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Integrated Application of Lean Manufacturing and Theory of Constraints in Automotive HVAC Manufacturing Assembly

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Abstract

Integrated application of lean manufacturing is used for the identification of critical drivers in production of automobile hose. Company's historical performance is reviewed to enlist problems like overtimes, low productivity, low production line efficiency and suboptimal utilization of resources. To cope with the aforesaid impediments, system constraints were identified through process flows, time study, work element analysis and identification of value added and non-value added activities which were making production line fragile. Constraints were exploited through drum identification, current line balancing of hose assembly line, current targets, manpower requirements analysis, and current line balancing efficiency. The constraints were further elevated through ECRS technique, set-up time reduction, optimized layout, and resource levelling through largest candidate method. Non-Constraint processes were subordinated through largest candidate method of resource levelling. Constraints were further elevated by induction of New Crimping Machine. As a result of this study; production were increased from 365 to 630 Systems per day and overtime was reduced from 315 man-hours/month to zero man-hours.

Keywords: Theory of constraints • Largest candidate method • Lean manufacturing • Resource levelling • Identify • Exploit • Subordinate • Elevate constraints

Introduction

From the last two decades, there is high competition between organizations to produce cheap products without compromising its quality. As competitive price with high quality product helps to survive in market. Customer does not care about how many extra operations you done to complete the product but they care about only two things quality and price. In order survive in the market; organizations focus on different cost saving tools i.e. lean manufacturing. First time Lean manufacturing was adopted by Toyota Production System in 1970. Lean is the technique of continuous improvement in manufacturing, customer driven production and zero defects. It is multi- dimensional tool for manufacturing that have wide variety of practices like Just-In-Time (JIT), quality systems, work teams, cellular manufacturing, supplier management and six sigma to reduce defects for any integrated system. The ultimate target of the lean manufacturing to produced high quality system that produces the products not only fulfil the customers demand but also with little waste or no waste. Majority of paper on lean manufacturing system focus on the relationship between implementation and application of lean manufacturing system and performance. Different gaps are still present in implementing the lean manufacturing like grounding lean studies on existing managerial theories. Lean manufacturing could be divided by five principals that facilitate to the organization to reduction of waste (muda) named as: 1-value, 2-mapping the value steam, 3-flow, 4-pull and 5-continuous improvement. We did an exploratory study for implementing the lean manufacturing tool to the organization to reduced overtime, bottleneck process, to increase the availability of the machine and line efficiency [1].

Literature Review

Different sectors like textile, manufacturing and automobile etc. used six sigma tool to reduce their defect ratio, ultimate result to increase the production rate in the organization. Lean is another tool used to improve the production in the organization by targeting on wastages area. When these both techniques; lean manufacturing and six sigma combine then lean six sigma is come to exist which have ultimate goal of continuous improvement with zero defect. Lean manufacturing tools and different metrics suggest the manufacturing

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problem. For company who want to improve their productivity is lean manufacturing tools are so much important. Different companies used different lean tools in order to survive in the market. These lean tool are used as production indicators in the organization [2]. Lean production is also applicable in service sector perhaps it is more applicable as compare to manufacturing. There are some similarities are present between service sector and manufacturing so possibilities learn from each other. There is interaction present between lean manufacturing and Triple Bottom Line approach. This approach have ultimate target economic growth, environment preservation and social responsibility. Like service and manufacturing sector; it has wide application in process industries [3].

It is as simple to apply in process industries like other industries; for example technique like, how people do their daily routine works and what level of context to improve their daily routine works. If the organization focus on their production system and come to cross for lean implementation tools, then it should be get a competitive advantage from the non-lean suppliers in different aspects and fields like production systems, customer-supplier relationships, on time delivery and distribution system. As compare to application of lean approach in discrete manufacturing and continuous sector, it has more application in discrete manufacturing. By the implementation of lean manufacturing, it reduce lead time and work in process which benefits the organization in terms of cost and profit. So there is different aspect for any organization to increase the production and productivity as well with same resource and limitation by using the different lean manufacturing tools and techniques. Japanese and Chinese know the importance of lean manufacturing so they started the implementation of lean tool since 1970s in automobile industry. Lean tools like Materials flow, scheduling, defect rate and on-time delivery has more weightage as compare to layout design, volume-mix flexibility, visual factory and setup. Another study tells about the influencing of plant size in lean manufacturing while on the contrast plant age is less pervasive [4].

