

Total Productive Maintenance (TPM) Practices Adopted at Manufacturing Unit: An Analysis

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Abstract

Total Productive Maintenance is a maintenance program which involves a newly defined concept for maintaining plants and equipment. TPM program allows manufacturing units to look for evolutionary changes happened in business environment. TPM is an evolving technique which is followed in the all organization. This helps improve key business process which helps firms to identify key performance indicators. The objectives of the study is to examine the advanced methodologies that can be implemented to bring betterment of the process being used and to compute overall equipment effectiveness (OEE) to analyze maintenance performance of machine and to understand the quality standards and customer expectations over the products manufactured. The Research design taken for this study is Analytical research. The secondary data are collected from annual company records for the month July 16 to Dec 16. The various tools used for analysing the data for this research paper is Pareto chart, Histogram, Why-Why analysis, Fish bone diagram, Pie chart. The findings of this research is OEE (Overall Equipment Effectiveness) has increased due to proper utilization of machine; In-process scrap gets reduced due to development of gauges for measuring the dimension near the machining area and inspection area near the machining center. The suggestion given to the management from this research is Cleaning and Inspection time and machine setting change over time to be reduced to utilize the machine as much as possible to meet the production target and to increase the OEE.

Keywords: OEE; Machine loss; Maintenance; Quality defects

Introduction

With advancements in technology all manufacturing firms moving towards automation centralizing their plants for survival by maximizing productivity levels by reframing their all legacy applications. The concepts of Total Productive Maintenance (TPM) helping firms to maximize the equipment effectiveness till the expiry of the equipment. Maintaining equipment throughout its lifetime requires larger amount of time effort. TPM helps organizations in maintaining equipment to protect from quality defects, speed losses and also prevent unexpected breakdown because of accidental and incidental losses. This study executing ways by identifying new methodologies like cost reduction, promoting employees to face newer challenges and also transform new culture at work place. Through TPM practices manufacturing organizations ultimate goals transformed themselves towards zero defects, zero break downs and zero accidents all the time.

Nakajima suggests the ultimate goal of TPM is to minimize wastage of man hours, raw material, power, tools etc. The concept of overall equipment effectiveness (OEE) allows firms to realize an opportunity for zero defects, zero machine stoppage, zero pollution etc. All manufacturing firms adopts different strategies to make cross functional teams to root cause the barriers in machine uptime, rigorous maintenance programs, equipment maintenance training to all levels (strategic to operational) which allows teams to lower the cost and higher reliability. TPM practices keeping equipment to operate on full capacity with better efficiency and responsiveness.

According to Kennedy [1] Total Productive Maintenance (TPM) allows manufacturing plants to look for revolution on their existing methodological practices. It allows firms to maximize overall plant and machine efficiency. Since it adopts Japanese lean production approach making firms a complete sense of ownership for plant and equipment operation, promote continuous improvement through team based approach in all functional areas. It improves human capital management by continuously addressing them in elimination/minimization of machine losses.

Most of the production and their total production cost (30-50%) are currently undertaken within the factory. Due to this business profitability greatly affected because of quality of maintenance. It is important for the firm to improve the maintenance cost since its entirely affected the operating budget of many manufacturing firms. The firms continuously improve the maintenance functions by improving availability of product all the time, their quality and also improving their safety standards and requirements.

Sun et al. [2] quotes every business organizations applied TPM approach either directly or indirectly to improve their efficiency and effectiveness in their manufacturing approaches.

Kalbande and Thampi [3] quotes TPM is an important activity for a business in term of maintenance factor. It was not regarded as a non-profitable activity. However, it does can be more profitable in the long term. Many number of researchers and contributors drafted definitions mainly on autonomous, planned, quality and education and training maintenance.

Need for the Study

TPM is an evolving technique, which is followed in the all organization. This helps to increase the productivity of an organization. Currently, TPM has been implemented in manufacturing unit which has good impact in all aspects. This study is based on TPM impact after

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Implementation in the manufacturing company. There is a benefit in terms of productivity, reduction of scrap material, oil cost reduction, material utilization. So this study helps us to understand how TPM is beneficial to the organization of TPM after implementation. After detailed study findings and suggestions will be given to management in order to improve the TPM methodologies in the organization.

