PRODUCTIVITY ENHANCEMENT USING LEAN PRINCIPLES IN MULTI-MODEL ASSEMBLY LINE: A REVIEW

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***Abstract*: A basic starting point for characterizing the various industries' lean manufacturing practices is to review the current literature. The confusion in the beginning of the study and operational challenges surrounding lean practice are also highlighted, and a collection of lean operational metrics is gathered that can be used to reflect the performance of any business. For this assessment, we began with the earliest writings on lean manufacturing's potential for increasing both production efficiency and product quality, and we ended with the most current ones. There are a lot of articles on lean manufacturing, but there aren't many on lean manufacturing in India. Several scholars have identified methods for implementing lean manufacturing practices. Also, we tried to make a conceptual representation related to lean and its components along with benefits of having lean environment.**

***Keywords*: Productivity improvement, Lean manufacturing, Processing waste, HLLS (Head Lamp Leveling Switch)**

I. INTRODUCTION

Designing of assembly lines are more preferred in industries for the ordered functioning and arrangement and of workers, tools or machines, and parts. One of the main aims of assembly lines is to minimize the motion of workers to a great extent. The usage of conveyors or motorized vehicles such as forklifts or gravity (without manual trucking) is used for handling machine parts or assemblies along the assembly lines. Overhead cranes or forklifts are mainly used for heavy lifting. One simple operation is to be performed by each worker. Classification of Assembly line based on numbers of models assembled on the line and according to the line pace

1. Single Model Line- Only a single model can be assembled in a single model line. The products produced by such lines have no variations among one another. Several of similar units can be produced by such lines. For all the units the task performed at each station is similar. Products with high demand are intended for this line.
2. Mixed Model Line - More than one model can be produced using the mixed model line. Different products are made simultaneously on the same line. All the stations are allowed to perform their job at the same time. Various tasks are performed in every station which results in the production of any model that moves through it. Most consumer products are assembled more on a mixed – model line.
3. Batch Model Line – Each model is produced in batches in the batch model line. The work stations are often reconstructed accordingly to what model they want to develop at that duration of time. Assembly of products in batches is preferred when the demand for the products is not quite so high. One assembly line is preferred to produce several products in batches, which is even more economical than building a separate line for each model.

To meet the required production rate and to achieve a minimum amount of idle time it is preferred to assign each task to a workstation within an assembly line. In - Line balancing the tasks are assigned to their respective work stations along the assembly line in such a way that each workstation has the same amount of work to be done in spite of considering the reality in which impossible in assigning the same amount of work to each workstation.

The term 'lean' can be defined as: a system which utilises less input, when it is compared with the conventional production system for the same output and increased varieties of products. It is also called by different names as world class manufacturing, agile manufacturing, synchronous manufacturing etc are used in parallel with lean production. Therefore, the basic principle of lean production is to minimize waste from the system of concern by adding more and more values.

For industrial companies waste may be considered as:

1. Excess material in any form because later or sooner it may convert into scrap.
2. Production more than required quantity (overproduction).
3. Labour in excess and unwanted form.
4. Complicated way of problem solving.
5. Unproductive and excess utilization of energy.
6. Poor space arrangement for people, workstations and equipments.
7. Defects as these require efforts to solve it.
8. Unnecessary movement of materials and information (Transportation)
9. Time in the form of machine breakdowns, long setups and delays.

II. LEAN-MANUFACTURING TOOLS & TECHNIQUES

Using technologies like cellular manufacturing continuous improvement, just-in-time production, production smoothing kaizen, and others, firms can decrease waste by identifying and eliminating the most common sources of waste. There is a brief summary of these tools in the following sections.

2.1 Cellular Material Production

As a workplace design model, cellular manufacturing is an important aspect of lean manufacturing systems. In order to take full use of parts' commonality, cellular manufacturing follows the concepts of Group Technology, which aims to standardize and process all parts the same way. Similar machines in a block are clustered together in functional manufacturing (e.g. lathes, grinders, milling machines etc). It is more difficult to break down a functional arrangement due to the presence of common jigs and fixtures in the same location. Manufacturing systems that use Cellular Manufacturing organize machines according to the families of parts they make.

There is a significant improvement in material flow, which minimizes inventory, lead times, and distance traveled by materials.

