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A LITERATURE REVIEW ON "BOTTLE NECK ANALYSIS, CONTINUOUS IMPROVEMENT THROUGH LEAN TOOL AND ALTERNATIVE LAYOUT TO IMPROVE PRODUCTIVITY IN MANUFACTURING INDUSTRY"

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Abstract- **This paper aimed to explain the implementation of lean manufacturing techniques in the automotive manufacturing system. The objective of the industry was to increase the productivity throughout the production process, with the support of Value Stream Mapping (VSM). It was possible to detect several wastes, implement standardized work which comprises elements i.e. takt time, work sequence, in process stock. This article suggests several lean tools that can be used, indicating the improvements that can be obtained with each of the recommended hardware. This study simulates the first process stage of manufacturing in batch process involving product variation a process variant. The study analyses the operation status, bottlenecks, and the interdependence of the manufacturing activities between machines and reduces the manpower. This paper gives the literature survey on various type of industry to apply the lean manufacturing by takt time results in the removal of bottlenecks by** reducing **cycle time. The methodology adopted includes reduction of cycle time, to eliminate Muda, Muri, Mura and rearrange the machine layout to increase productivity.**

Keywords— **Value stream mapping tool, Bottleneck, machine layout modification, Increase in productivity, Takt time.**

I. INTRODUCTION

This Paper is a case study explaining about the successful implementation of lean manufacturing tools and techniques in the development and implementation of a manufacturing system at various industry plant. The vision of the researchers was to increase the productivity by VSM tool, bottle neck identification. Uneven cycle time is the main problem in industry and improper arrangement of machines in working area. Due to this, productivity of that company goes low. Company manufactures a variety of parts, many customers spread across the country. The order quantity of parts was very small because loss of production time at bottleneck machine. Because of bottlenecks, production target of has not achieved as per targeted demand. Thus, there was need to increase the productivity by improving manufacturing performance in production line. This includes increasing capacity of machine resources and better utilization of workforces. It is proposed to understand and apply Lean system (5S system and visual management, TPM, continuous flow, JIT, KANBAN, KAIZEN) approach to current problem by focusing on bottleneck in the assembly line

Different researchers have suggested different methods to detect bottlenecks, reduce cycle time, time and motion study, and modification of layout in shop floor. As a lean manufacturing is a technique to reduce human efforts and produce defect free product and Increase in productivity to meet customer demand. Detailed survey of literature has been carried out to identify the findings and directions given by the researchers. The contributions and directions of selective research works reported in the literature have been presented below.

II. LITERATURE REVIEW

Value stream mapping tool for identifying process steps and achieving continuous improvement

The study by Erlach, K., created Value stream map and identify possible improvement in layout. Author categorize the data in value stream map by cycle time, quality and EPEI-value. Cycle time reveals the efficiency as well as the available capacity in the production process. EPEI-value as changeover time for all the different variants of the production process. waiting time in each individual workstation was calculated by using Little's law, i.e. the WIP was divided with the daily demand of different workstation [1]. Dal Forno et al, proposed a new opportunity for applying the VSM. VSM could be gained if the timely effort for the measurement of the relevant production data could be reduced. The papers were classified into 11 problem categories mentioning the limits of VSM. Related to production lines, three of these are of special importance: "process measurements", "map obsolescence" and "high product mix". Together, these problems occurred in 74% of the analysed contributions. These limitations of VSM are partly due to the "pen-and paper" approach, in which a lot of manufacturers fail to apply the VSM repeatedly and regularly [2]. Venkatraman, Vijaya Ramnath, implemented lean manufacturing in recent year for reducing and eliminate waste. Application of VSM for reduction of cycle time in a machining process. Various type of tools is applied to create a current state map of the crank shaft assembly line and creates a future state map for improving process of crank shaft assembly. Three-assembly available for producing a crank shaft was to improve the process and reduce waste so that apply three type kaizens. Analytical hierarchical process (AHP) for decision making, results were to eliminate inventory between two machines and quick response to customer and Single piece Flow established [3]. Chitturi, RM., survey articles of Practical issues like how to calculate Takt time using VSM. where to place supermarket, how to use continuous flow processing, process improvements , and how to handle different product families while mapping job shop operations using a standard VSM were explored and it was also explained that while drawing a standard VSM in job shop operations, all pertinent information should be collected from the last to the first operation in so, the average demand in the previous years should be considered for mapping a particular product family [4].Hines, P. Rich, N., conducted case study of application of Value stream Mapping distribution in industry. The application of VSM to the development of a supplier network around a prominent distributor of electronic, electrical, and mechanical components was described. This involved mapping the activities of the firm, identifying opportunities for improvement and then undertaking with the firm an improvement program and involved around 50 key suppliers across eight product category areas [5].

