ABSTRACT

Lean manufacturing is a performance-based process used in manufacturing organizations to extend the competitive advantage. The essentials of lean manufacturing employ continuous improvement processes to focus on the elimination of waste or non value added steps within an organization. The purpose of the study is to develop a value stream map (VSM) for a kitchenware manufacturing industry in Chennai. In this study researcher developed a current state map to make a sketch of production flow and understand the company’s current cycle times, change over time, communication process and competence of machine equipment. This provides information needed to produce a future state map although that will not be done in this study .The aspire is to spot and eliminate waste and to progress the process flow .Based on the data gathered, the company will utilize these results as an idea to map the future state and implement lean manufacturing.

KEY WORDS: Value Stream Map(VSM), Lean Manufacturing, Current State, Future State Map, Kitchenware Industries.

INTRODUCTION

Kitchenware manufacturing industries are continually striving to increase productivity and output of their operations. Their objective is to persuade the customer with the precise product, quality, quantity and price in shortest amount of time. Tapping (2002) stated that Value stream management is a management tool for planning a production process involving lean initiatives through systematic data capture and analysis author further explained that lean manufacturing is more than a cost reduction program or a problem solving approach .Efficient production can be achieved by the lean manufacturing by an inclusive approach to minimize the waste. This means eliminating surplus production and inventory, unnecessary materials movement, waiting and delays, over processing, excess employee motion and the need for repair and corrections.

Womack & Jones (1996) defined that value stream map is the set of processes required to transform raw materials into finished goods that customers value. Sing et al.,(2005)and Lummus et al.,(2006) quoted that lean manufacturing is an integrated manufacturing system intended to maximize
Lean Manufacturing Approach to Improve the Performance of Kitchenware Manufacturing Industry in Chennai (India)

capacity, re-utilization and minimization of buffer inventories through minimization of system variability. Ajit Kumar Sahoo et al. (2008) defined value stream map (VSM) as a pictorial representation of all of the value-added and non-value added activities required to produce a specific product, services or combination of products and services to a customer, including those in the entire supply chain and the internal operations thereby, made it easy to identify the implementation plan.

In this study, a value stream map was developed for a kitchenware manufacturing industry in Chennai. Creating a value stream map will enable the company to document current production lead time, change over time, cycle times and inventory levels. In order to determine the ratio of value-added time to total lead time of the product family being analyzed, making a vision of a perfect value flow. The goal is to spot and eliminate the wastes in the production process. The company can use these results in order to map the future state and implement lean manufacturing.

REVIEW OF LITERATURE

Womack & Jones (1996) outlined that value stream is that the set of processes, together with value-added and non-value-added activities, needed to transform raw materials into finished product that the customers value. Liker (1997) discussed that lean manufacturing is an operational approach oriented towards achieving the shortest possible cycle time by eliminating waste. The method often decreases the time between a customer order and shipment, and it is intended to improve profitability, throughput time, employee motivation and customer satisfaction. Feld. w (2000) explained the five primary elements to consider when implementing lean manufacturing are manufacturing flow, process control, organization, metrics, and logistics. These elements signify the variety of aspects needed to sustain a flourishing lean manufacturing implementation program.

Corner, (2001) mentioned that within the past companies are centered on the value-added steps. The goal was to cut back the value-added part of lead time and not pay an excessive amount of attention to the non-value-added activities. Today, lean production strives to enhance the maximum amount as potential the value-added part of lead time, however focus initial on reducing the non-value-added part of lead time.

Rother and Shook (1998), Womack et al. (2002), Pavnaskar et al. (2003) mentioned that the value stream mapping (VSM) technique as a useful technique aimed functional method aimed at rearranging production systems from a lean point of outlook. Value streams bring a precise goods or service through three vital management tasks: problem solving (figuring out what has to be changed), information management (improving the flow of information), and physical transformation (implementing the changes).