To meet the expectations of customers who demand a wide variety of goods at a fast delivery rate, Cellular Manufacturing uses setup reduction and flexibility in the process. By grouping comparable items into families, the same equipment may be used to process each one, allowing for a great deal of flexibility. This will also reduce the amount of time it takes to switch between items, which will lead to more small-scale production. Another benefit of self-balancing cells is that it reduces lead times and helps organizations to produce high-quality products at low costs, on schedule, and in an agile manner. The ultimate goal of lean manufacturing is to reduce waste to the absolute minimum in order to maximize the utilization of resources.

Cellular manufacturing also has the advantage of reducing inventory, particularly work-in-progress (WIP).

- More efficient use of space – reduced transportation and material handling, as well as shorter lead times Identifying the root causes of machine malfunctions and flaws.
- A rise in productivity Enhancement of teamwork and communication Greater adaptability and transparency.

2.2 Just-In-Time

It is way of improving productivity and quality of the system, in which attempt is made to produce right parts at the right place and at appropriate time. It is better way to minimize those parts of the manufacturing, which does not add value to the system.

Just in time or pull system is better way to address manufacturing waste than push or traditional system. However, customer demand is basic principle for adoption of both the systems, but pull system is better way to fulfil customer requirements. Three elements of just in time or pull system may be involved in production, distribution and purchasing areas.

2.3 Production Smoothing

The Toyota Production System and Lean Manufacturing both rely on production smoothing, also known as production leveling or – by its original Japanese title – heijunka, as a method for eliminating muda waste. Producing intermediate items at a constant rate is the general principle; producers aim to keep output levels as regular and predictable from day to day so that subsequent processing can be carried out consistently and predictably.

To eliminate waste in a lean manufacturing system, it is necessary to increase the level of process control.This concept of production smoothing in the world was adapted from TPS. After having production smoothing in manufacturing area, waste can be controlled effectively so, productivity and quality may be improved to higher level.

2.4 Standardization of work

It is a principle of lean manufacturing in which worker actions in the system are standardized. It provides a better and effective way of working for workers and give equal opportunity to do job in the same effective manner. It is an important principle of lean manufacturing for reducing manufacturing waste.

‘Takt time’ is a tool to standardize work and worker action. Based on the takt time pace of producing parts is established. It should not be higher than takt time to achieve target without deviation.

Following formula is used to calculate takt time:

Takt Time (TT) =Available work time in a shift or day/ Customer demand per shift or day

2.5 Total Productive Maintenance

Machine breakdown is an important issue which relates with productivity and quality in the manufacturing system. It is very much concern with the shop floor people. Machine breakdown can down the production on that machine and consequently whole production line may suffer. Total productive maintenance is a tool to maintain machine and equipment reliability. It reduces or prevent sudden machine breakdowns. In lean manufacturing environment, it is an important programme, which should be followed carefully to improve the efficiency of machine.

2.6 Kaizen

Kaizen word is used in Japan for ‘improvement’ or change for better by adapting continuous improvement processes in manufacturing sector and to improve business environment. Now, this philosophy is being applied continuously throughout the world to improve productivity and quality in different sector. These sectors of concern are industries, banking, healthcare, small and big business houses.

2.7 5S (FIVE S)

5S is a technique of workplace organization that emphasizes order and the use of visual cues to create more consistent operational outcomes while also reducing waste. To put it simply, these are the following five characters in Japanese:

Ashiro (sorting)

"Setion" (setting in order)

It is called "Seiso" (systematic cleaning)
It's called "Seiketsu" (standardizing)
The Shitsuke (sustaining the discipline)

2.8 Six Sigma

Six sigma, a system that was developed by Motorola in 1990. Six sigma is a tool for reducing process variation by collecting statistical data and analyzing them to improve the process for variation. A sigma quality level describes or indicates for occurring defects in the system to show process variability. Six sigma level is used to show minimum process variability and high quality level (approximately 3.4 defects per million opportunities).

2.9 Other Waste Reduction Techniques

In today's scenario to improve productivity and quality, companies are adapting some other tools of waste reduction. These techniques are illustrated in next paragraph as:

1. Poka yoke or zero defects
2. Setup reduction
3. Line balancing

III. ADVANTAGES OF LEAN MANUFACTURING

The implementation of lean manufacturing techniques and measures within our operations can improve the following in any company-

- Better quality, fewer errors and rework, and lower inventory levels.
- More frequent stock turnovers.
- There is less of a footprint.
- Increased productivity and production per hour of work. "
- Deliverability has improved; development has been accelerated; and customer satisfaction has gone up.
- Positive effects include a rise in profitability, a rise in employee engagement, a rise in supplier relations, and a rise in new business.