Bottleneck identification in manufacturing systems.

Roser, C. Lorentzian, K & Deuse, J., studied Shop floor bottleneck detection for flow lines through process. Besides the usual results of a VSM (long change over times, stock, chaotic material flows, etc.), a less known tool in the VSM literature can localize the bottlenecks of the value stream of a product. In a takt diagram, the process cycle times are displayed and compared to each other with the customer takt time. The highest bar exceeding the customer takt time is the (current) bottleneck. In this paper, statistical analyses method of multi-variant production lines, using automatically collected data to enable a frequent and simple dynamic takt and bottleneck analysis [6]. Bottleneck identification in manufacturing systems by Yu C. & Matta, Roser c, based on the categorization of Yu and Matta, they listed methods of bottleneck detection and compared different parameters, by procedurally compared to the bottleneck walk of Roser et al. (2015). The bottle neck walk, developed by Roser over the last 15 years, is an active period method. During the walk, the inventory level along the production line is noted down at each station. "Repeating a string of observations multiple times" is recommended to receive a full picture of the timely shifting bottlenecks. Hence, Roser et al. (2015) solved the problem of having only one snapshot of the conditions by repeating the bottleneck walks several times [7]. Wedel et al. proposed an algorithm that predicts the bottlenecks based on the buff er levels. Though there are various predictive algorithms, the algorithms are developed and tested in a simulation environment using a discrete event simulation model of the production system and are limited to the real-world validation of the algorithms using the online data collected from the machines on the shop floor [8]. Value Stream Mapping for bottleneck detection by Sunk et al, Braglia, stated VSM and described as a "pen-and-paper" method which maps the "value adding, non-value-adding, and value preserving activities that are required to create a product. The VSM method currently faces a "diminishing gradient" of effectiveness, identification and elimination of waste and inefficiencies has become more complex. Moreover, VSM can hardly be used for products with a high number of product variants Sunk et al or products with a complex bill of materials. Based on their findings, Braglia et al proposed supplementary VSM tools as a future field of research; these tools are a match with the variances of production processes by employing statistical methods [9]. Study of the Toyota Production System from an Industrial Engineering viewpoint by Coleman, B.J, in 1994, introduced "Factory Physics" concepts by analyzing manufacturing processes by queuing theory, the most fundamental relationship is “Little’s Law.” It is expressed as: WIP = TH * CT. Here WIP is work in process inventory, TH represents the throughput of the system, and CT represents the cycle time per unit processed in the system. The theory of constraints focusses on bottleneck that causes the main inventory of the system. The buffer line must be set up for the production to have smooth flow [10].

