Productivity Improvement through Lean Manufacturing Tools in RCB Gear Product

S. Rethinavel, V. Samson Jayakumar, Ayyappan Rajagopal

Abstract-**The economic reforms- Liberalization, Privatization, Globalization, (LPG) started in 1991 in India. The main objective of the government was to achieve high economic growth and industrialize the nation for the well-being of Indian citizens. Thus Indian market became Global and open market. Increasing productivity is an ever present challenge in the manufacturing industry where demands on resource utilization and reduced tied up capital are increasing constantly in order to match the competition and stay ahead as a world class manufacturing. Lean manufacturing tools are one of the most influential and effective methodologies for eliminating waste, controlling quality, improving overall performance of any machines, system or process. By using the lean manufacturing tools, time consumption, human effort, effective utilization of machines, raw material usage and control the inventory are analyzed which is converted into productive output. By this process the increase of productivity and develop an overview of conceptual framework of lean manufacturing practices to minimize the production cost. An Investigation was carried out in automotive industry manufacturing commercial vehicle power steering gear for implementation of lean manufacturing the following part line – cover. By using following lean tools Heijunka (Level scheduling), Kanban (Pull system), VSM (Value Stream Mapping), Visual Factory and Standardized work will be carried out for implementation of lean manufacturing. The various parameters collected during the investigation will be simulated using FLEXSIM simulation software for finding the optimal solution.**

Keywords- Lean manufacturing, Productivity, Wastes, Heijunka **(Level scheduling), Kanban (Pull system), VSM (Value Stream Mapping), Visual Factory and Standardized work.**

I. INTRODUCTION

The concept and roots of Lean are based on foundational ideas that date back to W. F. Taylor (1911) and to H. Ford, who put in place an impressive production system in the Highland Park manufacturing plant, in 1913. There, a set of practices and tools (interchangeable parts, standard work and the assembly flow line) was put in place in such an integrated way that allowed them to turn out products at incredible speeds, with very short flow times and high consistency. Increased demand for shorter product cycles and more variety, as well as the market demands after World War II, changed the competitive marketplace in such a way that Ford's early "Leanness" was not sustained in the long run (Duque & Cadavid, 2007). K. Toyoda (member of the founding family of Toyota) and T. Ohno (Toyota's leading manufacturing engineer) visited Ford factories right after World War II and observed their operation. They were convinced that with some elements from the Ford system, their adaptation to their scale and reality and a lot of ingenuity they could make Toyota a competitive force in the automotive market. In lean manufacturing system the use of tools is, Kanban, Visual Factory, Value stream mapping, Seven wastes. Improved Layout, Standardized Work ,Heijunka (Level Scheduling).

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II. LITERATURE REVIEW

In this report is discussed the implementation problems in Lean manufacturing companies. A survey was conducted for the data gathering to company which implemented lean Manufacturing. The result shows that there are a lot of challenges or problems face by companies in their business to implement Lean Manufacturing and maintaining the overall operational system [1]. This paper is demonstrate the Lean manufacturing appears to hold considerable promise For addressing a range of simultaneous, competitive demands including high levels of process and product quality, low cost and reductions in lead times. This research addresses the application of lean manufacturing concepts to the continuous production sector with a focus on the motor manufacturing industry. The goal of this research is to investigate how lean manufacturing tools can be adapted from the discrete to the continuous manufacturing environment [2]. This paper is explain the implementation of lean manufacturing strategy allows strengthening the phase sequence that leads to operational excellence, a continuous improvement and the elimination of non value added activities. The tool kaizen is applied as a way to progress toward lean manufacturing and as a formula to lead the activities of improvement. It has been increasingly adopted as a potential solution for many organizations, particularly within the automotive and aerospace manufacturing industries [3]. This paper describes the Lean Product Development (or Lean Engineering) affects many organizations within an enterprise including Purchasing, Sales, Finance and Manufacturing. At the center of Product Development is clearly the Engineering organization [4]. This paper explains the Lean manufacturing is defined as a systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection. This paper describes some learning from the literature and actual practices in USA, UK, and India. Attempts are made to present the gaps between the principles and practices [5]. In this paper researcher has applied lean manufacturing concept in order to increase productivity of coalmining. By application of lean tools the Overall Human Effectiveness is analyzed which is converted into productive output to increase the productivity and develop an overview of the conceptual framework of lean manufacturing practices to minimize the production cost of mining [6]. This paper explains the large number of organizations are following Lean technologies and experiencing vast improvements in quality, production, customer service, and profitability. Lean Manufacturing is a systematic approach to identifying and eliminating waste through continuous improvement [7]. The purpose of this research is, to identify the critical lean manufacturing factors responsible for implementation of lean manufacturing in the Indian manufacturing sector and then to incorporate these factors into a framework, which can be represent the present status of lean practices in Indian industries. Also to identify the barrier and benefits of lean manufacturing in industries [8]**.** This paper explains *the* implementation of lean manufacturing starts with the development of Value Stream Maps. A value stream is comprised of all the actions, both value added and non-value added. The main strategy of lean manufacturing is increasing the operating speed, reducing the duration of flow quality, and improving the cost and delivery performance [9]. The objective of this paper is to present an overview on a new combined methodology for the efficient improvement in productivity with the help of various Work Study Methods associated with Lean Manufacturing Principles & Tools. Lean manufacturing tools are one of the most influential & most effective methodologies for eliminating wastes (MUDA), controlling quality, and improving overall performance of any machine, system or process in any industry with the complete assurance of large annual profit margins [10].