Dickson et al (2009), described the results of Lean, a technique improvement strategy pioneered by Toyota, on quality of care in the four emergency departments (EDs). Lean principles adapted to the native culture of care delivery will results in behavioral changes and sustainable enhancements in quality of care metrics within the ED.
Vinodh et al (2011) discussed about the environmental waste as the ninth waste and the article focuses on the exploration of various issues of sustainability using lean initiatives also mentioned the key issues include envisaging wastes to eliminate environmental waste in value stream and recognize the lean improvements that would enable EHS compliance issues. The future state map includes 5S improvement, pull production to control inventory levels, and Kaizen events. VSM is a process mapping method for better understanding of the sequence of activities and information flows used to produce a product and deliver a service.

SIGNIFICANCE OF THE STUDY

The value stream map that will result from this study could reduce costs, improve lead time, quality and increase productivity of the products produced by XYZ kitchenware manufacturing industry in Chennai. It hoped that the company uses this value stream map in future to eliminate the non-value adding activities.

Objectives

- To examine and gather the information related to product and process flow from raw material to finished goods for the value stream selected.
- To create the current state map of the process activities by mapping the material and the information flow.
- To find out the lean metrics from the value stream map.
- To analyze the current state map for opportunities to eliminate wastes and improve the process flow.

CASE STUDY

The case study considered in this research is one of the leading stainless steel kitchenware products manufacturers in Chennai. The identity of the company is protected; however, researcher shall refer to the industry as XYZ industry. XYZ produces several types of stainless steel products that are used as kitchenware’s. The focus of this VSM is on one product family (i.e.) hot pot. A single hot pot consist of four parts namely outer lid, inner lid, outer body and inner body. The outer lid was attached to inner lid and inner body was attached to outer body. Average expected customer demand for hot pot was approximately 52,500 numbers per month.

![Fig:1-Blanking materials for Lid & Body(I/O) operation]
The process sequence of outer lid of hot pot starts with blanking of sheet metal to circle cut followed by drawing operation was performed using 150 ton triple action hydraulic press machine (120 hp), in addition to that profile cutting was done in lathe machine. Further side holes and hand holes were made using 25 tone power press machine. Finally riveting the handle of the outer lid were done by pneumatic rivet gun and blocking the holes in outer lid were performed using 25 ton power press machine.

The sequence of operations on hot pot inner lid were blanking of metal sheet to circle shape followed by drawing operation was performed using hydraulic press (60 hp) and trimming operation at profile of inner lid were done in the lathe machine. The joining of two lids (inner and outer) is done in the sequence of bending the inner and outer (I/O) lid, filling the chemical using Puff Mixture Pneumatic (which was filled by Isocynate poly oil to retain heat). Automation was not used to transfer the (I/O) lid materials to polishing area, only by manual handling was done. The lid was polished in the grinding machine using 7.3 HP Buffing Motor followed by drilling the lock hole operation and finally riveting the lock was done using 25 tons power press machine in the (I/O) lid and sent for packing. Inspection of the (I/O) lid was done during packing.

The process sequence of outer body of hot pot starts with blanking of sheet metal to circle cut followed by drawing operation was performed using hydraulic press machine (120 hp) followed by annealing process was done in Induction Annealing Machine. Annealing is a heat treatment in which material is exposed to an elevated temperature and gradually cooled. Annealing of the materials changes physical properties of the materials such as strength and hardness. In addition to that, out cutting operation was done in lathe machine to remove excess material followed by outer ring forming. Further side holes are drilled using drilling machine. Finally, holes were blocked in the outer body.
The sequence of operations on hot pot inner body were blanking of metal sheet to circle shape followed by drawing operation was performed using hydraulic press (60 hp) and annealing operation was done in the Induction Annealing Machine. In addition to that, trimming operation was done in lathe machine to remove excess material.

The joining of two bodies (inner and outer) is done in the sequence of bending the inner and outer (I/O) lid, filling the chemical (which was filled by thermo foam to retain heat). Automation was not used to transfer the (I/O) body materials to polishing area, only by manual handling was done. The body was polished in the grinding machine followed by drilling the lock holes operation and finally riveting the lock was done in the (I/O) body and sent for packing. Inspection of the (I/O) body was done during packing.