Research Objectives

- To examine the advanced methodologies that can be implemented to bring betterment of the process being used.
- To compute overall equipment effectiveness (OEE) to analyse maintenance performance of machine.
- To understand the quality standards and customer expectations over the products manufactured.
- To lubricate machines involve in smaller scale maintenance before and after closing them.
- To improve the skills of the employees by providing training to them.
- To satisfy the customer's needs by providing best-of-breed products with quality.

Literature Review

Ahmed et al. [4] contributed his research work by implementing total productive maintenance (TPM) in pharma sector. The study focused by identifying major losses and their factors which contributes productivity losses. The study suggested planned maintenance program to be implemented which helps pharma sectors to have smooth and increased efficiency on manufacturing load time, cycle time, and reduction in defects while producing units.

According to Katkamwar et al. [5] study performed how Total Productive Maintenance approach undertaken in spinning industry. The study suggested ways in implementing TPM effectiveness of the equipment. The study initially implemented TPM practices on model machine where the author derived direct and indirect benefits by applying quality tools. The methodological results obtained from this study showing ways to improve effectiveness of machines based on availability and performance.

Goyal and Jindal [6] identified overall equipment effectiveness (OEE) has important parameter for success in implementing TPM within firm. The study evaluates areas like reduction of manufacturing cycle time, customer complaints, handling autonomous groups on their skills and confidence levels and derived recommendations and conclusions to improves equipment efficiency and effectiveness.

Wudhikarn [7] proposed a new framework Analytic Network Process (ANP) along with OEE for improving the existing OEE measures and adapted measurement. ANP allows accurate judgment on decision maker even though OEE still a balanced tool to rectify unconformities to undertake appropriate decisions in handling and managing equipment.

Singh and Bhatia [8] discussed current TPM solutions and methodological practices avail world class manufacturing by overall effectiveness of equipment through team of people not by technology and standalone systems. The success of TPM implementation depends on the attributes like human interaction, effective matrix organizational structures and also through continuous TPM programs.

Singh et al. [9] implemented TPM practices on CNC machines by incorporating pillars of TPM through phased approach methods to eliminate losses for proper utilization of CNC machines. The author investigated TPM practices on CNC machines with different capacities by analyzing their overall equipment losses to identify effectiveness and efficiency.

Wakjira and Singh [10] identified correlations between various attributes of TPM to improve manufacturing efficiency by applying overall equipment effectiveness (OEE) in boiler plant in Ethiopia. Major success factors of TPM identified in this study to improve performance enhancements.

Research Gap

In the above literature papers, the authors clearly highlighted the importance of TPM methodologies to be followed in the organization [11]. The literature authors listed above focused implementation of TPM and focused on ways to improve performance efficiency and effectiveness. And also they addressed the issue faced during the implementation of TPM in the organization. They have calculated the various losses which affects directly the productivity of an organization. They also suggested how to improve the Overall Equipment effectiveness by eliminating the various losses. However, they didn't discussed how the productivity has increased after implementing the TPM in the organization. This article focused on ways how TPM contributes towards the increase in productivity after implementation within an organization. And also how material scrap percentage is got reduced gradually after implementation of TPM is to be studied in the paper [12].

Methodology

The research design adopted is analytical research where the researcher has used already available facts or information, and analyzes them to make a critical evaluation of the subject. The study concerns with cause-effect relationships among various variables by analyzing situation to make critical evaluation.

Parameters considered for this study is restricted to In-Process scrap, cleaning and Inspection, Customer complaint, Training, Oil and Spare cost reduction, Break down occurrence.

Secondary data are used for this study. Data collected from part of Research papers and Journals and from company records related to TPM methodologies.

Tools used for data analysis and interpretation

- Pareto chart
- Histogram
- Cause and Effect Diagram
- Why-Why Analysis

Data collection Period: July 2016 to December 2016 from Annual report of the firm.

Data Analysis and Interpretation

Findings

During the month of July'16 cleaning and Inspection time was found to be 30 min for a single machine. During the consecutive month the cleaning and inspection time gets reduced from 30 min to 10.4 min due to regular maintenance done (Table 1 and Figure 1).

Months	Time in min
Jul 16	30
Aug 16	6.2
Sep 16	24
Oct 16	16
Nov 16	12
Dec 16	10.4

Table 1: Cleaning and inspection.

