PRODUCTIVITY IMPROVEMENT IN A PRESSURE VESSEL USING LEAN PRINCIPLES

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Abstract - *This paper deals with implementation of lean manufacturing concepts in the industry in order to improve the productivity of pressure vessel manufacturing in a small-scale industry that manufactures chemical separators pressure vessel for water treatment plants. The challenge face by the industry is not able to meet the customer demand due to production line stoppages and longer lead time of the product. The facility experiences production line stoppages due to non-availability of subcomponent. The major issues are due to unstructured way of the inventory management, the time between the placing the order and receiving the finished product from the company is 6.5 days, which is a longer lead time significantly influence the stoppage in production. The supply chain activities were analysed with the help of the current state and future state value stream maps with the help of commercial software. Kanban system is implemented in industry as cards and placed. After implementing the Kanban system, the line stoppages were eliminated and improved to 68% and lead time is reduced from 6.5 days to 4.3 days.*

Key Words: productivity improvement, inventory, Kanban, value stream mapping

1.INTRODUCTION

The pressure vessel manufacturing company manufactures pressure vessel for water and chemical separators. They buy the raw material as blank sheets and they cut them into separate pieces for dished and shells. The dishes from the Pressure Vessel Division (PVD) follow a outsourcing model for forming the blanks into dish ends. PVD receives cut and blanked sheets from its raw material supplier and stores them at PVD. The sheets to be rolled into shells and edge beveled before being sent to the outsourcer for rolling process. The blanks are then sent to the outsourcer for forming. The formed dishes are then withdrawn from them and stored in PVD for fabricating them into pressure vessels for water treatment plants. The outsourcing process for forming the dish ends is inevitable, as PVD does not have the facility for forming the blanks into dish ends. This model where PVD receives raw material from its supplier, sends them after pre-processing (if any) to a outsourcer and receives them back after forming and uses them for fabrication is referred to as the outsourced model. The inventory process flow is depicted in a flow chart in the Fig 1

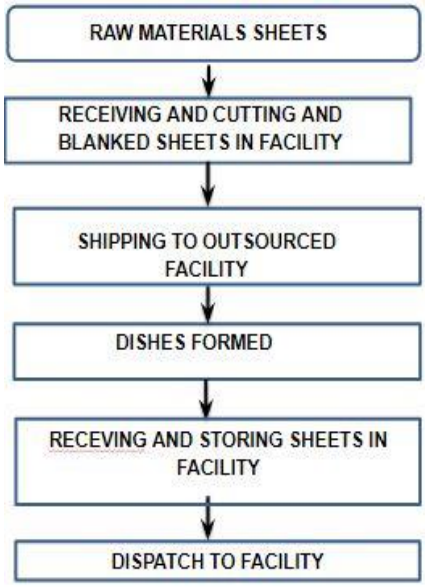

Fig -1: Inventory flow

2.LITERATURE REVIEW

Preetinder Singh Gill, (2012) [1] reported that Value Stream Mapping (VSM) as a lean/quality management tool which assists in establishing the current state of a process while aiding to uncover opportunities for improvement vis-a-vis the seven sources of waste. This research paper involves a review of existing literature pertaining to application of the VSM tool in departments. The author presents the potential benefits emanating from application of VSM along with assessing its effectiveness in scenarios where it has been implemented already. Furthermore, challenges faced in implementation of the VSM tools are collated. Various solutions to address these challenges have been presented in the light of tribulations faced by today's industry.

Rahani AR et. al. (2012) [2] VSM is the starting point of the lean manufacturing tools, it having the three stages there are current stage, future stage and implementation. Rahani AR says current state VSM is used to identify the problem and future stage VSM (Value Stream mapping) eliminate NVA (Non-Value Added activity) and NNVA for enhance the productivity then make the SOP in production line by reducing lead time and improving method study. This tool is reducing the bottleneck for making continuous flow.

Venkataraman et. al. (2014) [3] Lean manufacturing initiative is being followed by various organizations in the recent years which mainly focuses on improving the efficiency of operations by eliminating and reducing wastes has discussed about the application of Value Stream Mapping for Reduction of Cycle Time in a Machining Process.

Patange Vidyut Chandra, (2013) [4] describes the procedure to do work study including the method study and work measurement. It also gives the standards to follow during the operations in manufacturing industry. It helps to improve the quality. The effective use of time study and line balancing in industry is perfectly analysed by Johan Oscar Ong, in his paper he provided a case study of a doll manufacturer focusing on productivity increase through time study, redesign of work arrangement and line balancing

According to Meyers (2002) [6] Time study is the technique of establishing an allowed time standard to perform a given task, based upon measurement of work content of the prescribed method, with due allowance for fatigue and personal and unavoidable delays. ILO defines time study as a work measurement technique for recording the times and rates of working for the elements of specified job carried out under specified conditions, and for analyzing the data so as to obtain the time necessary for carrying out the job at a defined level of performance. time standards can be defined as "the time required to produce a product at a work station with the three conditions: (1) a qualified, well-trained operator, (2) working at a normal pace, and (3) doing a specific task."