IV. LITERATURE REVIEW

A lot of efforts have been put by the researchers to improve productivity and quality in the area of lean manufacturing. Few of the findings may be described as under:

It has been described as an intellectual approach that consists of a system of metrics and procedures that when taken together have the capacity to bring about a lean and thus competitive condition in a firm in terms of productivity and quality improvement. To a lesser level, after-sales support is also included in the scope of these activities, but it is not as critical. Early in Germany's "Humanization of Working Life" [25] program, the basic components of this approach were examined in depth. B. W. Braiden and K. R. Morrison (1996) argued that after implementing the lean techniques in any organization productivity may be increased within the organization of concern. Also, up time of the machines and facilities may be improved by the implementation of the same theory [16].

Based on a case study F.B. Gieskes et al. (1997) surveyed for Dutch companies and concluded that by using CI process productivity may be improved and it is not limited to manufacturing companies only [17]. B. H. Rho and Y. M Yu (1998) studied and concluded that by reducing waste in an air craft manufacturing division productivity improved by 250% and inprocess quality by 50% [2].

According to N. Hayati et al. (2013) after implementing lean concepts in assembly line of an automobile company, productivity improved with the following data:

Cycle time reduced by 17.6%, setup reduction time by 84.93% and lead time was observed to reduce from 3.23 days to 0.533 days [18].

C. W. Gan et al. (2013) have described in their study in Singapore based small and medium enterprises that with limited resources, it is difficult to improve such type of enterprises. Hence a new technique based on lean and kaizen was developed to improve the productive performance of the same. By the application of new methodology on different companies an increase in productivity was measured from fifteen percent to ninety five percent [19]. J. Sahno and E. Shevtshenko (2014) have explained that A variety of quality-improvement methods and lean techniques are used by businesses to stay competitive and enhance their products, production processes, and customer satisfaction [20].

According to B. E. Narkhede (2014) competitiveness of any organization refers the ability to survive in a competitive environment around the world by offering products or services at minimum cost to the customers. In this scenario business advantage can be achieved by improving cost, quality, delivery and flexibility by adoption of advanced manufacturing strategies [21].

K. Ramdass (2015) explained that When applied to the service business, however, it can be just as effective as when used in the industrial sector. Because it lowers waste and adds value to the process, 5S is a lean tool. In order to boost productivity, 5S can be used in conjunction with other methods such as kaizen, TPM, and Kanban. [22] Apparel manufacturers can improve their work environment and techniques by using the concept of Industrial Engineering, according to a study by P. Chandurkar et al. (2015). Using industrial engineering methods like method engineering, work study, capacity study, line plan, and other operations management systems can lead to timely delivery of goods, high profit and the development of a pleasant working environment. During this project, the time between stitching operations was lowered by up to 22.91 seconds by reducing the number of stoppages. There was an increase in productivity of 26.51% [23].

According to H. Abdulmouti (2015) kaizen refers to the philosophy that improves organizations through continuous improvement processes. The improvements through kaizen associates with minimum expenses and without sophisticated techniques. By implementing the kaizen tools at Toyota centre in Saudi Arabia, the following results may be summarized as a saving about 5.5 million without investing in new facilities, manpower reduction by 26.9%, an increase in effectiveness by increasing the annual output about 13% and improving in quality was observed [24]. A. T. Bon and T. S. Kee (2015) have emphasized in their study, that implementation of lean was tested for a selected company in Malaysia. To prove the theory, the total average score for gap analysis in 10 specific areas was observed and it was found 4.22 out of 5, which strengthen the fact of improving the system by implementation of lean manufacturing [25].

V. CONCLUSION

In the way of lean journey as the competition gets tougher, there is more pressure on organizations to improve their productivity and quality and customer satisfaction while reducing cost and waste. A common challenge faced by organization in this changing scenario is to increase the productivity within limited resources of manpower and available floor space, without investing in new technology, thus improving process under cost constraints. A number of tools and techniques are available to the modern day managers which can help in affecting such changes. Reduced lead times, improved on-time delivery, waste elimination, and cost reduction are all part of a lean manufacturing process. In this course of action when processes are rationalized, there is greater possibility for improving the productivity and once the system of manufacturing Cutbacks in inadequacies, if reasoned, can yield enormous benefits.

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