Implementation of Total Productive Maintenance in Automotive Chain Manufacturing Industry: A Case Study

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Abstract: Total Productive Maintenance is shared and implemented in Automotive Chain Manufacturing Industry. The research investigates the answers of these Challenges by analyzing and modeling the equipment condition and response of action required in Chain Manufacturing Industries. Overall Equipment Efficiency, Production per hour, Output/Man, Reduction of Breakdown hours & Occurrences, Reduction of Customer Complaints, Reduction of In-house rejection. Reduction of Accidents is used as measures of Success of TPM Implementation. The losses related with the equipment efficiency, Customer Complaint Data from Customer Portal, Production/Hours, Output/Man data & Accidents data collected from various sections & division, That data we called as “BENCH MARK Data to Identified the success of implementation in the Company. The Method of this Problem to Implement the five Pillar of TPM Aimed at Strengthening of process in more Realistic application. For effective utilization of TPM 1st developed the TPM Policy and its is linkage with the Key Performance indicators, key Area of inductor & Key Management index.

Keywords: OEE, Total Productive Maintenance, 1s-2s, Production per hours

1. Introduction

Ensuring earning of targeted profits in manufacturing is becoming tough day by day Market conditions do not allow revise/increase price of products due to tough competition, where as ask for price reduction. On other hand, Power cost going up Overheads going up Hence, profits are shrinking. Project investigates the Optimum utilization of resources 4M1T Resources i.e. Man, Machines Material, Method & Tooling. Optimum Utilization of resources is the main objective of TPM it insure the effective implementation of Total Productive Maintenance. It include total Employee involvement to achieve the desired objective this Projects. Due shrinkage in Profit TPM is the Tool in which Optimum Utilization of resources is Possible to achieve the project objectives. TPM as a tool helps to: Elimination of production losses increase productivity Elimination of defects in manufacturing process & Controls 4M1T Conditions, Elimination of cost losses / wastages cost improvements Elimination of cost losses / wastages cost improvements. Since the introduction of PM, the predecessor of TPM, to Japan in 1951, “Seiichi Nakajima” has dedicated over half century to influence the concept of PM and TPM as a leader, and continues to this day. In these days, increasing numbers of TPM Award winners in overseas evidence that over 50 years of his committed effort is a genuine and valuable dedication to not only the Japanese manufacturing industry but also for manufacturing industry all over the world. Without his remarkable effort, TPM and manufacturing industry would not have been what it is today.

TPM is a unique Japanese systems of managerial expertise. Developed from PM preventive or productive maintenance) style of US in 1950s subsequently developed to its present stage by JIPM Now, TPM promotes entire company structures every line of businesses and all parts of the world. TPM is implemented company wide. To eliminate these problem, Five pillars strategy (EPS), one of Total Productive Maintenance (TPM) strategies, is the metrical approach established by The Japan Institute of Plant Maintenance (JIPM) in 1971.

TPM gives concept of zero product defects, zero breakdowns and minimal losses and better operating and maintenance managements for the plant to practice with the principle of 5S, Autonomous maintenance, Kaizen, Planned maintenance, Quality maintenance, Training, Office TPM, and safety Health and Environment according to its objective. EPS also aims to increase availability and effectiveness of existing equipment in a given situation in many production companies, through the effort of minimizing input (improving and maintaining equipment at optimal level to reduce its life cycle cost) and the investment in human resources which results in better hardware utilization and, operation and maintenance managements.

This Paper experience the practical works of TPM Implementation of in Automotive Chain Manufacturing Industry. The main objective of this paper is to implement five Pillar Methodology to all Process in one Roof like RM storage, Stamping, Bush, Different Heat Treatment Process, Induction Hardening, Chain Assembly, Storage warehousing, Robotic Turning, Hobbing, Naming, Fine Blanking, Tapping, Debarring. In the part one all five Pillar are explained and approach taken for Implementation of is also mentioned. After that discusses the analysis of the idea before and after implementation of the TPM. Finally we given the conclusion of the case study.

