Implementation of Value Stream Mapping and Kanban Method for Improved and Sustainable Production in Piston Industry

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ABSTRACT: The global market has dramatically changed during the past years. Consequently, products with low quality, long lead time, and limited variety are no longer acceptable among customers. Customers‟ demands are increasing by time and traditional production systems cannot meet this new level of demand. Hence, applying new production methods in order to produce high quality product, in short time, with low price becomes essential for survival in current competitive global market.

I. INTRODUCTION

Lean production is one of the approaches which has been used by many companies around the world to achieve these competitive advantages. However, lean production was developed by large companies and based on their characteristics. Large companies are not the only important enterprises and Small and Medium sized Enterprises (SMEs) have a large share in the world economy: for example 55.5% of all the added value in Europe comes from SMEs (European Commission, 2005). Therefore, it is important to find out; whether or not SME scan also enjoy the advantages caused by applying lean production. Since lean production is not tailored for SMEs and their characteristics, these companies may face some difficulties with implementation of it in their organizations.

II. EMERGENCE OF LEAN PRODUCTION

No new idea emerges unless all the conventional ideas and solutions are no longer useful. This was mentioned by Womack et al. (1990); who introduced "Lean production" as a western version of Toyota Production System (TPS), regarding realization of Toyota production system. TPS, by itself, arose while there was a need for industrial development in Japan, while due to specific economic conditions (down time) in Japan at that time, conventional methods did not work. Therefore, in the spring of 1950 Eiji Toyoda, top man of Toyota at that time, traveled to USA to conduct the second Toyoda family‟s visit of cast Rouge, which was known as the largest and most efficient factory of the world at that time. As a result of this visit and his discussion with TaiichiOhno, genius production engineer of the Toyota at that time, Eiji concluded that they cannot exactly copy the Ford production system (mass production), yet there are some possibilities for improvements and establishing a tailor made production system. This later led to Toyota Production System (TPS), which later on the western version of it was introduced as Lean production.

III. LEAN MANUFACTURING

Lean Manufacturing is a systematic approach to identifying and eliminating waste through continuous improvement. Lean is about doing more with less: Less time, inventory, space, people, and money. Lean is about speed and getting it right the first time. Lean production is aimed at the elimination of waste in every area of production including customer relations, product design, supplier networks and factory management. Its goal is to incorporate less human effort, less inventory, less time to develop products, and less space to become highly responsive to customer demand while

producing top quality products in the most efficient and economical manner possible. Lean is a mind-set, or way of thinking, with a commitment to achieve a totally waste-free operation that's focused on our customer's success.
Lean production is an integrated socio-technical system whose mainobjective is to create flow and eliminate waste by concurrently reducing orminimizing supplier, customer, and internal variability.

Figure 1: Lean Manufacturing Concept

IV. THE PRINCIPLES OF LEAN MANUFACTURING

As with most other production philosophies and management practices, lean principles cannot be universally applied. However, because they are fundamentally customer value driven, they are suitable for many manufacturing environments. These five lean principles work together and are fundamental to the elimination of waste. There are five basic principles of lean manufacturing:

Fig.2 principle of lean manufacturing

V. METHODOLOGY

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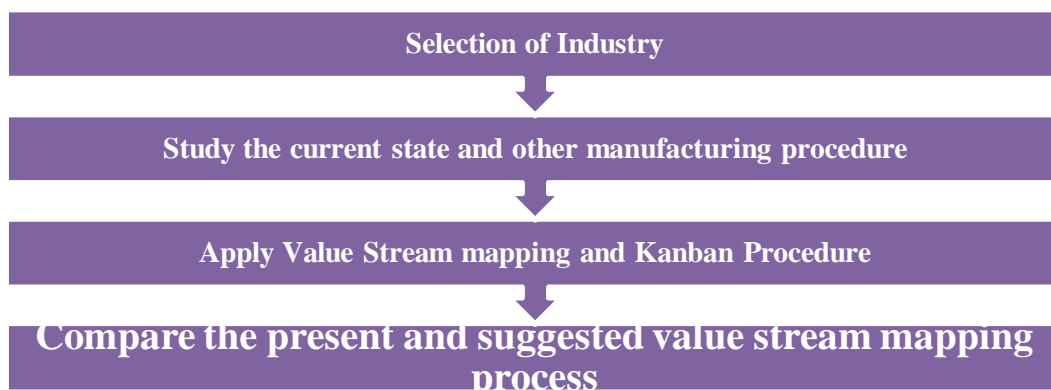- Finally Comparing both the states that is present and future state with incorporated benefits

Selection of Industry

Study the current state and other manufacturing procedure

Apply Value Stream mapping and Kanban Procedure

Compare the present and suggested value stream mapping process

Figure 3: Flow chart of methodology

➢ Industry: For the present Study a **Piston manufacturing industry** is considered for performing the study based procedure.

Precision Engineering works Pvt Ltd.:
A unique industry covering machining of Traction Alternator End Shield 1400 mm diameter etc, fabrication of Stator Frames – Tubular & Non-Tubular up to 15 Tonnes (Siemens design) besides manufacturing plugs & sockets etc for, oil rig controls, Contactors & Relays for Electric Traction, Aluminum Alloy Slides and Card Retainers for Bharat Electronics, Dashpot assembly for vacuum circuit breakers etc. Besides all the products company also manufactures pistons for various clients and customers.

