Applications of value stream mapping in condenser coil manufacturing industry.

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Abstract— Companies are experiencing intense competitive pressure due to, globalization and changing competitive environment. SMEs have to improve their production performances & reduce waste. They cannot afford to operate with waste in their process and products. Lean thinking is a philosophy used to reduce wastes and improve production performance. Lean thinking is a part of Toyota production systems. VSM is a technique used to implement lean systems in SME.

But many enterprises fail in the process of implementing lean. This paper aims at implementing lean in a coil manufacturing unit using the most important lean manufacturing tool called VSM. It also details the use of VSM in waste reduction, unnecessary inventory and defects. The paper also concludes that lean thinking is applicable to SMEs with some necessary adjustments; Value Stream Mapping can be a valuable tool in revealing improvement potential

I. INTRODUCTION

Lean philosophy was initially introduced by the automobile industry; its principles have more recently spread into other industries. There are a variety of companies that have experienced the advantages of applying Lean in their manufacturing area. One of the important tools of lean is VALUE STREAM MAPPING.

Value stream is the entire process the product undergoes from the receipt of order to delivery of item to the customer. Every process that the product undergoes should add value to the product. But many a times this is not the case. Hence the value stream mapping is done which aids in indentifying value adding and non value adding activity. A value stream map is an end-to-end collection of processes/activities that creates value for the customer. A value stream usually includes people, tools and technologies, physical facilities, communication channels and policies and procedures. VSM is the process of visually mapping the flow of information and material as they are preparing a future state map with better methods and performance.

An important phase in Lean is the identification of non-value added steps in order to streamline a process. Once the activities are classified as value added and non value added activities, actions can be initiated to improve value added activities and eliminate the non value adding ones by reducing wastes in the activities. In his book, Toyota Production System, Taiichi Ohno lays out the main foundations of Lean Manufacturing, and describes seven wastes existing in manufacturing. These wastes are transportation, inventory, waiting, defects, over-processing, excessive motion, and over-production.

The value stream mapping is used to analyze & map in order to reduce the waste in processes, enable flow, and to make the process for better efficiency. The purpose of value stream mapping is to highlight sources of waste and eliminate them by implementing the future-state value stream that can become a reality. The main aim of this paper is the application and adaptation of VSM for a manufacture-to-order small and medium enterprise (SME) in its early Lean implementation process. As the implementation of Lean methodologies in SMEs is still under-researched.it summarizes the experiences gathered having a special focus on the batch-of-one environment

II PROBLEM DEFINITION

The productivity and quality problems of the coil shop are an obvious starting point for focusing attention. The question now becomes what within the coil shop can yield more returns for improving productivity and quality. Bharath refrigerations Pvt. Ltd. wants to adopt lean production methods to tackle the following problems.

1. High WIP (bottle necks)
2. Very less productivity.(max of 18 coils/day)

III LITERATURE REVIEW

In this literature review first the most commonly used lean tools, and the results which can be achieved by implementing lean will be elaborated upon.

3.1 Lean Tools

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Around 101 different tools mentioned in the academic literature can be identified. Based on works of different authors, such as a selection of most common tools is discussed here.

5S

This method aims to improve work area efficiency by strictly selecting what material is essential at a certain workstations. This material is given a specific location close to where it is required. Non-essential materials are placed on less prominent locations.

Kaizen

Kaizen is the Japanese expression for "improve for the better". It is the daily effort to constantly improve the process of a company. Origins of wasteful activities are identified and sought to be eliminated.

Just-in-Time (JIT)

By producing products and parts 'just in time' it is ensured that only the necessary amounts of products and parts are produced Furthermore, parts arrive to the process where they are needed at the right time and are placed in the order in which they are needed. This decreases the amount of waste associated with excess inventories.

Single Minute Exchange of Dies (SMED)

In order to be able to produce in unitary batches with the flexibility demanded by the customers, it is essential to have extremely short change-over time. A great advancement in change-over reduction was achieved by Shigeo Shingo, who was hired as a consultant at Toyota.. His method studies the process of a change-over with great detail and identifies wasteful activities and activities which can be performed while the machine is running. Eliminating or relocating these activities can reduce change-over times from hours to minutes.