2. TPM Implementation

2.1 Kobestu Kaizen (KK Pillar Activity)
Definition of KK: To Improve the Operational efficiencies by systematic Monitoring and reducing the losses resulting in effective Utilisation of machines and manpower.

KK Pillar Mainly Focus & Aim on:

Production: To increases production / Hr by maximising utilisation of plant capacity through OEE improvement, focusing on major losses in the cell, increasing loading time & debottlenecking of cell's. To increases production / man by automation, eliminating add-on operations, reducing throughput time and based on approved offloading. * Reduce lead time by reducing no. of processes, mfg. stages, waiting time transportation time.

Cost: To reduce manufacturing cost by improving material yield & reduction of conversion cost by identifying and elimination of cost losses and introduction of new processes. To reduce WIP by reducing the imbalance in production rate of different cell of same model.

“Kaizen” literally means “change for the betterment”. Kaizen involves small improvements and it is carried out on a continual basis and involving people of all level in the organization. The principle behind Kaizen is that “a very large number of small improvements are more effective in an organizational environment than a few improvements of large value”. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools.

Table 1: Details of Implementation Report Kobestu Kaizens

2.2 Jishu Hozen—Autonomous Maintenance (JH Pillar Activity)

Definition of JH: The purpose of Autonomous maintenance is to teach operators how to maintain their equipment by performing daily checks, lubrication, and replacement of parts, repairs, precision checks, and other
maintenance tasks, including the early detection of abnormalities.

JH Pillar Aims to eliminate force deterioration of m/c. To maintain basic condition of machine. Enhance maintenance skills of workmen. To Achieve Zero Breakdowns, Defects & Accidents, this is not being achieved due to weak JH, and to change the mind set of operator from. “I operate, you maintain” to “I operate, I maintain”

7 Steps of JH Pillar


7 1s Implementation

![Image](image1)

Figure 1: 1s-2s Activity

![Image](image2)

Figure 2: 1s-2s Implementation

Fig No. 1.2 JH for JH step-3

1. Operators are given training by shop floor in charge in a pair of two about daily maintenance.

2. Earlier helper use to clean the machines, and they are not cleaning it regularly, as a result of which lots of work is accumulated during preventive maintenance.

3. In Step -2 Activity 6281 nos of Red Tag Abnormalities including SOC, Hard To CLIRt Identified and Removed through maintenance. 2475 nos. White Tag Identified & Removed by production Department.

4. Operator and helper are cleaning machine from its top and now they are responsible to upkeep the machine on which they are working.

5. Completed the Step-o3 on total No. of 142 machines.

6. With the help of maintenance department, shop floor in-charge and manuals of all machines, Autonomous Maintenance CLIRt Standard & Check list is prepared. Now following this checklist is mandatory for all the operators. It is a responsibility of shop floor in-charge to see that every operator fills up this check list.

2.3 PM Pillar Implementations

2.3.1 Why PM?

PM Pillar plays an important role in plant TPM industrial journey. it possesses a standard purpose to give uninterrupted production by sustaining optimal condition at all times and standard activities to provide services to enhance the knowledge and skills of maintenance operators.

2.3.2 Aim & Backgrounds:

PM Pillar helps to achieve the organizational main objectives. The main objectives are to make zero breakdown, sustain zero breakdowns, to make zero defects due to equipment by ensuring the availability and reliability of equipment to get uninterrupted production.

2.3.3 Support to JH Activity

PM Pillar team removed all the abnormalities which has identified by Production.

2.3.4 Equipment Failure Analysis and Countermeasures.

- Minimize Breakdown Time. Our main motto is to minimize the maintenance cost by optimizing the equipment condition. When look on history of equipment, very high breakdown time occurs must maintain the equipment in optimal running condition so that we could maintain uninterrupted production.

- Controlling Breakdown Occurrences. B.D. Occurrences completely affects the production plan. So we must maintain the zero break down occurrence to get uninterrupted production. Actually break down occurs due to weak design, lack of skills, poor operating condition and unattended deterioration.

Table 2: Action on Breakdown
2.3.5 Preventive Maintenance

Machine wise PM Planed & PM done as per Schedule. Whatever PM abnormalities observed during the PM activity must closed immediately.

