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The Evaluation and Implementation of Various Techniques in Lean Manufacturing

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Abstract

The idea of lean manufacturing was originated for maximizing the resource utilization by minimizing the waste. Due to fast changes in business environment the industries are compelled to face challenges and complications. Any institution either manufacturing or service related to survive may eventually depends on its ability to systematically respond to these changes for increasing the product value. Therefore adding value to the process is important to attain this perfection; hence implementing a lean manufacturing system is becoming important for any type of institution to sustain. In this paper, we aimed to develop a lean route map for the institutions to carry out the lean manufacturing system.

Keywords— Cellular manufacturing, Pull system

1. Introduction

Lean Manufacturing is considered to be a waste reduction technique, but in practice lean manufacturing increases the value of the product through reduction of waste. Lean principles provides value to product/service as required by the customer and then making the flow in-line with the customer for perfection through continuous improvement in elimination of waste by sorting out Value Added activity(VA) and Non-Value Added activity(NVA). The sources for the NVA activity wastes are Transportation, Inventory, Motion Waiting, Overproduction, Over processing and Defects. The NVA activity waste is vital hurdle for VA activity. Elimination of these wastes is achieved through the successful implementation of lean elements. Various Survey demonstrate that most of the researcher focus on one or two elements for finding out the existence of wastes and suggest their views on implementing these elements.

2. Overview of Lean Elements

The major elements considered by the earlier researchers for the implementation of the lean manufacturing system are Cellular Manufacturing defines the facility grouping in order to produce the product with minimum process time, waiting time, and transportation by smoothen the process flow. Further fluctuating line flow is improved by U-line concept and line balancing concept, Kanban is Material Flow Control mechanism (MFC) which delivers the right quantity of parts at right time. Stages of this Kanban implementation are production stage and withdrawal stage. Production Levelling enhances production volume as well as production mix and production efficiency by means of reducing waste, unevenness, and overburden of people or equipment. Levelling of parts leads to successful implementation of lean manufacturing.

3. Review of Lean Implementation

The perfect strive of the manufacturing system can be achieved through successful implementation of lean elements. Most of the survey on lean elements focuses on only one or two element or combination of two or three elements. For successful implementation of lean, practically need incorporation of all lean elements and sequencing of implementation task. This literature review explains the incorporation and sequencing of lean elements during implementation period along with implementation issues.

3.1 Scheduling

Scheduling includes deciding the preference order for different jobs and decides the starting and finishing time of every job. It also involves scheduling of machine tools, equipments, inspection and raw material etc. By defining a clear production plan any organization can start initializing the manufacturing system implementation.

3.2 Group Technology

Group Technology is a methodology in which similar parts are identified and grouped together to take advantage of their similarities in design and production. It reduces the work in process inventory and reduces lead time. Shunk et al. suggested that the complete utilization of flexible manufacturing system needs grouping of parts using similarity among the design and manufacturing attribute which make the production plan and manufacturing process flexible. After grouping of parts by similarity in process, dissimilar machines are grouped together to form a cell. Formation of Cell entirely depends upon the nature of the process which changes from institution to institution.

3.3 Cellular manufacturing (CM)

Cellular Manufacturing includes processing a collection of similar parts on a dedicated batch of machines or manufacturing process. Parts are identified such that they will be ideally processed within a machine cell. Wemmerlov et al. suggest those dissimilar machines are clustered in sequential manner in order to meet process need of a family of product. Metternich et al. suggested that the effective and efficient clustering of machine or cell is improved by moving employees, Workstations, or both into a U-shaped line which improve the employees' interaction. CM reduces the manufacturing lead time by decreasing the setup, work part handling, waiting time and batch size. CM improves the quality by allowing each cell to specialize in producing smaller number of different parts which in turn will reduce process variability. The success of Cellular Manufacturing system depends on the successful utilization of U-Line manufacturing system, Line balancing, and Flow manufacturing.