III.KIND OF WASTES

Waste elimination is one of the most effective ways to increase the profitability of any business. Processes either add value or waste to the production of a good or service. The seven wastes originated in Japan, where waste is known as “muda." "The seven wastes" is a tool to further categorize “muda” and was originally developed by Toyota’s Chief Engineer TaiichiOhno as the core of the Toyota Production System, also known as Lean Manufacturing.

- Over-production
- Defect
- Inventory
- Transportation
- Waiting
- Motion
- Correction
- Unused Employee Creativity

IV. LEAN MANUFACTURING TOOLS AND TECHNIQUES

Various techniques such as 5S, Just-in-Time, cellular Manufacturing System, Value Stream Mapping(VSM), Kaizen, Minute exchange of dies(SMED),Six Sigma, Kanban, ,Total Quality Management (TQM), Theory of constraints(TOC), Total Productive Maintenance (TPM) etc.

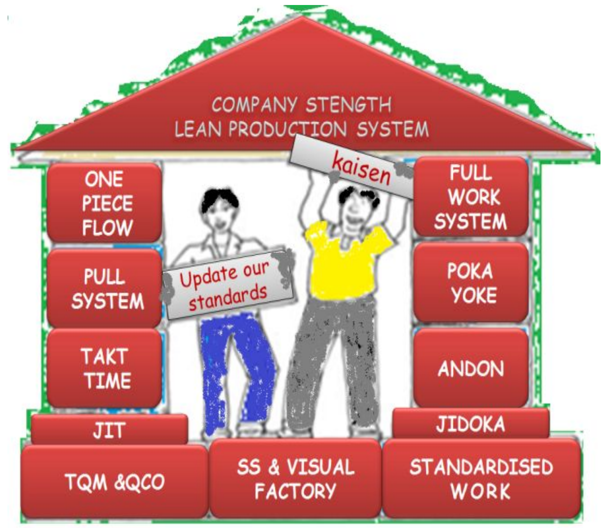
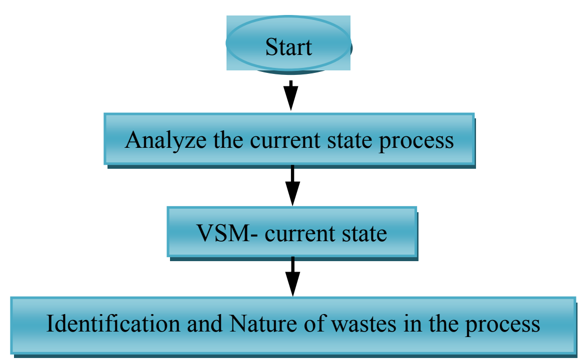


Fig. 1: Pillars of Lean Manufacturing

V. BACKGROUND OF COMPANY

Rane group of companies was originally founded by Shri T. R. GanapathyIyer in the year 1929 and the group was originally named as Rane Madras (Ltd).It started off as a distributor of automobiles and parts. Under the leadership of LLN, the company was shaped into an auto-component business house. LLN remained as the founder chairman of the group for over three decades.Rane is the joint venture of TRW, originally stood for "Thompson Ramo Wooldridge"; it was formed when Thompson Products merged with Ramo-Wooldridge in 1958. Automobile companies that use its products include Ashok Leyland, Volvo, M&M,Tafe, and Tata among many others. A Tata motor remains its major customer and is the primary parts manufacturer for Tata's Nano.Rane (Madras) Ltd received the Japanese Deming Grand Prize in 2012. The company also won the Deming Application Prize in 2007. Rane (Madras) Limited is the only steering and suspension manufacturing company globally to win the Deming Prize and Deming Grand Prize.