TBM Methodology

Base on TBM Methodology TBM calendar Prepared & executed.

2.3.6 Maintenance cost

Optimization of production and minimizing the cost is the main motto of each and every industry.PM pillar provides a planning to maintain optimal equipment condition with minimum maintenance cost.

Table 3: Kaizens Maintenance spare cost Reduction

<table>
<thead>
<tr>
<th>No.</th>
<th>Machine</th>
<th>Sub-Asy</th>
<th>Problem</th>
<th>Improvement</th>
<th>Manufacturing</th>
<th>Actual</th>
<th>Expected</th>
<th>Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ADEA Pump</td>
<td>Operating motor</td>
<td>Easily, loosely bounded to ADEA pipe</td>
<td>Motor done by developing its motor facility</td>
<td>30000</td>
<td>30000</td>
<td>30000</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>Meat Flap 1 &amp; 2</td>
<td>Meat Exchanger</td>
<td>PM done to be done at once</td>
<td>PM done by developing its motor facility</td>
<td>30000</td>
<td>30000</td>
<td>30000</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>Sausage 1 &amp; 2</td>
<td>Heat exchanger</td>
<td>PM done to be done at once</td>
<td>PM done by developing its motor facility</td>
<td>30000</td>
<td>30000</td>
<td>30000</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>Sausage 1 &amp; 2</td>
<td>Component Cleaner</td>
<td>Reverse S.S. sheet belt</td>
<td>Explained the Piece of sheet belt by alternative motors.</td>
<td>30000</td>
<td>30000</td>
<td>30000</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>CMC Bore, Bore OD Trim</td>
<td>Chip converter</td>
<td>Chip converter per two parameters failures</td>
<td>Chip converter per two parameters replaced by high tech one.</td>
<td>15000</td>
<td>15000</td>
<td>15000</td>
<td>0</td>
</tr>
</tbody>
</table>

Total savings: 821260

2.3.7 Energy cost Reduction

Table 3: Summary for Energy Saving Kaizen

<table>
<thead>
<tr>
<th>Area</th>
<th>Kaizen Theme</th>
<th>No of Kaizens</th>
<th>Saving in Rs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant shop /Rice lights</td>
<td>To save energy by time based</td>
<td>56</td>
<td>49560</td>
</tr>
<tr>
<td>Rear sprinkler</td>
<td>To save energy by hyd motor in auto off mode</td>
<td>01</td>
<td>2600</td>
</tr>
<tr>
<td>Sausage finnace 1 &amp; 2</td>
<td>To save energy by using minimum job changes over time</td>
<td>02</td>
<td>52500</td>
</tr>
<tr>
<td>Sausage finnace 1 &amp; 2</td>
<td>To save energy by using min job adjustment</td>
<td>02</td>
<td>23000</td>
</tr>
<tr>
<td>Water tank</td>
<td>To save energy by using water level sensor</td>
<td>02</td>
<td>8400</td>
</tr>
</tbody>
</table>

Total saving: 821260

2.3.8 MTTR and MTBF

It play a role of reverse characteristics i.e. when MTTR is very high while MTBF is low. Hence more time and cost on breakdown maintenance. Following the Some Major kaizens done in plants.

Table 4: MTTR Kaizens Implement

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Theme</th>
<th>Problems</th>
<th>Routes</th>
<th>Kaizen Idea</th>
<th>Countermeasures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTTR</td>
<td>Kaizen</td>
<td>To increase the life of replacing the assembly line</td>
<td>2 months</td>
<td>To provide SS (8) grade for shaft &amp; fan blades.</td>
<td>Maintenance cost reduced</td>
<td></td>
</tr>
<tr>
<td>MTTR</td>
<td>Kaizen</td>
<td>To increase life of Bore &amp; Bore of Boiling Machines</td>
<td>Daily 8 hours</td>
<td>Maintenance cost reduced</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MTTR</td>
<td>Kaizen</td>
<td>To reduce production of Boiling Machine &amp; Cylinder rod servicing</td>
<td>3 days 8 hours</td>
<td>Maintenance cost reduced</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.4 QM Pillar Implementations

Definition of QM: To Produce the Defect free Product & Install sustainable systems for Defect Preventions.