3.4 U-line manufacturing system

In U-line Manufacturing System entry and exit is located at the same position. A narrow U-shape line is generally formed because both ends of the line are located narrowly together. It reduces number of work station, improve line balancing, visibility, communication, quality, flexibility, material handling. Guerriero et al. clearly define the line flexibility for stochastic U line system and suggested that when demand uncertainty occurs, U-line layout provides greater flexibility to increase or decrease the necessary number of workers.

The performance of U-Line was evaluated by minimum number of workstations, minimum work relatedness, and minimum workload smoothness. Generally U-line flexibility is disturbed by line imbalance in mixed product production line. To remove this imbalance analysis of both balancing and sequencing task is to be carry out together.

3.5 Line balancing

Line Balancing means assigning operations to workstations along an assembly line in such a way that the assignment be optimal. Line balancing tries to achieve a best combination between facility, labour and resources to provide a given volume of production. Monden et al. suggested that the consideration of task time variability is due to human factors or various disruptions which leads to line balancing problem. The variability in task time is mainly due to the instability in the work rate of humans and failure sensitivity of complex processes. Becker et al. and Chiang et al. suggested task itself a sources of variability and explains the worker performing the task, and the environment where the task is performed. These sources of variability are controlled by minimizing the moving cost of men and machine. The operator walking time and fluctuation of man and machine cycle time leads to line imbalance. Also the change over time creates imbalance in the line for mixed model line which is necessary for lean. Based on demand, the number of worker and machine within the workstation are increased or decreased in order to overcome the line imbalance. Man-machine flexibility is achieved through free flow of material and information in the manufacturing process.

3.6 Flow Manufacturing

The principle of flow manufacturing is producing an item at a time at a rate equal to the cycle time, the successful implementation of flow manufacturing needs U-line layout, multi-skill operator, standardized cycle time, designing operator work as standing and walking manner and the equipment/machine should be standard and less expensive user friendly. Miltenburg et al. Suggested that the break-through or tedious process flow can be balanced by introducing the customized machine in the workstation in order to balance the machine with the workstation cycle time. The mixed model flow is smoothened by designing the workstation with Quick changeover and Small lot size.

3.7 Small Lot size/Small Batch

A batch is a group of parts of the same part family. While part families are supposed to be given prior, lot sizing is a part of the decision making process. Conventional manufacturing systems are run based on buffer production system. The built-in inventory system was involved to overcome the material flow disturbance in case of machine break down, absenteeism which lead to high quality problem and lead time. In order to keep the material flow smooth and to overcome the problem of quality and lead time, inventory quantity should be optimized. In practice, Lean is associated with zero inventories to increase the visibility of product flows and optimize the utilization of capacity.

3.8 Inventory

Inventory may be defined as any resource that serves has a buffer or safety against ill planning and continuous production, when the demand for the item will arise. Studies from various research shows that 60% of wastes in production system are due to inventory. These Inventories are in the form of Raw material (RM), Work-in-process (WIP) (semi finished goods), Finished goods (FG). Increase in inventory of RM, WIP or FG leads to less inventory turnover. Inventory plays a vital role in firm’s turnover. Present trend is to go for Minimum inventory level because large inventory is a sign of inefficiency. Sakakibara et al. suggested that the large RM is due to poor implementation of product plan, availability of raw material, defective parts, waiting for processing leads to more WIP, and unnecessary transportation between working stations or plants increases WIP inventory, overproduction of parts beyond the plan leads to FG inventories which wait long time in the warehouse or might never be sold. Inventories are reduced by improving the quality levels, rejection rates, delivery rate, lead time and customer satisfaction. Demete et al. suggested that WIP is controlled by implementing cellular manufacturing/dedicated line Assemble or manufacture the parts against the customer order reduces FG which means FG goes to customer without unusual delay. Imperfection due to lack of process control in the manufacturing system creates the WIP requirement in workstation. In order to reduce the impact adjacent process, the decoupling buffers is placed between processes to overcome the imperfection. The inventory allow each of the teams to make decisions regarding stopping the line to fix problems. Inventory contradicts the lean system but in real condition safety buffer is important in case of system variations.