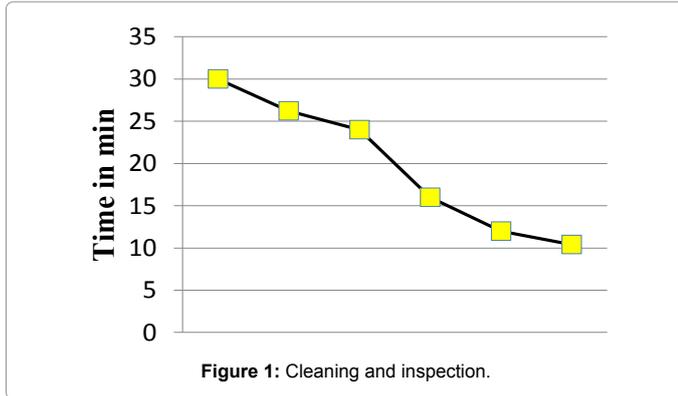


Figure 1: Cleaning and inspection.

Customer complaint	
Months	No of complaints
Jul 16	19
Aug 16	15
Sep 16	12
Oct 16	9
Nov 16	7
Dec 16	5
2017 (Target)	0

Table 2: Customer complaint.

During the month of July 16 Customer complaint found to be 19 mainly due to part mix-up. During the consecutive month the customer complaint has got reduced from 19 to 5 as on date (Table 2 and Figure 2).

Over all equipment efficiency calculation

Equipment Name: XYZ

Date: 1st 2016

Total losses: Setting time loss=30 min in 1st hour

First off time=15 min in 1st hour

Tool change time=20 min in 1st hour

Material not received from store=60min in 5th hour

Total loss=120 min.

$$OEE = \left(\frac{ROA \times ROP \times ROQ}{1000000} \right) \times 100$$

$$ROA = \frac{(\text{Time planned to use the machine} - \text{losses})}{(\text{Time planned to use the machine})} \times 100$$

= 72%

$$ROP = \left(\frac{(\text{Total no of products produced} \times \text{cycle time})}{(\text{Time planned to use machines} - \text{Losses})} \right) \times 100$$

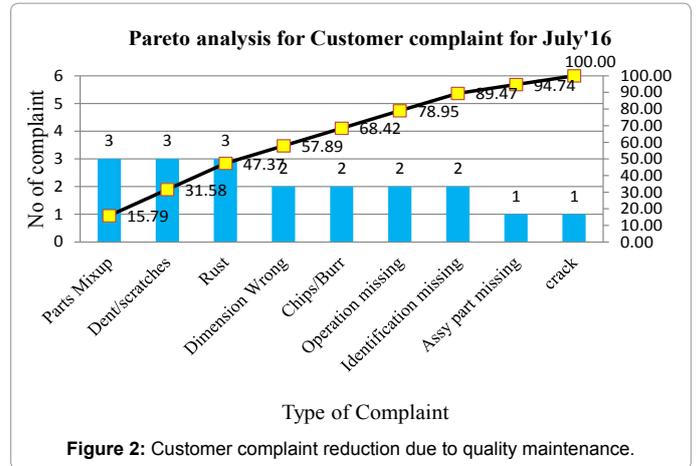


Figure 2: Customer complaint reduction due to quality maintenance.

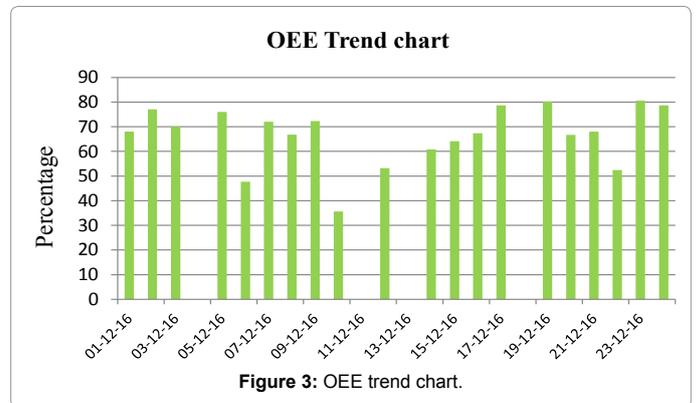


Figure 3: OEE trend chart.

$$\left(\frac{358 \times 0.83}{430 - 120} \right) \times 100 = 95\%$$

$$ROQ = \frac{(\text{Total no of products produced} - \text{Quality defect product produced})}{(\text{Total no of products produced})} \times 100$$

$$ROQ = \left(\frac{358 - 0}{358} \right) \times 100 = 100\%$$

$$OEE = \left(\frac{ROA \times ROP \times ROQ}{1000000} \right) \times 100 = \left(\frac{72 \times 95 \times 100}{1000000} \right) \times 100 = 68\%$$

OEE found to be 35.5%. But it has gradually increased to 80.53% due to proper utilization of machine without any losses (Figures 3 and 4).