Value Stream Mapping
The value stream is analyzed and mapped in order to reduce the waste in processes, enable flow, and move the process towards the ideal of rapid response to customer pull. In the product development context, this means rapid response to customer needs for both new products and modifications and adaptations of existing ones.
A value stream is a collection of all actions value added as well as non-value added that are required to bring a product or a group of products that use the same resources through the main flows, from raw material to the arms of customers. Value stream maps are a very common technique when you're implementing a lean system.
The study discusses the implementation of Value Stream Mapping.
Step -1 Calculate Takt time: Takt time is the maximum amount of time required to complete operation as per customers' satisfaction.
Step-2 Understand Customer Demand: Customer demand is monthly or daily demand of customer as per need.
Step -3 Mapping the Process flow: This step involves various processes which are in sequence to complete product development and calculation of cycle time, changeover time, and uptime for each.

Step -4 Maps the material flow: The flow of material form row to finish good is given by supplier to customer.

Step -5 Map information flow: The information flow is also incorporated to provide demand information which is an essential parameter for determining the process in the production system. Various data regarding cycle time (C/T), change over time (C/O), uptime, take time etc.

Step- 6 Calculate total product cycle time: After both material and information have been mapped. A time line is displayed at the bottom of the map showing the processing time for each operation and the transfer delay between operations. The time line is used to identify the value adding step, as well as waste. Where,S/T is setup time, C/T is cycle time, and C/O is change over time. The production of the pistons is done by implementing the Kanban (pull system) from the machining stage till the assembly stage. Further after this process there is also the need to check for bottleneck process in the complete system.

Takt Time is the rate of a completed product needs to be finished in order to meet customer demand.Available time = Working time - Regular 'non-direct' time

VSM Data for current state

S.No.	Operation	WIP	Cycle time (sec)	Changeover time (sec)
1	Cutting	200	24	4
2	Centering	150	6	14
3	Drilling	550	58	20
4	Tapping	600	86	18
5	Milling	375	48	6
6	Polishing	75	4	4
7	Inspection	450	60	2
8	Welding	125	6	6
9	Packing	200	17	17
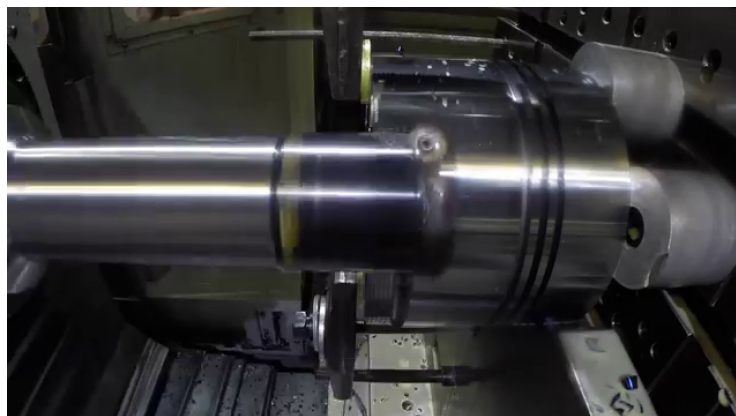
Figure 4: Cutting operation
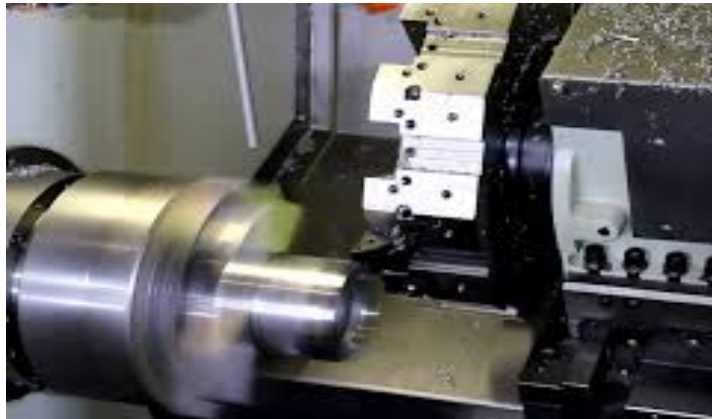
Figure 5: Centering Operation

Figure 6: Welding Operation

Figure 7: Drilling Operation

Figure 8: Tapping Operation

Figure 9:Inspection Process

Where, non-direct time represents stand-up Meetings, breaks, vacations, sick time, cleaning, etc. This is simply thework time in the time period selected, regardless of the number of people actually doing the work.Takt Time = Available minutes for production / required units of production.

VI. RESULTS FOR INVENTORY

Current state:
Total quantity of raw materials = 1500, &Finished goods = number of units/day = 600

Raw Material	**1500**
WIP	2725
Finished Goods	600
Total	4825

Future State:

Raw Material	**1500**
WIP	2175
Finished Goods	0
Total	3675

Based on the manufacturing comparison of production process in current state and future state.By the following proposed implementation path of the improvements, the performance of the production process can be improved. This research work has been done for improving the overall productivity of a small scale industry by implementing the lean methodology.

Table Comparison table

	Σ(WIP)	Σ(CT) sec	Σ(CO) sec	Number of Operations
Current state	2725	309	91	9
Future state	2175	194	74	7

In comparison analysis based on manufacturing process in current state and future state are discussed in this section. The comparison table clearly shows that the overall summation of WIP of the current state is reduced from 2725 to 2175. Further, the number of operations in current state is 9 where as in future state is 7. The operations of centering and drilling are combined in to a single operation in the future state. Similarly, the operations polishing & inspections are combined as single operation. Also the last operation in future state is combination of polishing inspection and packing.

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