Standardized operation to balance production and minimum Work in process

McDonald et al explained wasteful steps that had to be eliminated and flow can be introduced in the remaining value-added processes. The concept of flow is to make parts one piece at a time from raw materials to finished goods and to move them one by one to the next workstation with no waiting time in between. Perfection is achieved by continuous improvement process of eliminating waste and reducing mistakes while offering what the customer wants becomes possible [11]. Hourani, M., proposed scientific methodology for objective techniques that cause work tasks in a process and Optimize the production flow based on takt time of various parts. In the present work, a design methodology for cellular layout is proposed for implementing lean concepts in a manufacturing industry dealing with center lathes. Based on takt time for various parts, the production flow among cells was optimized thus minimizing several non-value-added activities such as bottlenecking time, waiting time, material handling time, etc. This case study can be useful in developing a more generic approach to design cellular layouts in lean environment [12]. Zero defects set up reduction and line balancing are some of the waste reduction tools for improvement in manufacturing process by Fled, M.W, SMED is to reduce the set-up time on a machine. There are two types of setups internal and external. Internal setup activities can be carried out while the machine is stopped while the external setup activities can be done while the machine is running. After all the activities are identified then the next step is to simplify these activities (e.g., standardize setup). The idea is to make every workstation produce the right volume of work that is sent to upstream workstations without any stoppage [13].

Improvement activities, machine layout modification and implementation of lean practices.

Shah and Ward carried out a Survey on Lean Manufacturing Implementation in Malaysian Automotive Industry. Twenty-two LM practices that are frequently mentioned in literatures and categorised them into four bundles associated with Just-in-Time, Total Quality Management, Total Preventive Management and Human Resource. They divided the lean practices into six areas which are process and equipment; manufacturing, planning and control; human resources; product design; supplier relationships; and customer relationships. The first four areas are grouped as internal oriented lean practices, whereas supplier relationships and customer relationships are under external oriented lean practices [14]. Arunagiri et, al. identified high impact lean tool in auto mobile industry using weighted average method and they study about 91 industry and using 30 or more lean tools used get a result by weighted average method to maximum useful tools in automobile industry, first one is 5s lean tool are preferred to elimination waste [15]. Lean manufacturing in a pharmaceutical company by Bopanna v. Chaudhary et, al. (2012). This paper takes a case study of the product line is creams and ointment this paper improves the operation with help of lean manufacturing so detect the problem where is the waste are occurs, and use the lean tools is VSM. Prepare a current state map and use the 5-why method for the collect information. Create future state map for the improvement with the help of 5s tool and used cellular manufacturing and the result is reduce inventory, and customer satisfaction, and on time delivery, total cycle time reduced, non-value-added time has been decreased. [16]. Santosh Kumar et, al. analysed to apply the lean tool by method time measurement and line balance efficiency. Reduce the cycle time in a truck body assembly line and improve efficiency in that product line also says that lean manufacturing is a business philosophy that continuously improves the process involve in manufacturing [17]. Riyad, H. Subrata, T., introduced a theory for the re-layout of an assembly plant and confirmed that the re-layout is an effective tool for process improvement. The minimization of workflow realized on the shop floor is an often-applied objective function during the layout redesign. In this study, the mathematical method for workflow calculation was introduced. Material flow efficiency is used for the determination of the amount of total workflow of the manufacturing system. Material flow efficiency (W=q*l) is the multiplication of material flow volumes and distances between the workstations [18]. Heragu, S., attempts to illustrate the use of modified systematic layout planning (SLP) procedure and uses a simplified approach in layout selection criteria. The results include four possible rearrangements of production departments. These layout alternatives are evaluated on basis of improved accessibility and material flow efficiency criteria. The results illustrate the impact of layout design on elimination of waste and the economic benefits achieved by reducing overall material flow and lead time [19].

Increase in productivity to meet customer demand.