It is geared towards achieving customer satisfaction through delivery of highest quality product. Through focused improvement defects are eliminated from the process after identifying the parameter of machine which affects the product quality. Transition is from Quality Control to Quality Assurance. Approach: The condition is checked and measured in time series to verify that measured values are within standard values to prevent defects. The transition of measured values is watched through charts to predict possibilities of defects occurring and to take counter measures before hand.

2.4.1 EFR & Warranty

There is no Accepted warranty & EFR Complaints from customer. So Proactive activity done as follows

Table 5: Proactive EFR & Warranty study
Possible Customer Complaint Study
IPO updated for defined actions & followed (IPO displayed in all lines).
Q-defect mapping for possible customer complaint

Table 6: Q-Defect Mapping

<table>
<thead>
<tr>
<th>No.</th>
<th>Defect Type</th>
<th>Causes</th>
<th>Action + Action</th>
<th>Result</th>
<th>Action + Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Defect 1</td>
<td>Cause1</td>
<td>Action1</td>
<td>Action2</td>
<td>Result1</td>
</tr>
<tr>
<td>2</td>
<td>Defect 2</td>
<td>Cause2</td>
<td>Action3</td>
<td>Action4</td>
<td>Result2</td>
</tr>
</tbody>
</table>

2.4.3 IHR prevention Activities implement as follows

- Captured the defect phenomenon of process
- Prepare the QA matrix to understand the generating points
- Stratify the defect as A, B (poka & B-chronic), and C Type
- Analyze by doing why why analysis for A, B (poka) and C type phenomenon. Make the kaizen or poky yoke for arresting the defect at source.
- Carry out PM (P- Means Physical Phenomenon & M-Means Mechanism) analysis and simulation study for B (Chron) type defect phenomenon. Make a kaizen or pokya yoke for identified causes. Identify the 4M1T conditions
- Combine, make a plan for sustenance for ensuring zero defect status with the help of QM Matrix
- Maintain as per QM matrix or update the same if required.

2.4.4 Sustenance of Zero In-House Defects.
Zero IHR sustained through implementation of IRO methodology.

2.5 Safety Health & Environment (SHE):

Definition of SHE: - To Create Green Hygienic & Safe Workplace.

Aim of SHE

S: - To create safety awareness amongst the employees at work place, To achieve & maintain zero accident factory by continuous improvement & participation/involvem of employees To create awareness for the safe usage of equipment’s
H: - Creating awareness amongst the employee towards maintenance of Health & Hygiene
E: - Prevention of Air, water & Soil pollution,. Preventive Measures towards Norms led down by Pollution Control Board & as per the Act Definitions of Accidents:

Major Accident: Man days lost from workplace more than 48 hours. Minor Accident: Person injured is prevented from working for period of less than 48 hours. First Aid Injury Accident: Injured person returns to work immediately after administration of first aid.No man-days lost.

2.5.1 Safety: Safety petrol Audit Conducted to Capture the Unsafe Condition/Unsafe Condition /Near Miss Cases to avoid the accident. Same 470 nos of Unsafe Condition, Unsafe Act 63 nos are identified. Some Action Initiated as follows.

Table 7: Action on Unsafe Condition

<table>
<thead>
<tr>
<th>No</th>
<th>Unsafe Act</th>
<th>Location</th>
<th>Responsibility</th>
<th>Action Taken</th>
<th>Target Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aisle left &amp; not illuminated</td>
<td>Factory Area</td>
<td>Maintenance team</td>
<td>Repaired</td>
<td>20/09/2019</td>
<td>Completed</td>
</tr>
<tr>
<td>2</td>
<td>Loose wire connected to the switch panel</td>
<td>Electrical Panel</td>
<td>Electrical Engineer</td>
<td>Repaired</td>
<td>20/09/2019</td>
<td>Completed</td>
</tr>
</tbody>
</table>