VI. METHODOLOGY



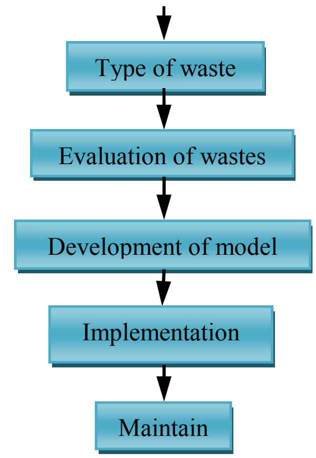


Fig .2: Methodology Flowcharts

VII. VALUE STREAM MAPPING

Value stream mapping, a lean manufacturing tool, which originated from the TPS, is known as "material and information flow mapping." This mapping tool uses the techniques of lean manufacturing to analyze and evaluate Value-Adding and Non- Value-Adding (Waste) processes.

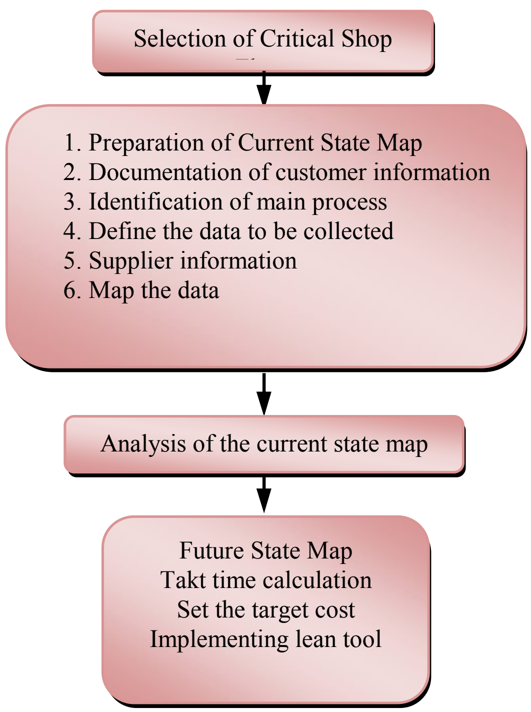


Fig .3: VSM Implementation Flowcharts

Table .1: VSM input data

SL.NO	DESCRIPTION	DETAIL
1.	CUSTOMER ORDER	15250 NO'S
2.	DEMAND	610 PER DAY
3.	WORK HOURS	3 SHIFT (24 HOURS)
4.	TOTAL AVAILABLE PRODUCTION TIME PER DAY	8 ½ +8 ½+7 HOURS PER SHIFT (510 + 510 + 420 MIN)
5.	SCHEDULED PLANNED DOWNTIME	10 MIN (TEA BREAK) + 30 MIN (LUNCH BREAK) + 15 MIN (CLEANING & LOG BOOK ENTRY) = 55 MIN
6.	AVAILABLE PRODUCTION TIME PER SHIFT	(510 – 55) = 455 MIN (27,300SECONDS)
7..	AVAILABLE PRODUCTION TIME PER DAY	(455+455+365) =1275 MIN (76,500SECONDS)
8.	RAW MATERIAL	EVERY 15 DAYS

Table .2 : Process cycle time

SL. NO	PROCESS DESCRIPTION	CYCLE TIME IN SEC (PER COMPONENT)	
1.1	PORT HOLE MACHINING1(PALLET- 1)	159.5	280.5
1.2	PORT HOLE MACHINING–1(PALLET -2)	121	
2.	PORT HOLE MACHINING – 2	206	
3.	MACHINE DE BURRING	66	
4.	PREWASHING	46	
5.	BORE FINISHING	40	
6.	FINAL WASHING	134	
7.	MANUAL DE BURRING	42.5	

VIII. TAKT TIME CALCULATION

Takt demonstrates the rate at which the customer buys the product. TAKT reflects the frequency at which the product has to come out of the manufacturer to meet the customer demand. Takt time is calculated by dividing available working time per shift (in sec) with the customer demand per shift.

Available Time =Working hours – Breaks
= (8.5 x 60x 60) – (0.916 x 60 x60)
= 27,300 sec

TAKT TIME = Available Working time per day / Customer Demand per Shift

TAKT TIME = 76,500 / 610 = 125.4 seconds

TAKT Time of 125.4 seconds represents, every cover has to be completed in every 125.4 seconds. The current state map sights out that the Port hole machining -1, port hole machining - 2 processes takes 280.5 Seconds and 206 Seconds more than the Takt time. In order to address the problem layout modification was carried out.