Productivity Improvement through Line Balancing by M.R. H. Shamon, H, K. Zaman, A. and Rahman, A., Opined that Assembly line balancing problem when ergonomics principles are taken into account is considered. The existing layout takes long time to complete the finished product , the time does not match theoretical efficiency of company through bar chart for existing model layout which helps to know the problem occurred by line as there are 20 process has different cycle time because of improper layout and handling time . Here honing process is bottle neck process as one honing machine is used.Changing the layout there are improvements which have moved among 21 operators which reduced to 19 operators hence target increased to each workstation from 75% to 90%[20]. Mallikarjun Koripadu et.al, utilise three basic tools namely Ishikawa diagram, Pareto chart and Why-Why analysis in problem solving management in IT industry. They found that volume of calls and incidents were very much higher. And after using of three basic QC tools in improvement process, call volumes dropped by 60% and improved average quality improved from 75% to 92% with reduced utilization from 100% to 88%. [21]. Malik Meghana R. proposed a Productivity Improvement through application of MOST project, Activities for washing each single part was captured. MOST Data Acquisition Tool (MDAT) which is developed by Mahindra and to give timings and index for activities. Manpower utilization and scope of improvement measures were suggested using ECRS technique (Eliminate, combine, replace, simplify). Hence Manpower utilization was improved by 40.70 percent and productivity improved by 78 percent for GP Washing machine activity in Engine Product unit [22]. Mahajan Harsha V, Implemented of Single Minute Exchange of Dies (SMED). Assuming it leads to save process, time and MOST is used to calculate the new improved time for the process with the help of standard sequence chart for the movements. He reviewed MOST technique and compared it with traditional time study application method [23].

Selection of Material handling equipment

Chu, Egbelu and Wu introduced ADVISOR (A computer-aided MHE selection system) to help finding the most appropriate MHE among 77 of the most common equipment types used in material handling operations including transport, positioning, unit formal ion and storage. Two evaluation stages are generated in the selection process to meet the physical specifications feasibility and economic feasibility. First stage finds the feasible alternatives according to physical requirement defined by users. The final decision is made through second stage which assesses alternatives listed in the previous stage according to present worth (PW), equivalent uniform annual cost, return on investment and payback period (PP) methods [24]. Burt (2008) in her thesis related to the MHE selection developed an optimisation model for MHE selection in surface mining. A mixed integer linear programming (MILP) was formulated by considering several conditions such as single- and multi-period mining schedule, single- and multi-location and utilised cost-based equipment selection. Burt (2008) in her thesis related to the MHE selection developed an optimisation model for MHE selection in surface mining. A mixed integer linear programming (MILP) was formulated by considering several conditions such as single- and multi-period mining schedule, single- and multi-location and utilised cost-based equipment selection [25]. Welgama and Gibson., developed expert system combined with optimisation method for selection of material transport system. Appropriate possible alternatives are filtered based on the compatibility of tasks and technologies [26]. Naoum and Haidar., proposed a hybrid method for excavating and haulage equipment in opencast mining by using expert system and optimisation via genetic algorithm. The final selection is executed based on the minimisation of total operation cost [27]. Dias., adopts the term “moving” to describe what, in this article, is called management (handling) to adopt the terminology of Groover ,When dealing with equipment, Dias presents a broad classification that covers five categories: (i) transporters (belts, chains, rollers, etc.); (ii) cranes, hoists and lifts; (iii) industrial vehicles (carts, tractors, pallet transporters, forklifts); (iv) positioning equipment, weighing and control (ramps, transfer equipment); and (v) stents and support structures (pallets, holders, reels) [28]. According to Sule apud Sujono & Lashkari., material handling accounts for 30–75% of the total cost of a product along the production chain, and efficient material handling can be responsible for reducing the manufacturing system operations cost by 15–30% [29]. According to Gurgel .,MHE selection and determination of number of MHE (for load carrying maximisation).Equipment should be selected based on some preliminary consideration ,examine the dimensions of doors and corridors; pay close attention to ceiling height, identify the environmental conditions and their nature, avoid the use of combustion engines traction equipments in storage of food products, meet all safety standards to protect humans and to eliminate the possibility of incurring criminal and civil liabilities arising from accidents, and examine all kinds of available energy options and their capacity to supply required movements[30].