Most research on lean thinking focuses on large organizations. As indicated before, due to lean thinking organizations are able to be more responsive to customer demand while requiring less equipment capacity and employ a more stable number of employees Both elements, less equipment capacity and more stable number of workers are relevant for SMEs. SMEs generally do not have the financial capital available to acquire high equipment capacity. Also, since SMEs often are family owned and have an (almost) family-like relation with their employees, they generally aim to have a stable number of workers. Not having to hire temporary workers or having to fire people when sales are down is also less costly. This supports the assumption that implementing lean thinking is appealing for SMEs**.** Based on the available literature it is difficult to state conclusively that lean is or is not particularly applicable for SMEs Based on the available literature it is difficult to state conclusively that lean is or is not particularly applicable for SMEs. A method to implement lean in SMEs is Value Stream Mapping

3.2 Definition of Value Stream and Value Stream Mapping

"A value stream is all actions (both value added and non-value added) currently required to bring a product through the main flows essential to every product. The production flows from raw material into the arms of customer, and the design flow from concept to launch. Introduced three categories classifying operations as non-value adding (NVA), necessary but non-value adding (NNVA) and value adding (VA).

IV. PRODUCT.

The plant is equipped with the most advanced technology to produce condenser and evaporator coils. The important machines in the coil shop are fin press machine, tube bending machine, expander machine, auto-brazing machine, coil bending machine, water deep testing setup, and drying oven. The flow diagram of coil shop is shown. At the fin press, the aluminum sheet is cut according to the width of the coil. This piece of punched coil is called "fin." The fins are stacked according to the height of the coil. At the hair pin bender machine, the copper tubes are bent and cut into size according to the height of the coil. At the lacing table, the punched fins and copper tubes are assembled by inserting tubes into fins. Then, the assembly is taken to expander machine. At the expander machine, the coil assembly is mounted vertically on the machine, and the expansion bullet is passed through inner grooved copper tubes. After expansion, the fins get firmly locked with copper tubes. The coils then pass through the auto-brazing machine to close the open ends of the coils. The coils are then taken to coil bending machine, when bending is needed in the coil. The header and capillaries are then brazed with the coil at the manual brazing station. Finally, the coil is tested for brazing joint at water deep testing stage and subsequently dried in the oven.

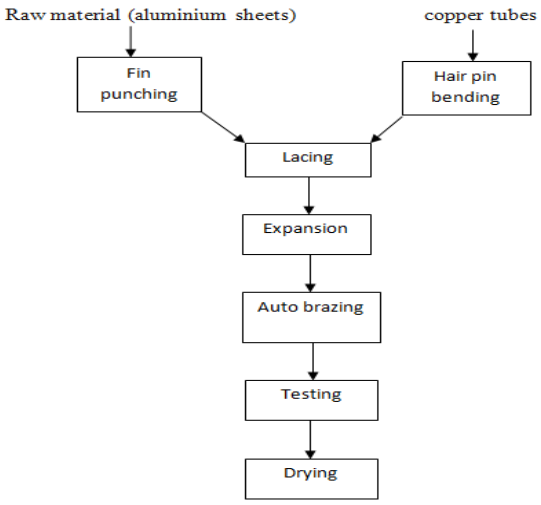

Fig.4.1: flow chart of the coil shop.

To map the process and calculate the VA and NVA times, it is necessary to calculate WIP inventory level at each stage of the operation.

To carry out the process mapping of the coil shop, a high moving model is selected and the process times are collected

for each operation involved in the coil shop. The following provides relevant data for the selected coil code and the workshop details.

Table 4.1: coil shop data.

Machine name	No. Of operators	Setup time in mins.	Process time in mins
Fin press	1	10	2
Hair pin bender	1	10	2
Expander	2	60	3.5
Auto brazing	2	10	3
Water testing	1	0	5

The following figure shows the VSM diagram for the model CODX-D60 VSM analysis reveals that the percentage value addition (%VA) is 5.55 %. It is observed that the high setup time of expander is making expansion operation a bottleneck and causing a high WIP inventory and preventing one piece flow across the shop floor. This high setup time causes the material to be pushed by each workstation to sequential workstation, which is not ideal in terms of lean manufacturing. The high WIP level causes material handling problem, coil damage, and other quality problems. To reduce the WIP level between fin press and expander, it is imperative to reduce the setup time of expander, so that instead of pushing the batch material to the expander, it will allow the expander to pull the material from the fin press. Also to reduce the WIP between the expander and the auto-brazing, the production rate of the auto-brazing machine should be reduced. Necessary adjustment should be made in speed and number of operators to attain a balance between output of expanders and output of auto-brazing machine.