Nakayama, (2002) [7] Stopwatch time study measures how long it takes an average worker to complete a task at a normal pace. A "normal" operator is defined as a qualified, thoroughly experienced operator who is working under conditions as they customarily prevail at the work station, at a pace that is neither fast nor slow, but representative of an average. The actual time taken by the above average operation must be increased, and the time taken by the below-average must be reduced to the value representative of normal performance. Performance rating is a technique for equitably determining the time required to perform a task by the normal operator after the observed values of the operation understudy have been recorded Hence, when a work is measured with the stop watch device it is known as stop watch time study method.

Kanawaty, (1992) [8] Work is a technique which contains the method study and time study which are used in examination of human working all its contexts and which leads systematically to the investigation of all the factors which effect the efficiency of situation being reviewed in order to seek improvements. In the book Introduction to Work study by International Labour office

Kanban means sign board. A Kanban can be a variety of things, most commonly it is a card, but sometimes it is a cart, while other times it is just a marked space. In all cases, its purpose is to facilitate flow, bring about pull, and limit inventory. It is one of the key tools in the battle to reduce overproduction. Kanban provides two types of communication. In both cases, it gives the source, destination, part number, and quantity needed. Kanban provides two major services to the Lean facility [9].

- The Kanban serves as the communication system.
- The Kanban is a continuous improvement tool.

Traditional manufacturing strategy is driven by 'Push system' which is aimed to keep large inventory of product according to customer forecast. However, this has created big problem to people on floor in dealing with high of WIP inventories, unsynchronized production processes and producing unnecessary stock. Due to that, established company like Toyota Motor Corporation has moved to next level of manufacturing approach or strategy by adopting Kanban system [6]. The adoption of Kanban system has improved their efficiency and flexibility of manufacturing according to customer needs. Kanban system is pull system approach that gives authorization to produce at required rate and at specific time in order to replenish part that is already consumed by customer. The number of Kanban is calculated by [10]

$$\text{Number of Kanban} = \frac{\text{Demand} * \text{Lead Time} (1+\text{safety stock}\%)}{\text{container quantity}} \quad (2.1)$$

3.CURRENT STATE VALUE STREAM MAP OF THE SUPPLY CHAIN ACTIVITIES

The current state map has been drawn for the outsourced dishes. Fig 2 shows the current state map for the dish ends.

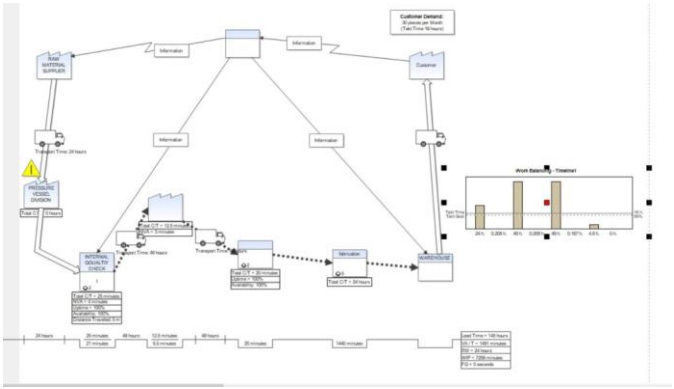

Fig -2: Current state value stream map for dish ends.

The current state value stream map was drawn, and the inventory process ratio was determined as

- VALUE RATIO= (VALUE ADDED TIME)/ (TOTAL LEAD TIME)
- The current state map has been drawn for outsourcing dish ends. The value ratio is being 0.17%
- The current state value stream mapping show that this is a pull type production system

- The VSM shows the material department receives necessary blank sheet with a lead time of dayfrom the raw material supplier
- The sheets after passed the quality checks they wait for 2 days in the storage area before processing
- Then it is pushed to the outsourcer facility where it is formed into dishes. The processing time varies in the capacities of the outsourcer facility.
- As it is dumped at the outsourcers facility it takes utmost 10 days to withdraw the formed dishes.
- as the withdrawal is in arbitrary batches the formed dishes wait at the outsourced facility before being bought into the pressure vessel division facility.
- The received dishesare stored in the storage area after the quality tests.