There is very importance role of management for implementation of lean tools and technique in the organization. This thinking have both type of positive and negative as well impacts on organization. There is strong positive relationship between lean manufacturing and environmental management practices. So for the management prospective, it is better to measure environmental performance through environmental management on outcomes of business performance then go for effective implementation of environmental management. Another aspect that have also play the role of mediate between lean manufacturing and financial performance relationship. Lean manufacturing has become stronger and composed with highly integrated elements with widely variety of management practices. So all these aspects show that the lean manufacturing have strongly influenced by the management involvement and decision analysis. It can't done without support of management. Lean manufacturing have widely implemented in hospitals in order to look after more patient with less time. Lean education, emergency department, process redesign, full implementation, new process testing and flow analysis are the six focus are in the health care for implementation of the lean. Like application of lean manufacturing in health care, it has application and integration with supply chain to improve the schedule with less lead time. It means that when lean manufacturing attain a level; it is suitable to satisfying a fluctuating demand [5].

Methodology

Study start with the identification of constraints using development of process flow and process work element analysis of S-Hose (2PU). After knowing the process flow segregation of value added and non-value added processes are done. First of all time study is done by Direct Time Study (DTS) method then all types of data like process flow, value added and non-value added processes are evaluated to identify the bottle neck process because study target is to equalize the capacity of the bottleneck process. Last step is elevation of constraints by using ECRS Analysis, rearranging the bottleneck process, resource or manpower balancing by the strictly follow the precedence of the processes, layout optimization and setup time reduction.

Current process study

Current situation was measured through the existing process flows. Work element analysis was done in order to measure the value added and non-value added time of operations. It was used to find out the potential lean wastes like setups, over processing, waiting time, transportation and inspection waste. Time against every work element was measured. Based on bottleneck activity and by Including all the setups and wastes, we calculated the current capacity of production line. Total Productive maitenance time, lunch breaks, plan no production and daily briefing times were taken as the standard set by the organization. So they may change from organization to organization. Low efficiency of line shows that the resources are not being used optimally. From demand and current cpacity analysis, required manpower to meet the customer requirements is 8 workers. Currently to meet the current customer demand organization is planning overtimes besides the required manpower is enough for mneeting demand.

Purpose of the line balancing is to equally divide the work among all operations. To detect the reasons behind low efficiency, high overtime and low productivity; current work- load distribution was calculated. Operation 1 and Operation 2 in the workload distribution graph (left to right) clearly are under utilized. Current assembly line workload distribution is at suboptimal level. By using resources effectively; we can balance our production line with better flow of production.

ECRS analysis

ECRS is a simple lean tool used to break down and synchronize the bottleneck process with whole process. ECRS consist of Eliminate, Combine, Rearrange and Simplify. Eliminate is the first step in this process improvement technique, it involves the elimination of non-value added activities. If work can't be eliminated, combine the processes. If they can't be combined, it should be re arranged and last step is to simplify the processes for better performance. For the optimal utilization of resources; all resources was leveled considering bottleneck activity. Each worker allotted operational time max to bottle neck in order to avoid any delays, inefficiencies and sub optimality of human resources. Workload was equally divided among all the workers.

Conclusion

Theory of constraints and Lean manufacturing is used to resolve the critical problems of business processes systematically and scientifically. Integrated application of both of these technique's empowered to overcome the major constraints i.e. suboptimal use of space and resources, large set-up times, poor early management and bottleneck problems. From the better constraints management assembly line productivity was improved from 365 pcs/person to 630 pcs/person. This study will entitle the practical implementation of lean and Theory of Constraint concepts in gaining process excellence for the research enthusiast.

References

1. Shah, Rachna, and Ward Peter T. "Lean Manufacturing: Context, Practice Bundles, and Performance." *J Oper Manag* 21 (2003): 129-149.

2. Danese, Pamela, Manfe Valeria, and Romano Pietro. "A Systematic Literature Review on Recent Lean Research: State-of-the-Art and Future Directions." *Int J Manag Rev* 20 (2018): 579-605.

3. Dieste, Marcos, Panizzolo Roberto, Garza-Reyes Jose Arturo, and Anosike Anthony. "The Relationship between Lean and Environmental Performance: Practices and Measures." *J Clean Produ* 224 (2019): 120-131.

4. Dickson, Eric W, Singh Sabi, Cheung Dickson S, and Wyatt Christopher C, et al. "Application of Lean Manufacturing Techniques in the Emergency Department." *J Emerg Med* 37 (2009): 177-182.

5. Bakar, Fairul Anwar Abu, Subari Khairanum, and Mohd Daril Mohd Amran. "Critical Success Factors of Lean Six Sigma Deployment: A Current Review." *Int J Lean Six Sigma* (2015).

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