APPLICATION OF LEAN MANUFACTURING IN DEVELOPING BEST PRACTICES FOR PRODUCTIVITY IMPROVEMENT IN AN AUTO-ASSEMBLY PLANT

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Abstract

Principles of lean manufacturing and total productive management have been applied to increase the plant's output in order identify bottlenecks in the plant that limits the output and lean manufacturing helped to identify waste (muda) in the constrained production areas[1]. A very useful best practice for the productivity improvement that is easy to use by plants' management to help them identify and manage bottlenecks, and to eliminate waste from the production system. Lean manufacturing is one of the best suited total productive maintenance practices for quick responsiveness through integrating various processes like, high machine utilization, best utilization of man power, elimination of waste, mistake proofing. The main objective of this process is to control cost through focus on Zero breakdown, Zero accident, Zero defect. To meet the changing requirements & expectations from our customers, we need to be more agile, which leads to improved responsiveness, More Cost competitive to address cost reduction expectation or minimizing where it is not possible to eliminate. The Exercise of identifying the wastes starts with application of value stream map techniques throughout the scope of the supply chain.

Key Words: *Automotive Industry, Lean Production, Manufacturing Systems, Productivity Rate.*

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1. INTRODUCTION

Quick responsiveness to the customer needs and expectations, are key services required for our sustainability in the market. Lean manufacturing is one of the best suited practices for quick responsiveness through integrating various processes like, high machine utilization, best utilization of man power, elimination of waste, mistake proofing. The main objective of this process is to control cost through focus on Zero breakdown, Zero accident, Zero defect. This paper starts with identification of gap through SWOT analysis. Outcome of the SWOT analysis helps to arrive at primary objectives to meet current expectations of our customers. To meet the changing requirements & expectations from our customers, we need to be more [2] agile, which leads to improved responsiveness, More Cost competitive to address cost reduction expectation.

2. LEAN MANUFACTURING

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3. SWOT ANALYSIS

To understand this in detail, SWOT analysis of AAL process and list the drivers and barriers to identify the need for lean manufacture based on the above analysis, it is evident that, there is an absolute need for an organizational structure which facilitates smooth flow of information, material & funds and Lean manufacturing system which converts threats into opportunities.[3] The lean manufacturing process plays a vital role in addressing today's volatile market which is hard to predict and ever increasing demands of OEM's in terms of responsiveness to flexible schedules and cost reduction. TPM is the sub set of the lean manufacturing system and in this dissertation; an attempt is made to make use of value stream mapping technique to identify the wastes in the various manufacturing process and application of lean manufacturing initiatives like TPM methodology to eliminate / minimize the waste in manufacturing process, setup time reduction, machine down time reduction, zero defect component, unnecessary process elimination to build agile manufacturing system to address the objectives of this exercise.

4. ANALYSIS OF GEAR MANUFACTURING PLANT

The objective of this project is to achieve the best manufacturing company with better utilization of man, machine and material with a minimum waste the focus on key areas are: Change in manufacturing process. Better cost control with minimum waste in the process. Scope of the project—the process starts from Receipt of material from stores processes in various departments like machine shop, gear and pinion soft cutting area, heat treatment process, lapping and testing process. The manufacturing process starts from machine shop to the gear set inspection area is the scope of this project.

5. PROPOSED METHODOLOGY

It concludes with all the improvement activities taken up at various manufacturing processes in various departments of the gear manufacturing and explains the proposed manufacturing model which will achieve the objectives of this dissertation and leads us to be the world class manufacturing company. The first step in implementing lean system is to carry out initial calculations of critical parameters to define the production rate. These parameters are used to design new system based on the demand and effectiveness of the existing system. The parameters to be calculated are: customer takt time, planned cycle time, overall equipment effectiveness. For the above calculations, the exact data of the demand for the type & quantity of the gear sets for axles (including OEM & spares). There are more than 9 series in which 50 different ratios are manufactured in automotive axle's ltd, where each ratio has a different specification. The steps involved in processing the different ratios are almost the same. The major series are:R-149 series, R-149 forward series, Q-109 series, R-145 series, Rs-120 series, C-100 Series. The total demand for the gear sets on an average for the year 2007-08 is 12180 sets (in 5 cut method). This quantity will be considered for the future calculation. To Maintain AAL[5] as the leader in the Axle manufacturing, to compete with the global challenges and to fulfill the customer demand, requirement and cost. Implementing lean production through TPM (Total productivity maintenance) in the Gear manufacturing department to deal with the challenges, we need to

- Select one machine as model machine
- Study and implement how to increase the productivity by increasing the production time
- Study and implement how to get the best quality product
- Study and implement how to get the better safety
- Study and implement how to increase the machine uptime by correcting all abnormality in the machine
- Develop tools to study the validity of the above process
- Finally deploy all the activity of the model machine to all other machine.