METHODOLOGY

The procedures for this study were chosen to satisfy every of the project objectives. In order to map the current state, the researcher set to travel to the ground so as to gather information, which began with the receiving space and worked toward the shipping space. The researcher collected information regarding material flow, inventory between processes, and method attributes including: a) amount of hotpot needed per month, b) amount of hotpot shipped per day and per month, c) range of shipping days per month, d) delivery schedule e) regular planned down time, f) available production time per day g) range of shifts per method. Also, the researcher collected the subsequent individual metrics at every method involved: a) cycle time, b) changeover time per shift, and c) available uptime. Once the
information was collected and ordered the researcher calculated daily necessities and Takt time, and started to map the current state value stream.

After the present state map was developed, the researcher selected the suitable metrics based mostly on their ability to produce specific measures for a selected operation. The researchers followed Juana C. Tinoco (2004) method for calculating the metrics for entire value stream. Following could be a list of the metrics selected:

1. work-in-process inventory: This metric was calculated dividing the whole value stream work-in-process inventory by the daily quantity of components needed by the client.

2. Total production cycle time: so as to work out the whole cycle time the researcher computed the cycle time for every method and then added up the amounts.

3. Total lead time: To calculate total lead time, the researcher turned to the ground search from the instant that the order was released to the time the part was delivered to the client.

4. Cumulative available uptime: so as to work out the cumulative available uptime, the researcher observed the available uptime for every method and then multiplied the amounts. Available uptime for every method is decided by dividing actual operating time by offered production time. Actual operation time for every method is decided by subtracting offered production time minus changeover time.

The last step was to look at the current state map for opportunities to eliminate waste and improve the method flow. The researchers identified the maximum amount waste as they may within the value stream and prepared suggestions and recommendation to the industry.

RESULTS & DISCUSSIONS

The purpose of this study was to develop a worth stream map for a hotpot, for the XYZ kitchenware industry. This explicit tool permits an organization to document current lead time, inventory levels and cycle times to work out the ratio of value added to the entire lead time of the family cluster selected. So as to map this state, the researcher observed and picked up information regarding material and knowledge flow paths, process attributes and work-in-process inventory that helped to work out metrics for every method and for the whole value stream. This information enables the researcher to develop the value stream map of the method activities and helped to know the movement of materials and knowledge along the value stream selected. The ensuing information may be used to spot and eliminate waste within the production method and to supply a future state map by making a vision of a perfect value flow.

Metrics For The Complete Value Stream

Once the information was collected the researcher calculated the subsequent metrics for the complete value stream: collective Available time, Uptime, COT (Change over time), TCT (total cycle time) and TLT (total lead time).
Cumulative Uptime

The cumulative uptime, that is that the total on the uptime for the complete value stream, resolve by multiplying the on the available uptimes for every of the processes (98%, 94%,95%,98%,100%,99%,99%,100%) which consequences cumulative uptime of 97.87%.

\[ \text{Uptime(\%)} = \frac{\text{Available productive Time - DSR}}{\text{Available productive Time}} \]

WIP (Work-in-process) Inventory

The total WIP inventory resolves from by adding up WIP inventory between every method leading to a complete of 52,500 components inside the entire value stream.

Total Value Stream Days of WIP & Total Product Cycle Time

The total days of WIP inside the value stream resolve by dividing the amount total value stream WIP (52,500) by the daily quantity of components needed by the client (2,100 parts), outcome in 25 days. The total production cycle time was calculated by adding up the cycle time determined for every of the processes shown in figure-9, leading to 615 seconds.

Lead Time & Takt time

Lead time is that the time from 1st operation to last operation. Lead time is shown in figure-9; it takes 25 days to complete a customer order. The takt time resolve by dividing the on the available production time per day (840 minutes) by the overall daily amount of hot pot produced (2,100), resulting in twenty four seconds.

\[ \text{Takt Time} = \frac{\text{Available productive Time - day}}{\text{Quantity of Hot pot Produced-day}} \]