During the month of July 16 Oil cost found to be 2.5 lakhs. During the consecutive month the oil cost has got reduced from 2.5 lakhs to 1.64 lakhs due to proper filtration and by arresting leakages. Simultaneously, spare cost has got reduced from 1.21 lakhs to 0.47 lakhs due to proper maintenance and parts localization (Tables 3 and 4; Figure 5).

It is found that, during the month of July 16 in-process scrap found to be 10.3% mainly occurred in bearing housing because of machining scrap. During the consecutive month the scrap value has got reduced from 10.3% to 1.9% as on date because of Implementation of gauge measuring instrument, part inspection near to the machining area (Tables 5-7 and Figure 6).

Conclusion

The present TPM Methodologies followed in the organization

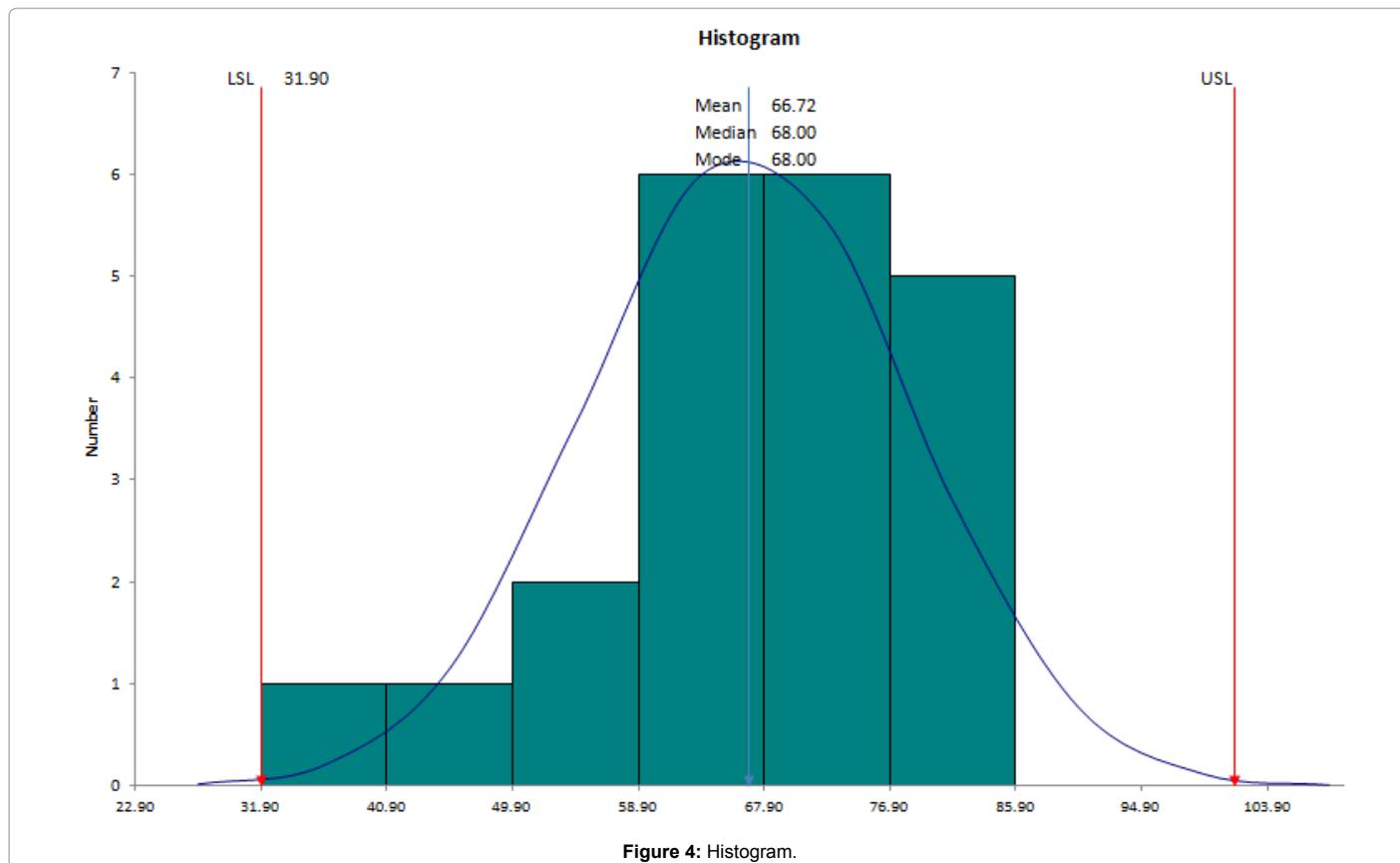


Figure 4: Histogram.

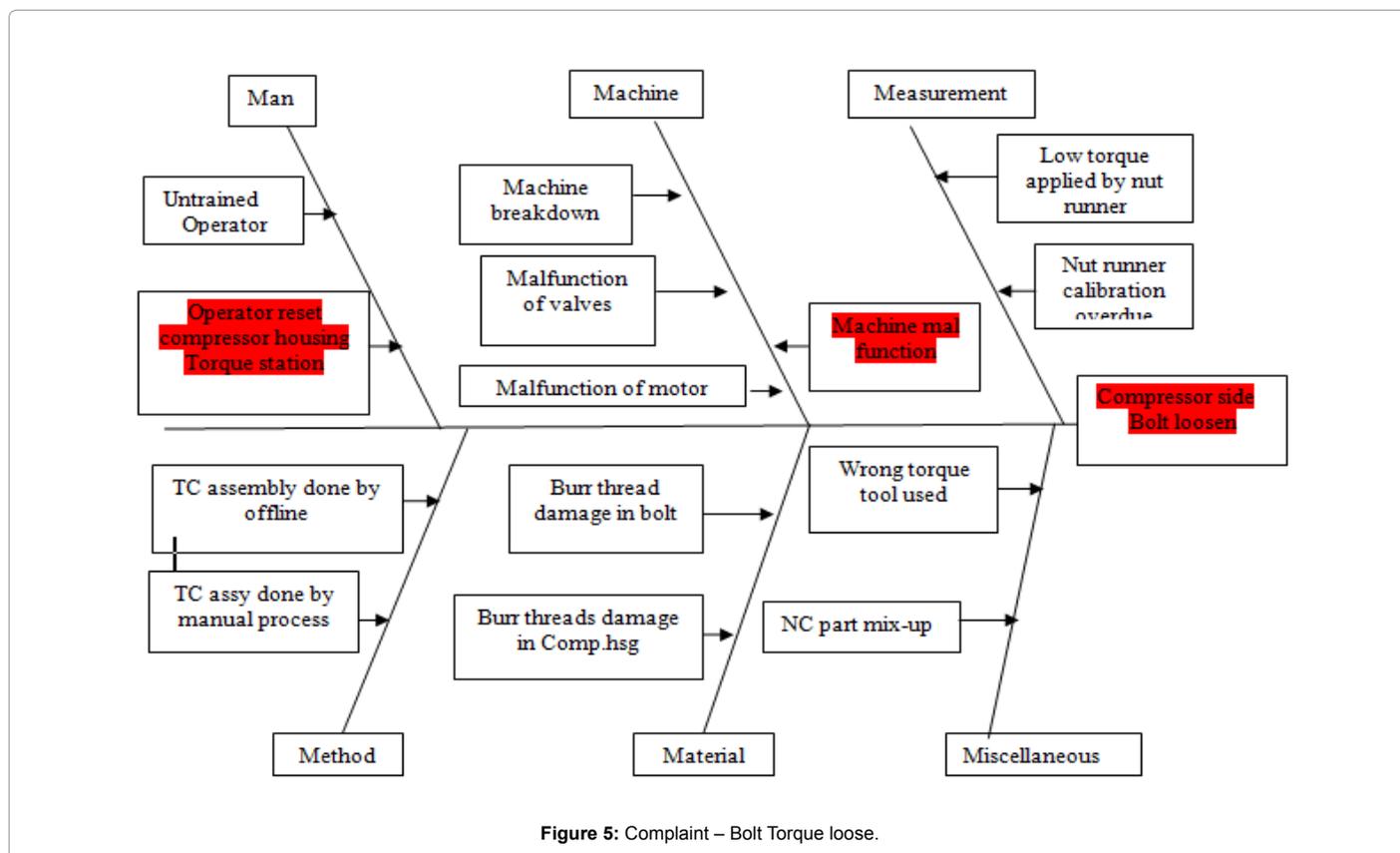


Figure 5: Complaint – Bolt Torque loose.