Role of Customer Satisfaction in Automobile Sector

Vikram Shende., studied consumer buying behaviour towards passenger car segment in India. The objective of this study was the identification of factors influencing customer's preference for segment of cars such as small & hatch back segment, Sedan class segment, SUV & MUV Segment and Luxury Car segment. Proper understanding of consumer buying behaviour will help the marketer to succeed in the market. Scenario of stagnancy in sales and cultivate future demand for automobile car market was also attempted in this study [31]. Nagaraj, S., studied on Customer Satisfaction in Automobile Industry – An Indian Online Buyers Perspective of Car Manufacturers Websites analysed consumer attitudes towards Internet-based car manufacturers websites. The aim was to obtain a theoretically and empirically grounded initial reference position, to examine and interpret the role played by changes in the variables representing consumer preferences and shifts in these preferences, and thus helps the car manufacturers learn in depth the ways to enhance customer satisfaction. Finding showed that the two independent variables significantly affect the satisfaction of Indian car buyers on the Internet [32]. Shuqin, W. and Gang, L., conducted an empirical study on the relationship between & after sales service qualities in China Automobile sector. They found that fairness, empathy, reliability and convenience have significant positive impact on customer satisfaction while responsiveness doesn't have a significant impact on customer satisfaction and at the same time satisfaction has a significant positive impact on trust and trust has a significant positive impact on commitment. They also found They also found satisfaction and commitment both have a significant positive impact on relationship value, but trust cannot impact relationship value directly [33].

III. RESULTS OF LITERATURE REVIEW AND DISCUSSION

There are different papers are referred on lean, and selecting the some papers from all areas to apply lean manufacturing like automobile industry, pharmaceutical company, IT sector , and 33 paper discussion based on lean manufacturing and this study concludes from this literature review to various lean tool apply in different industry as per requirement but Value stream mapping techniques , standardized work , 5s tool are much effective and use full tool for the detection of waste and improvement of the process and also lean manufacturing techniques applying in any industry and derived benefits . Below table summarises about tools used and benefits derived from the above researchers.

Table -1 Experiment Result of Literature.

SL. NO	Title	Author	Tool applied	Benefits derived
1	Value stream mapping, demonstration for improvement in layout design	Erlach, K., 2013.	VSM	Reduces the mean waiting time.
2	VSM through "pen-and paper" approach	Dal Farno	VSM	Elimination of waste.
3	Implement lean manufacturing for reducing and eliminate waste	Venkatraman, Vijaya Ramnath.	VSM, AHP	Reduced cycle time, single piece flow
4	How to calculate Takt time using VSM.	Chitturi RM, Glew DJ.	VSM, TAKT TIME	Reduction in lead time, processing time
5	Application of Value stream Mapping distribution in industry	HinesP, Rich N, Esain A.	VSM	continuous improvement
6	shop floor bottleneck detection for flow lines	Roser C, Lorenzen K. & Deuse J.	VSM	Total cycle time is reduced
7	Bottleneck identification in manufacturing systems	Yu, C. & Matta A, Roser c	Standardized work, JIT.	Identify the failure cycles
8	Algorithm that predicts the bottlenecks	Wedel, M	Simulation modelling and analysis	Verify the changes of m/c for throughput improvement
9	Value Stream Mapping for bottleneck detection	Sunk, A., Braglia, Dal Farno	VSM	Reduced value added.
10	Analyzing manufacturing processes uses "Factory Physics" concepts	Coleman B.J, Vaghefi, M.R. Heijunka.	Queue theory	Reduce lead time, Reduced work in process.
11	Wasteful steps elimination.	Mc Donald,	Standardized work	Single piece Flow established
12	Optimize the production flow based on takt time	AL. Hourani.	5s, Kaizen	Eliminate inventory between two machines.
13	waste reduction tools for improvement in manufacturing process	Fled, M. W	SMED	Reduce the set-up time on a machine
14	Lean Manufacturing Implementation in Automotive Industry	Shah, R.	JIT, TPM, TQM, JIT	Elimination of waste, Improves efficiency.
15	Identification of high impact lean tool in auto mobile industry	P.Arunagiri	5S, MUDA, MURI	Elimination of waste, Motion, overproduction,
16	Improvement of manufacturing operation at a pharmaceutical company, a lean manufacturing approach	Bopanna V. Chowdary, Damian George, Trinidad and Tobago.	5-why VSM, HEJUMKA	Total cycle time reduced. Work forced reduced.
17	Apply the lean tool by method time measurement and line balance efficiency	Santosh Kumar et, al	5s, Kaizen, Standardized work.	Reduce the cycle time, Improve productivity.