3.1CURRENT STATE VALUE STREAM MAP ANALYSIS

The map reveals that the materials wait unnecessarily without being processed before and after outsourcing.
One of the main reasons for unnecessary waiting is the materials department stocks inventory and pushes the inventory to the outsourcer and further down the line, instead of the inventory being pulled.

This is one of the main reasons for the very low process ratio or inventory turnover. Due to withdrawal in arbitrary batch quantities, the outsourcers need to be ready with the processed inventory, which leads to over processing, which is a waste.

Hence introducing Kanban system can be implemented for improving the current state.

4.FUTURE STATE VALUE STREAM MAP OF THE SUPPLY CHAIN ACTIVITIES

The future state map has been drawn for the outsource dishes.

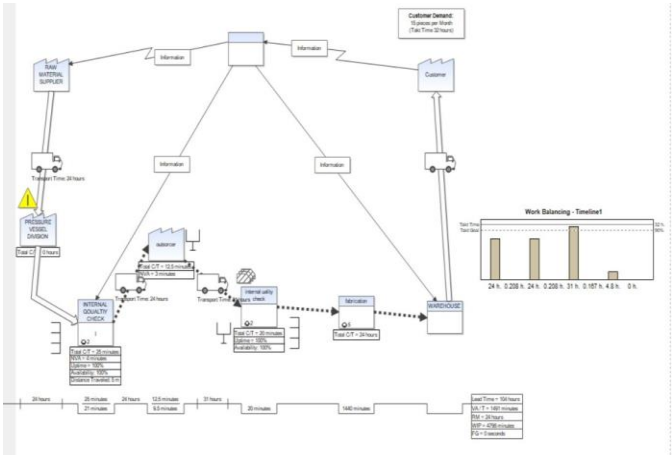

Fig -3: Future state value stream map for dish ends

The future state value stream map has been drawn and the inventory process ratio is determined as .35 %for dishes, which is 68%increased turnover ratio for dish ends. The VSM is explained as follows.

1. As indicated in the VSM, Kanban system implementation leads to pull type production, where the inventory is pulled from the end. This eliminates over processing, unnecessary waiting, and increased inventory turnover ratio as evident from table 8.2.
2. Processing and handling of inventory help in keeping a track of the inventory at the outsourcer's end which helps in the orderly movement of inventory.
3. The supermarket icon in the future state VSM indicates that only if the level of particular model of dish falls below the certain limit, the inventory is replenished
4. Kanban boards are need to be erected at the Kanban posts which helps in tracking of the inventory and also the implementation of pull production process

5.KANBAN IMPLEMENTATION

shows the Kanban cards designed to track inventory. Three colors are used for this purpose. Green color card is stuck on the Kanban board permanently. Yellow and red cards are circulated between the outsourcer and PVD. These cards are hanged on the Kanban board with the help of a hook.

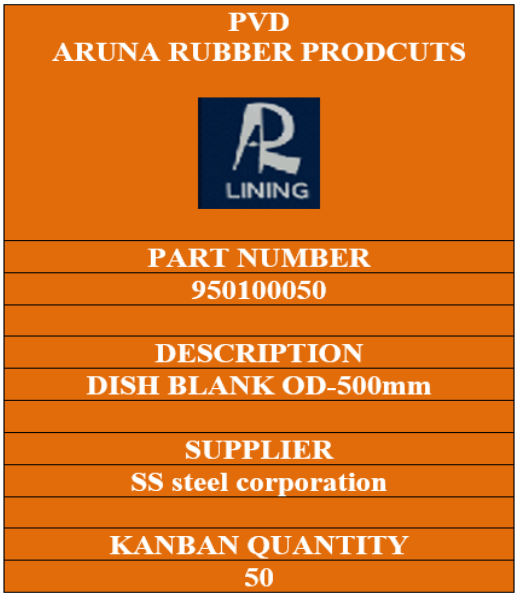

Fig -4: Kanban cards of outsourcer inventory.

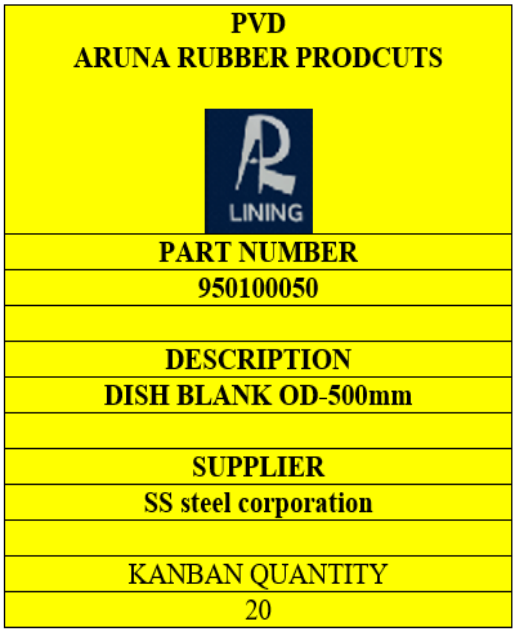

Fig -5: Kanban cards of outsourcer inventory.