Table 8: Action on Unsafe Act

<table>
<thead>
<tr>
<th>No</th>
<th>Unsafe Act</th>
<th>Location</th>
<th>Responsibility</th>
<th>Action Taken</th>
<th>Target Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loose wire not connected to the switch panel</td>
<td>Electrical Panel</td>
<td>Electrical Engineer</td>
<td>Repaired</td>
<td>20/09/2019</td>
<td>Completed</td>
</tr>
<tr>
<td>2</td>
<td>Loose wire connected to the switch panel</td>
<td>Electrical Panel</td>
<td>Electrical Engineer</td>
<td>Repaired</td>
<td>20/09/2019</td>
<td>Completed</td>
</tr>
</tbody>
</table>

Table 9: Near Miss Cases
1. Sufficient number of fire extinguisher is provided all over CNC shop floor.
2. Training is given to each and every individual about how to use fire extinguisher in case of emergency in every 6 months.
3. Management is given suggestion for giving training to employee what to do in case of emergency? What should be the exit plan? Management is also given suggestion to conduct mock drill once in a year.

1. Earlier water camper in the shop floor was washed weekly now helpers are advised to wash it within 2 days.
2. Workers are advised to maintain cleanliness of toilets, regular cleaning of toilets is also done.
3. Workers are also advised not to chew tobacco and spit it in CNC shop floor and not to smoke within company premises.

2.5.2 Healthy
1. Earlier water camper in the shop floor was washed weekly now helpers are advised to wash it within 2 days.
2. Workers are advised to maintain cleanliness of toilets, regular cleaning of toilets is also done.
3. Workers are also advised not to chew tobacco and spit overall shop floor and not to smoke.
4. Also Medical health Checkup Conducted. In Medical checkup no one found affected occupational disease. Acoustic provided to avoid sound Pollution.

Also Survey Taken for Poor ergonomic condition & Poor Unhealthy Condition. Some of Survey taken as follows

Table 10: Survey for Poor Ergonomic Condition

2.5.3 Environment
Green Initiatives taken to increase the Green Zone of Company & Achieved up to the 33 % of total Premises. Various test conducted to maintain the environment Condition.

Table 12: Test Plan to maintain the Environment

<table>
<thead>
<tr>
<th>S. No</th>
<th>Work</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Stack Emission Test</td>
<td>Yearly</td>
</tr>
<tr>
<td>2</td>
<td>Ambient Noise Test</td>
<td>Yearly</td>
</tr>
<tr>
<td>3</td>
<td>Waste water Test</td>
<td>Yearly</td>
</tr>
<tr>
<td>4</td>
<td>Hazardous waste disposal</td>
<td>Quarterly</td>
</tr>
<tr>
<td>5</td>
<td>Soil Test</td>
<td>Yearly</td>
</tr>
<tr>
<td>6</td>
<td>Tree Plantation</td>
<td>Progressive</td>
</tr>
</tbody>
</table>

3. Data Analysis
After Implementation of all Above five Pillar activity in All Process we observed following effective results includes Overall Effective implementations (OEE of Each Process & Division) as follows.

Table 13: Case Study results.

4. Conclusion
The key factors for this implementation are workers involvement and top management support. Still world class TPM implementation is possible with continual support at all the levels along with the supply of necessary resources. also number of Kaizen increase at the rate of 2 man/employee/month. Also Completed the 142 nos of Machines in JH Step -03.

Following conclusion is derived from implementation of TPM in the Chain manufacturing Industries of automotive company:
1) Success of TPM depends on various pillars like 5-S, Jishu Hozen, Planned Maintenance, Quality maintenance, Kaizen, Office TPM and Safety, Health & Environment.
2) Overall Equipment Effectiveness has improved from 63% to 85% indicating the improvement in productivity and improvement in quality of product.
3) Production/Hours/Output/man Improve by 30 % and Manufacturing Cost reduce by 20 %
4) Customer Complaints reduce & Sustain below 100ppm and In-house rejection reduce by 80 %.
5) Delivery Adherence Sustain by 100 %. & Accident reduce by 70%
Acknowledgement

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