6. CUSTOMER TAKT TIME (CTT)

The Takt time or customer Takt time is the rate at which customer required the product. Takt time defines the manufacturing line speed and the cycle time for all manufacturing operations of a product and becomes the heart beat of any lean system. The word "Takt" is derived from a German word "takt", meaning rhythm or beat. Takt time determines the required production rate to meet customer's demand. [Knowing how to identify 'fakes flow' develops your eyes for recognizing continuous flow by Rick Haris].Takt time is expressed as "second per piece", indicating that customers are buying a product once in so many seconds

Takt time is given by:

$$\text{Takt time} = \frac{\text{Net Available time per day}}{\text{Customer demand per day}}$$

The Takt time calculation is a critical calculation in lean line design, as it is the foundation for other calculations. The Takt time is determined based on the work load for each of the production cells in a day. [6]The number of cells to be designed is five.

An 8hr shift, consists of planned breakdown of 30 min (includes breaks, Meetings, Planned maintenance, etc…). Hence, the standard operating time for a shift will be effectively 7.5 hrs. The calculation for the Takt time is as follows:

Demand for gear sets per month = 12180

Demand for a day = 12180/25 = 487

Number of cells = 5

Work load for each line in a day = 487/5 = 97

STD operating time for each shift = 450 mins

Num of shift in a day= 3

Planned operating time per day= 450X3 = 1350mins

$$\text{Therefore Takt time} = \frac{1350}{97} \times 60 = 835.05 \text{ sec/set}$$

The Takt time is approximated as 835 sec/set

7. OVERALL EQUIPMENT EFFECTIVENESS (OEE)

Overall equipment effectiveness (OEE) offers a simple but powerful measurement tool to get inside information on what is actually happening in the system. The OEE concentrates on six major losses in the system as given below. Equipment failure, Setup and adjustments, Idling and minor stoppages, reduced speed operation, Scrap and rework, Setup loss. The calculation gives information on how effectively the machine or the line is functioning and which of six major losses needs to be improved. Overall equipment effectiveness is not the only indicator to assess a production system, but it is certainly very important if the goal is improvement.

$$\text{OEE} = \frac{\text{Net production time}}{\text{Planned operating time}} \times 100$$

8. TIME ANALYSIS FOR OEE CALCULATION

In auto motive axle there are three shifts in a day for each having an 8 hrs (480 mins). For each shift there will be a planned down time is considered for 30 mins which includes Beaks, Meetings, PM, 5S etc. hence the scheduled up time for particular shift will be 7.5 hrs (450 mins). Other type of losses which usually occurs in up time is shown in below table.

Table -1: Time Losses

Time losses	Minutes
Setup time	38
Equipment failure	14
Defect cycle	15
R/W cycle/scrap	4
Lack of man/material	10
Changeover time	5
Total	86

The net production time = 450 mins-86 mins = 364 mins

$$OEE = \frac{\text{Net production time}}{\text{Planned operation time}} X\ 100$$

$$OEE = \frac{364}{450} X\ 100 \quad = 80\ \%$$

Therefore OEE loss will be about 20%

9. PLANNED CYCLE TIME (PCT)

The planned cycle time is the production rate required to meet the customer demand. If the work stations or operator are balanced or made to operate at Takt time, and then any variations like longer cycle time, scrap, rework, or different operators will cause not to produce the product at Takt time. Hence the takt time is adjusted for these factors by carrying inventory to buffer against these variations or by balancing the work at each station slightly faster then takt time to offset the variations. This is called planned cycle time (PCT).

A good target for the planned cycle time is around 90 to 95 percent of the Takt time. The remaining time accounts for operator fatigue, minor interruptions in the cycle and variations in the processes [7]between products. The above variations and other losses like down time change over time and the breaks together come under O.E.E losses. Hence the actual PCT for a process is a product of actual Takt time and the OEE.

Planed cycle time= Takt time X OEE

Customer Takt Time = 835 sec/set

Overall equipment Effectiveness = 80%

Planned cycle time = 835 X 0.80 = 668 sec/set.

10. POST KAIZEN IMPLEMENTATION

The planned & unplanned time losses after implementation

Table -2: Time Losses After Implementation

TIME LOSSES	MINUTES
Set up time	25
Equipment failure	25
Defect cycle	24
Rework/scrap	20
Lack of manpower/material	12
Changeover time	8
Tea time	4
Total	98

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9. RESULTS AND DISCUSSIONS

After implementation of TPM the results are:

Table -3: Results

ITEMS	BEFORE	AFTER	DIFFERENCE	IMPROVEMENT
Set up time	40 min	25min	15 min	37.50%
Overall Equipment effectiveness	72.66%	78.22%	5.56%	7.65%
Planned cycle time	10.11min	10.88min	0.77min	7.61%

As per the results obtained from the analysis, the setup time is reduced by 15 minutes after the implementation i.e an improvement of 37.50% is obtained. The Overall Equipment Effectiveness (OEE) is increased by 5.56% after the implementation i.e an improvement of 7.65% is obtained. Similarly, the cycle time is increased by 0.77 minutes i.e an improvement of 7.61% is achieved. From the above results it is evident that after the implementation of lean manufacturing practice in an Auto-Assembly plant, the overall productivity has improved.

11. CONCLUSIONS

From the above analysis, we can say that TPM is one of the best suited methods in Automotive Axles and a higher efficiency can be achieved with further implementation of Total Productivity Maintenance which would lead to the achievement of Lean manufacturing. Result summary evidences the results of all the above actions in terms of P, Q, C, D, S, and M with comparison with the consecutive year's results.

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