3.9 Kanban

Kanban is to increase system efficiency or productivity and to secure operator involvement and participation to accomplish high productivity by making a highly visible means to monitor the product flow through the production system and the build-up levels of inventory within the system. Sipper et al. Classify the Kanban system into the two cards Kanban system for signalling production and withdrawal. During demand uncertainty the inventory is important for smoothening of production flow and reconfigures the Kanban System in order to lower the inventory. Therefore Kanban system gives mixed model production along with optimum inventory levels which results in reduction of lead time in the delivery of product and active use of resources like man, tools, machines etc.

3.10 Production Levelling

Present business environment are volatile which leads to variations in customer demand, these variations leads to variability in the production. In order to overcome this variation initially levelling of customer demand is required, without levelling, these variations leads to un-utilized resources such as man and machine idle times or quality problems, breakdowns, and defects. Bohnen et al. suggested that the levelling low volume and high mix production based on the principles of Group Technology is necessary for fluctuating demand of customer. Bohnen et al. develop the cluster technique for part family formation and family oriented levelling pattern for implementing low volume, and high mix production system. The concept of product levelling is to control the variability of the job arrival sequence to allow higher capacity utilization, also it removes ups and downs in the production schedule.

3.11 Continuous Improvement (CI)

Continuous Improvement (CI) is defines as “Improvement initiatives that increase successes and reduce failures” Continuous Improvement is the tool to determine the reason for any inefficiencies and to take effective measures to control those inefficiencies. Research shows that CI can take place at three different levels within the organization: at the management, group, and individual levels. At the management level, the implications of CI are on the organization’s strategy. Group level CI involves problem-solving tasks at a broad level, while individual level CI deals with improvement on a micro scale, i.e. on low level, day-to-day tasks. In order to get maximum benefits from a CI program, managers must implement CI at each of these levels.

In the present ambitious environment CI is very important to sustain in the market, but the benefits of the Continuous improvement rely on employee attitude, acceptance of variations, team work, leader commitment, interest, initiative, and training. CI training includes process problem solving, tools and technique, development of idea management and development of reward and recognition system.

3.12 Standardized Work

Standardized work is one of the most important tools of lean manufacturing. As the standards are improved, the new standards become the baseline for further improvements, and so on. Improving standardized work is a never-ending process. It helps in reduction in variability, easier training of new operators, reductions in injuries and strain. Berger at al. suggested that the Standard Work is the basic tool for continuous improvement. Standard Work refers to the safest and most effective method to carry out a job in the shortest repeatable time as a result the utilization of resources such as people, machines, and material is effective.

Standardization of work is defined as a set of Standard Operating Procedures (SOPs). SOP contain operator work process like process steps, work sequences, cycle time, work-in-process, process control etc., SOPs represent the best method to do a particular job within the target time.

4. Summary

Implementation and sequencing of lean elements with dependent elements are the vital factor for the successful implementation of lean manufacturing system as suggested by most of the research. In this paper, a lean road map is recommended for the implementation of lean elements along with other interdependent elements. Steps in implementing the Lean elements are as follows first step is implementation of Group Technology; here parts are grouped into part family and machines are grouped based on these part family. The Second step is implementation of Cellular Manufacturing. Cell formation depends on group technology and part family. Further U-line system is streamline through Line Balancing and material/information flow is streamline through Flow manufacturing. The successful implementation of Flow Manufacturing depends on Lot size reduction which stream line RM, FG and WIP. The Third step is implementation of Kanban system for triggering the production. The Fourth step is Production Levelling; implementation of this element depends on successful implementation of all the above said elements. The Fifth step is simultaneous Standardization and Continuous Improvement. In order to sustain in the competitive market five steps should be repeated.

5. Conclusion

Conclusion of this paper concludes that for implementation of Lean Manufacturing system requires assimilation and simultaneous implementation of Lean elements in a given order. The Paper also gives the thorough Road Map which gives a different theory for Lean Manufacturing System implementation. Therefore the given implementation reduces the duration and production system divergence. As a result it is recommended that the Lean Manufacturing System is important tool to sustain in this competitive business environment.

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