Availability

The available production time per shift resolve by taking the overall available production time per shift, that is equal to eight hours (480 minutes), and subtracting regular Planned downtimes events per shift (two fifteen minute breaks and one thirty minute lunch break); thus available production time is 420 minutes per shift. The available production time at every work center is set by multiplying 420 minutes by the amount of shifts that the work center typically operates. The work center operates a pair of shifts per day. So the available production time per day is 840 minutes. The overall available production time inside a process was resolve by adding along the available production time at every work center concerned for the particular process. The metal removal process for hot pot lid is comprised of 4 work centers runs for two shifts (840 minutes) which results in 3,360 minutes available for entire metal removal process for hot pot lid. The metal joining process, finishing process and drill & lock process of hot pot lid is comprised of 2 work centers each runs for two shifts (840 minutes) which results in 1,680 minutes available for each of these process metal joining process, finishing process and drill & lock process of hot pot lid. The blanking process, drawing process, metal forming process of hotpot lid comprised of only one work centers each runs for two shifts (840 minutes).
The metal removal process of hotpot body consists of 3 work centers runs for two shifts (840 minutes) which results in 2,520 minutes available for entire metal removal process for hot pot body. The metal forming process, finishing process and drill & lock process of hot pot body is comprised of 2 work centers each runs for two shifts (840 minutes) which results in 1,680 minutes available for each of these process metal forming process, finishing process and drill & lock process of hot pot body. Remaining drawing process, Annealing process, and metal joining process comprised of only one work centers each runs for two shifts (840 minutes).

\[
\text{Availability} = \text{Available production time} \times \text{Number of Shifts} \quad (\text{minutes})
\]

It was found that the time it takes to create one product or the full product cycle time for the value stream, was 615 minutes. However, the entire lead time, that is that the time to create a raw material into a finished product was 25 days. The lead time (25 days) minus the cycle time (615 minutes) is that the non-value-added activities like putting in machines, moving materials, and looking forward to materials. This means that there's a lot of chance for improvement.

Uptime of the drawing outer body method is affecting the results of the full value stream and will be the cause for delays on delivery of orders. The researcher observed that every operator runs the work center in numerous ways that which the operators modification the tools in numerous ways that, spending between thirty minutes to one hour to line up the work center. The speed of the method depends of the abilities of every operator.

Also, generally several of the work centers weren't running for the rationale that they'd mechanical issues because of poor maintenance. Once the components were created, they spent an excessive amount of waiting time before they were moved to consequent operation. The researcher observed poor communication either between the machine operators and production supervisor or between the machine operators and forklift operators. Plenty of defective components were placed anywhere round the assembly processes; there was no specific place to place defective materials. Overall, the place perceived to be disorganized.

In order to boost the complete production method for the value stream selected, the researcher created the subsequent recommendations.

Blanking operations can be done using press machine instead of performing in manual manner. So that we can reduce the cycle time by 30 seconds to 10 seconds in addition to that COT can be reduced from 15 minutes to 5 minutes. Hydraulic machine can be used for blanking operations by changing the die .change over time also be reduced by using conveyors. In order to cut back the changeover time at the drawing outer body method for hot pot the researcher instructed the applying of fast changeover/setup reduction techniques. This setup reduction technique is predicated on the principles of the single minute exchange dies (SMED) system to dramatically scale back or eliminate changeover time. Some examples that might be utilized during this scenario embrace .setting tools near the work center will reduce the time for the operator spending in craving for the tools.
1. Standardization of the setup operations, therefore every operator should perform the setup within the same method and should run the work center equally.

2. New operators should be trained on the fast change over techniques to avoid delays.

In order to extend the capability of the plant while not capital investments and conjointly to avoid unplanned equipment downtime, the researcher instructed the implementation of total productive maintenance (TPM) that could be a method to extend the potency likewise the helpful lifetime of the equipment concerned. one among the key parts of this system is employee involvement and management involvement, therefore every operator should watch out of the work center he or she operates, maintain it, and report any injury if it happens and management has to take appropriate measures. If shop floor employees are giving any suggestion if the suggestion is valid, it should be appreciated if possible rewarded then only the workers will involve in their work.

In order to enhance the housekeeping the researcher instructed the implementation of 5S techniques for the workplace standardization and organization. It’s one in all the best Lean tools to implement, provides immediate results, crosses all business boundaries, and is applicable to every function with a corporation. As mentioned, this system includes the implementation of 5 steps: take away all unneeded things, produce locations for the required things and keep everything clean when utilization, set standards and procedures.