IX. BOTTLENECKS ANALYSIS

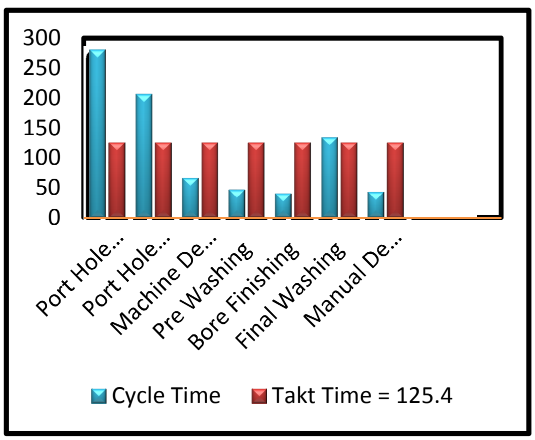


Fig .4: Bottleneck Analysis charts

X. CURRENT STATE VALUE STREAM MAP FOR COVER MANUFACTURING LINE

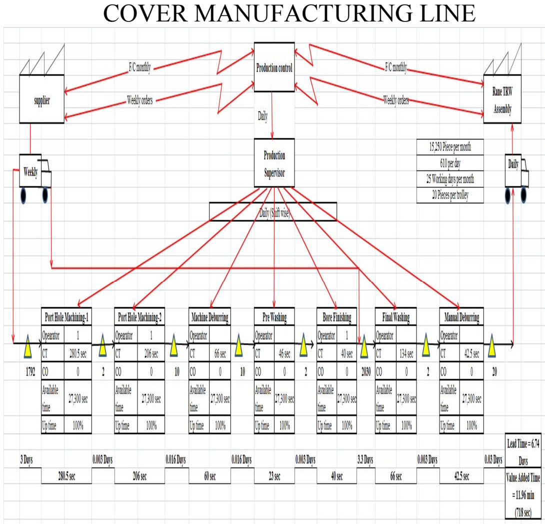


Fig .5: Current State Map

Table .3: Time Factor of Current State Map

SL. NO	PROCESS	VAT (SEC)	NNVAT (SEC)	NVAT (SEC)
1.1	PORT HOLE MACHINING – 1(PALLET - 1)	249	64	6
1.2	PORT HOLE MACHINING – 1(PALLET - 2)	182	44	8
2.	PORT HOLE MACHINING – 2	192	14	8
3.	MACHINE DE BURRING	48	14	4
4.	PREWASHING	36	8	2
5.	BORE FINISHING	30	8	2
6.	FINAL WASHING	124	10	
7.	MANUAL DE BURRING	80	6	3
8.	TOTAL	941	168	33

VAT - Value Added Time
NNVAT- Necessary Non Value Added Time
NVAT - Non Value Added Time

- ✓ Total VA = 941/3600 = 0.26 Hrs
- ✓ Total NVA = {168+33+582336(6.74 Days)}/3600 = 162 Hrs
- ✓ % VA = 0.26/162 = 0.16%
- ✓ Total Lead Time = (162+0.26)/24 =6.76 Days
- ✓ Inventory = 6.74 Days

XI. PROCESS IMPROVEMENT

Through the analyses of value stream map, can identify, according Lean´s philosophy, the following problems: In order to solve these problems, Lean Manufacturing contributes with several methodologies that aim to improve the system.

- ✓ Eliminating the Push production;
- ✓ To reduce Excess of inventory;
- ✓ To reduce Material movement;
- ✓ To reduce operator Fatigue;
- ✓ Rearranging the layout to eliminate large amounts of inventory between operations;
- ✓ Manual information;
- ✓ To improve the efficiency of the bottleneck activity
- ✓ Minimize non-value adding activities(decrease cost, reduce lead time)
- ✓ Add replace the De burr machine to achieve one piece flow.

✓

XII. PROCESS IMPROVEMENT SOLUTIONS

After diagnosis, it is necessary to apply following lean tools that solve the waste in a sustainable way or defects found in the analyses of Production Line

- ✓ Improved Layout
- ✓ Standardized Work
- ✓ Heijunka (Level Scheduling)
- ✓ Kanban
- ✓ Visual Factory

CONCLUSION

After the implementation of Layout improvement, Standardized Work, Heijunka (Level Scheduling), Kanban, Visual Factory is identified that throughput of the Industry is increased with less inventory, Less Space in layout area, Reduction in Material movement, Less Number of Operators to meet the varying demand, Reduction in operator Fatigue, increases the pull production. And this implementation work is proceeded with step by step and the obtained results are satisfactory. And the future scope of the work is to implement lean principles in the other area.

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