Occurrence	1-Why	2-Why	3-Why	4-Why	5-Why
	Compressor housing side bolt found loosen	Torque not applied on bolt	Nut runner position error	Malfunction of logic control in PLC program	Bug in PLC program

Table 3: Occurrence table.

Non detection	1-Why	2-Why	3-Why	4-Why	5-Why
	Compressor housing side bolt found loosen	Torque not applied on bolt	Not verified by operator	Manual error	

Table 4: Non detection table.

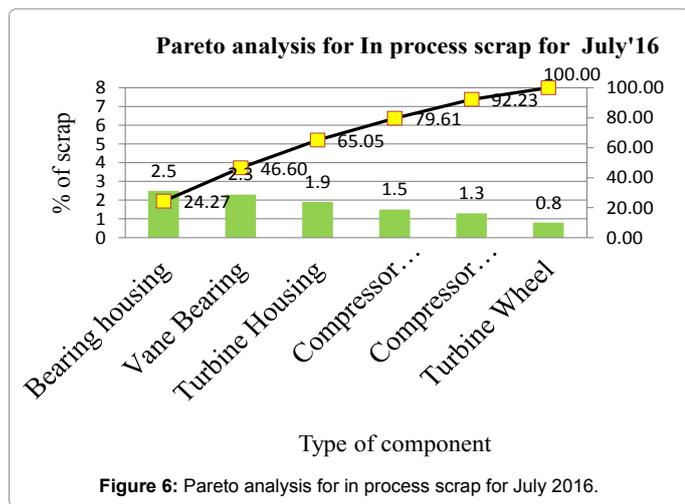


Figure 6: Pareto analysis for in process scrap for July 2016.

Oil cost reduction	
Year	Lakhs
July 16	2.5
Aug 16	2.3
Sep 16	2
Oct 16	1.89
Nov 16	1.72
Dec 16	1.64

Table 5: Oil cost reduction.

Spares cost reduction	
Months	Lakhs
July 16	1.21
Aug 16	0.74
Sep 16	0.77
Oct 16	0.56
Nov 16	0.52
Dec 16	0.47

Table 6: Spares cost reduction.

is thoroughly assessed with the available data. Based on the research findings it is concluded that major improvements reflected especially on productivity and outcomes of results. Further there are some suggestions given to the management to utilize the machine time as much as possible to increase the production number by doing the regular maintenance at scheduled period of time. And also few suggestions are given to reduce oil cost and in-process scrap cost.

Recommendation from the Study

- Cleaning and Inspection time to be reduced to utilize the machine as much as possible to meet the production target.
- Setting change over time to be reduced in future, so that OEE can be increased.

In process scrap	
Year	Percentage
Jul 16	10.3
Aug 16	7.4
Sep 16	5.3
Oct 16	3.1
Nov 16	2.2
Dec 16	1.9
2017 (target)	0.5

Table 7: In process scrap.

- Proper filtration and checking for the leakage at various joints to be done for oil in order to reduce the cost.
- Part localization instead of Importing to be planned to reduce the spare part cost.
- Electrical and Electronics items, and various mechanical systems in a machine to be serviced at scheduled period in order to avoid the machine breakdown.
- Part to be supplied from the before station or store to be on time to avoid the productivity.
- TPM training to be given maximum to all shop floor employees in order to have zero breakdowns and zero accident.
- Implementation of gauges and Measuring instruments to be done in all shop floor area in order to reduce the material scrap.

Direction for Future Research

TPM is evolving technology which is necessary for all the organization to meet the productivity with zero breakdown and zero accident. So in this research paper, the researcher has clearly highlighted how the OEE has contributing in increase in production. So a TPM methodology is the method which can be implemented in all the organization. So a further research, the researchers can this paper as a base research model to move forward in doing his research activity in TPM.

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