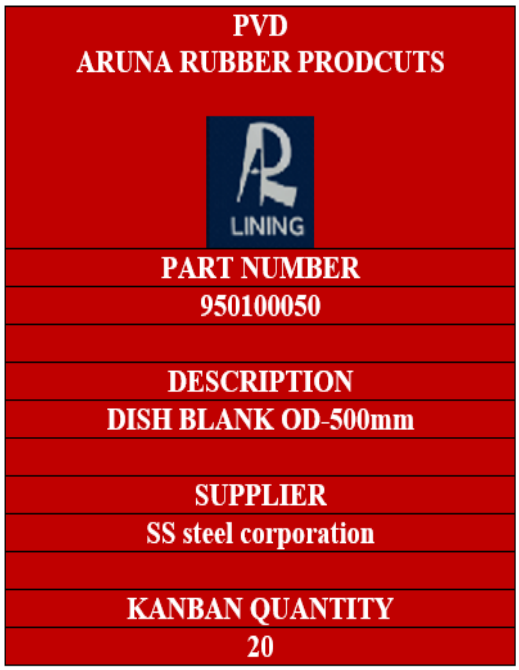

Fig -6: Kanban cards of outsourcer inventory.

6.RESULT AND CONCLUSION

The major outcome of the paper is to improve the value ratio of the supply chain process of the outsourced inventory and also the reduction of the lead time in the outsourced product. Here the current state process has only process ratio of 0.17% which have been improved to 0.35% by implementing the lean principle of Kanban in the supply chain process. This implementation of Kanban in the industry makes the production process to change from push system to pull system. This reduce the over production and line stoppage in the system.

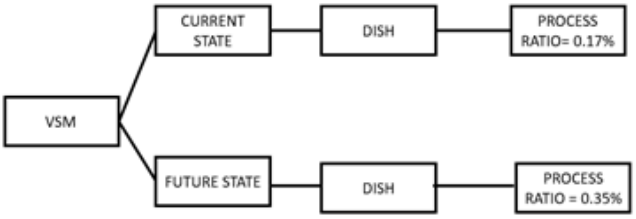

Fig -7: Result summary

REFERENCES

[1] Preetinder Singh Gill (2012) "Application of Value Stream Mapping to Eliminate Waste in an Emergency Room", Global Journal of Medical Research, 12, (2012), 15 - 17.

[2] Fawad A.Abdulmalek , Jayant Rajgopal, "Analyzing the Benefits of Lean manufacturing and Value Stream Mapping via Simulation: A Process Sector Case Study", Int. J. Production Economics, 107, (2007), 223- 236.

[3] Rahani A R, Muhammad al-Ashraf,"Production Flow Analysis through Value Stream Mapping: A manufacturing process case study," International Symposium on Robotics and Intelligent Sensors 2012, pp. 1727-1734.

[4] Venkataramanan K, Vijaya Ramnath B, MuthuKumar C, Elanchezhan C, "Application of Value Stream Mapping in the Reduction of Cycle Time in a Machining Process", 3rd International Conference on Materials Processing and Characterization, (2014), pp 1187-1196.

[5] Patange Vidyut Chandra, "An Effort to Apply Work and Time Study in Manufacturing Unit to Enhancing the Productivity", International Journal of Innovative Research in Science, Engineering and Technology. (2013), Vol.2, Issue 8, pp 4050-4058.

[6] Meyers, "Time Study Method Implementation in Manufacturing Industry", A B.E Report, Universiti Technikal Malaysia, Melaka, 2008, PP. 6.

[7] Nakayama. S, "A study on setting standard time using work achievement quotient", International Journal of Production Research, Vol. 40, No. 15, PP 3945-53, 2002.

[8] Kanawaty G, "Introduction to work study," International Labour

Organisation. 1992, Geneva, ISBN 92-2-107108-1.

[9] Wilson, L. "How to Implement Lean Manufacturing". New York: McGraw-Hill Professional Publishing; 2009.

[10] Ahmad Naufal, Ahmed Jaffar, Noriah Yosef, Nurul Hayati,2012, "Development of Kanban system at Local Manufacturing Company in Malaysia — Case Study, International Symposium on Robotics and Intelligent Sensors, vol 41, pp. 17211726.