In order to enhance communications, the researcher instructed the use of a visible management system a number of the techniques that might be applied embody decision lights and Andon board lights, digital show panels and a monitor screen. Decision lights and Andon board lights can be used to decision immediately for a supervisor or general staff for various styles of help (e.g. move material, drawback within the line, etc). standard operations sheets can be used for the primary line supervisors to eliminate unnecessary inventory and staff and to eliminate accidents and defective production. These sheets live all the parts (cycle time, percentage of defective parts, a regular operation routine, and quantity of work-in-process) for every day. Digital show panels are another recommendation which might normally be used to point out the range of units that has been created throughout the day.

This may inform everyone at the plant regarding specifically at what rate they have to be operating so as to satisfy client demand. Due to this visual management system communication was generally simplified.

In order to cut back waiting time between every operation, the researcher instructed the use of Kanban systems. It is a tool to attain just-in-time. It consists of a card with all the data that's needed to be done on a product at every stage along its path to completion and that elements are required at subsequent processes. By the use of this tool the elements are often rushed from one work center to a different, improving the product flow and reducing the work-in-process between processes. Cross training of their workers will provide the facility with the elasticity that accommodates employee absence. This in turn led to a reduction in the inventory levels between each of the operations.
CONCLUSIONS

Value stream mapping has proven to be success way to analyze a company’s current production state and illustrate crises areas. This analysis carries proof of real benefits in applying lean principles in Kitchenware manufacturing industries. As far as our knowledge is concerned, it’s the first time to use value stream map in kitchenware industries. The goal of this study was to collect necessary information and develop a value stream map for a hotpot for XYZ kitchenware manufacturing industries. The value stream map served as a tool for the researcher to form observations and proposals to boost processes at the industry. It was evidenced that VSM is a perfect tool to reveal the waste in value stream and determine improvement areas. This paper exhibits the effectiveness of lean principle in an exceedingly systematic manner. By combining information and material flow on one map (value Stream mapping), depicts how the two relate to the lead time. We recommend to XYZ kitchenware manufacturing industry to utilize the ways developed during this project. Eventually it allows the businesses to maneuver towards their final goal resulting in, profitability and to withstand in competitive market.

REFERENCES

APPENDIX - Value stream Map for Hot Pot Lid & Body

- Supplier
- Forecasting
- Weekly Order
- Weekly
- 52,500 parts/month
- 2,100 parts/day
- 25 shipping
- Customer
- Shonin
- Packi

- Receiving
- 50 tons of metal
- Sheets raw

- Blanking
  - CT-30
  - COT: 15
  - Availability: 840
  - Uptime: 98%

- Drawing Inner lid
  - CT-20

- Metal Removal
  - CT-55
  - COT: 55
  - Availability: 360
  - Uptime

- Metal Joining
  - CT-30
  - COT: 15
  - Availability: 55
  - COT: 15

- Metal Forming
  - CT-25
  - COT: 5
  - Availability: 840

- Finishing
  - CT-35
  - COT: 20
  - Availability: 1680
  - Uptime

- Drill & Rivet Lock
  - CT-35
  - COT: 20
  - Availability: 1680
  - Uptime: 100%

- Assembly
  - CT-30
  - COT: Nil
  - Availability: 480
  - Uptime: 100%

- Drawing Inner body
  - CT-25
  - COT: 60
  - Availability: 840

- Drawing Outer body
  - CT-25
  - COT: 90
  - Availability: 840

- Annealing
  - CT-40
  - COT: 4
  - Availability

- Metal Removal
  - CT-55
  - COT: 20
  - Availability

- Metal Joining
  - CT-10
  - COT: 15
  - Availability

- Metal Forming
  - CT-65
  - COT: 20
  - Availability

- Finishing
  - CT-50
  - COT: 20
  - Availability: 1680
  - Uptime

- Drill & Rivet Lock
  - CT-40
  - COT: Nil
  - Availability

1 day
2 days
1 day
2 days
1 day
2 days
1 day