementation Using Value Stream Mapping: A Case study of Pumps Manufacturing Company " International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Impact Factor (2012): 3.358
4. **Gleison Hidalgo Martins ; Marcelo Gechele Cleto** - "VALUE STREAM MAPPING AND EARNED VALUE ANALYSIS: A CASE STUDY IN THE PAPER PACKAGING INDUSTRY IN BRAZIL" Brazilian Journal of Operations & Production Management 13 (2016), pp 360-370
5. **P. Achanga, E. Shehab, R. Roy, G. Nelder**. Critical success factors for lean implementation within SMEs, Journal of Manufacturing Technology Management 17(2005).
6. **B Singh, S.K. Sharma.** Value stream mapping as a versatile tool for lean implementation an Indian case study of a manufacturing firm 13(3)(2009).
7. **Marodin, G. A. et al. (2017**) 'Lean production and operational performance in the Brazilian automotive supply chain', Total Quality Management and Business Excellence, (October), pp. 1–16. doi: 10.1080/14783363.2017.1308221.
8. **Meena, M. L. et al. (2018) '**Process improvement in an Indian automotive part manufacturing company: a case study', International Journal of Productivity and Quality Management, 23(4), p. 524. doi: 10.1504/IJPQM.2018.090263.
9. **Phanden, R. K., Jain, A. and Verma, R. (2013) '**An approach for integration of process planning and scheduling', International Journal of Computer Integrated Manufacturing, 26(4), pp. 284–302. doi: 10.1080/0951192X.2012.684721.
10. **Prakash, R. (2016) '**Six Sigma Implementation in Small and Medium Scale Electronic Industries : A Case Study', 5(11), pp. 169–173.