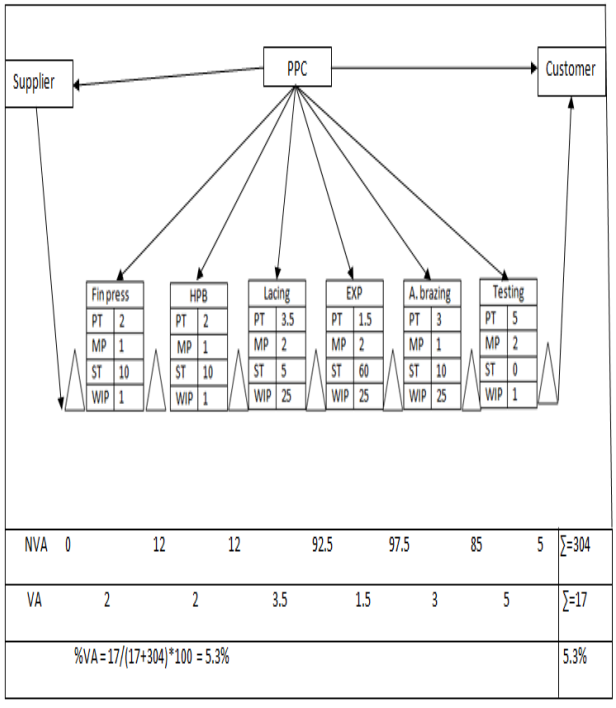

Fig.4.2: current state Value Stream map.

PPC: production planning & control

Pt: process time in minutes
MP: man power
ST: setup time in minutes
NVA= non value adding activity time= (pt*WIP) +ST
After the analysis of the current state value stream map, the following action plans were implemented.

- The setup time of the expander machine was reduced using Single Minute Exchange of Die (SMED) technique.
- Non value adding activities were reduced.
- WIP inventory was reduced.

The future state value stream map after implementing the above control actions is shown below.

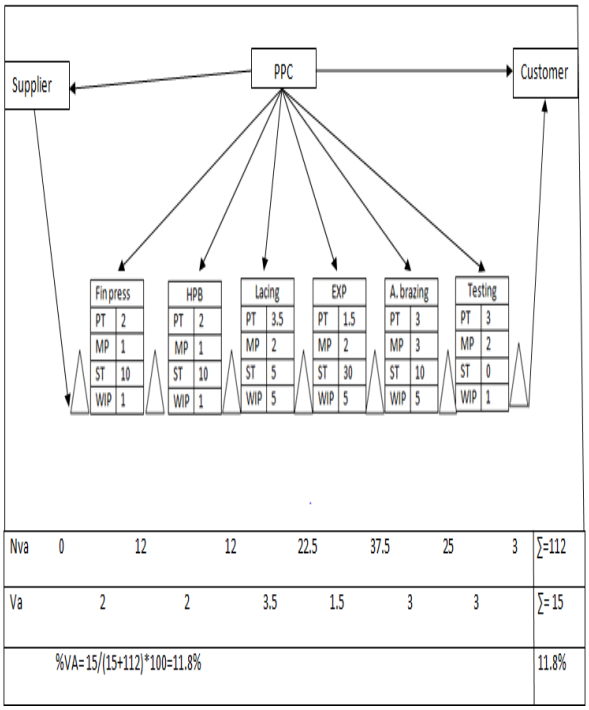

Fig.4.3: future state Value Stream map.

V. CONCLUSION

VSM, an LMS tool, revealed that the value addition percentage (%VA) of the coil shop was around 5 %. VSM (future state) projected the value addition percentage to be 11.8% after the implementation of all the improvement projects, the increment of 140 % from the current level, which resulted from the setup time reduction of expander machine.

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