18	Increasing productivity through facility layout improvement using systematic layout planning	Riyad H., Kamruzzaman R., Subrata T.	Production levelling, JIT	Reduction of shop floor area. Reduction in floor space.
19	use of modified systematic layout planning (SLP) procedure and uses a simplified approach in layout selection.	Heragu, S.	Kaizen, HEJUNKA	Reducing overall material flow and lead time
20	Productivity Improvement through Line Balancing.	M.R. H. Shamon, K. A. Zaman	production levelling, work simplification	Work in process reduction. Reduction of shop floor area.
21	Problem Solving Management Using Six Sigma Tools & Techniques	Mallikarjun Koripadu.	Quality control tools	Reduce cycle time and improve efficiency.
22	Productivity Improvement through application of MOST project.	Malik Meghana R.	MOST Data Acquisition Tool	Manpower utilization improved. productivity improved
23	Reduction in Tool Changeover Time by SMED through MOST	Mahajan Harsha V	Single Minute Exchange of Dies (SMED)	Tool Changeover time can be reduced
24	A Computer-aided Material Handling Equipment Selection System	Chu, H. K., P. J. Egbelu,	Consider ergonomics, Go green	Assist the selection of MHE equipment type among categories
25	Optimization Approach to Materials Handling in Surface Mines	Burt, C. N.	continuous flow, visual control,	Assignment MHE selection for cost minimisation with constraints
26	Optimisation method for selection of material transport system	Welgama, P. S., and P. R. Gibson.	Expert system and optimisation model	Reduces over processing and Over production
27	Classification of material handling equipment	Naoum, S., and A. Haidar.	Line balancing	Reduce transport, inventory, motion, and waiting time.
28	Article called management (handling)	Dias	Material flow, standardized work.	Improves productivity
29	material handling system selection in FMS design.	Sule, Sujono, S. Lashkari	5s, kaizen, Takt time.	Alternative selection for multi-operations, select the most appropriate type among the categories.
30	MHE selection and determination of number of MHE (for load carrying maximisation)	Gurgel, F.	TPM, production levelling.	cost minimisation and fitness maximisation with constraint
31	Research in Consumer Behaviour of Automobile Passenger Car.	Vikram Shende	5s, MUDA,	Set customer expectations early
32	Customer Satisfaction in Automobile Industry	Nataraj, S. and Dr.N. Nagaraj	Kaizen, Supplier Kanban	Email is the best channel to increase customer satisfaction.
33	Study on the relationship between & after sales service qualities in China Automobile sector	Shuqin, W. and Gang, L.	TQM, JIT, TPM	Make customer loyalty to increase customer satisfaction. Avoid making these customer memory mistakes.

IV. CONCLUSIONS

The objective of this paper is to highlight some of critical issues relevant to value stream mapping, Bottle neck analysis, machine layout modification, implementation of lean practices, Selection of Material handling equipment and Role of Customer Satisfaction. The available literature is about conceptual work, empirical/ modelling work, case studies and survey articles. Through this application, I have recognized the use benefits of the powerful lean tool and information about process flow, storage space, analysing bottleneck. The problems are derived from the information. Due to this production efficiency is increased.

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