REDUCTION OF BREAKDOWN HOURS THROUGH LEAN TECHNIQUE IN A HIGH VOLUME LOW VARIETY MANUFACTURING INDUSTRY

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Abstract - *The industries have become more competitive in nature due to the technological development and globalization which made the manufacturers to improve their productivity to meet their customer demand. The manufacturers started to invest more on machines for high productivity but when these machines get repaired it leads to breakdown hours and the manufacturers had to meet a huge loss in their productivity. In this paper, case study is provided on how Total Productive Maintenance which is one of the lean techniques used to decrease the break down hours in the manufacturing industry. The problem for the breakdown in the industry was identified and it shows that the major contributor to the breakdown hours is in the foundry. The objective is to reduce 25 % of the breakdown hours in the foundry. A solution has been suggested for reducing the break down hours and the results show that after implementation, 20% reduction in the breakdown hours is achieved in the industry. The research also shows that TPM proactive approach has a significant effect in improving the work culture of employees in the manufacturing industry.*

Key Words: **Lean Manufacturing, Total Productive Maintenance, Preventive maintenance, Corrective maintenance, Predictive maintenance.**

1. INTRODUCTION

Lean manufacturing is a process that aims at consistent elimination of waste through continuous improvement and strives for perfection. Lean manufacturing uses set of tools and methodologies to eliminate all the waste that occurs in an industry. The ultimate aim of lean manufacturing is to reduce the production cost, increased efficiency and shorter the production lead time. Lean manufacturing has been used in many of the manufacturing industries and also in automobile industries and their suppliers.

According to the oxford dictionary the word "LEAN" refers to strong and efficient and it also refers to thin and fit so this indicates that the lean manufacturing only gives facilities to get only required resources for an organization to be strong, efficient, thin and fit. To make this lean manufacturing has a core paradigm that is "elimination of waste". According to lean manufacturing paradigm Toyota Production system identified there are seven types of waste but due to some practitioners it has been modified and expanded that includes the following

- Transportation (T)
- Inventory (I)
- Motion (M)
- Waiting (W)
- Overproduction (O)
- Over processing (O)
- Defects (D)
- Knowledge Disconnection

1.1 TOOLS AND METHODOLOGIES OF LEAN MANUFACTURING

There are some tools and methodologies that can help an organisation for lean transformation and are listed below:

- Standard work
- Visual management
- Value stream mapping
- 5s
- Preventive maintenance
- Total Productive Maintenance
- Change over
- Batch size reduction
- Kanban
- Quality at source

1.2 TOTAL PRODUCTIVE MAINTENANCE

From the tools and methodology given by the lean manufacturing the study is done through Total Productive Maintenance and the proactive approach. Looking at the revolution there are three types of revolution that took place the Agrarian revolution, Industrial revolution, the ongoing IT revolution. After the industrial revolution due to the competition among the manufacturers in nature the manufacturing organization started to equip complex machines to manufacture products. This made to employ maintenance engineers in a manufacturing organization to execute maintenance activity to restore the working of machines that failed to work. This kind of maintenance strategy i.e. allowing the machine to work till its failure and repairing it is called break down maintenance. After this the engineers and the management began to develop a new maintenance approach that needs to eliminate the breakdown failures so they came with the preventive maintenance and predictive maintenance as a proactive approach to reduce the breakdown of machines. In this progress came the origination of total productive maintenance (TPM). TPM is a concept of maintenance activity and it was first introduced by M/S Nippon Denso Co. Ltd. Of Japan in the year 1971 and it was propagated by Japanese Institute of Plant maintenance (JIPM). TPM is a plant improvement methodology which enables continuous and rapid improvement of the manufacturing process through use of employee involvement, employee empowerment and closed-loop measurement of results. TPM is incorporated with preventive maintenance concept (Etui et al 2004). On one side TPM was expanded for maintenance activities and on other side was extended to other strategies such as TPM in lean manufacturing

2. LITERATURE SURVEY

MELESSE WORKNEH WAKJIRA, AJIT PAL SINGH [1] has proposed a case study in manufacturing industry through Total Productive Maintenance. This paper deals about the evaluation and contribution of total productive maintenance to the manufacturing industry by improving its performance. The research was done in an Ethiopian malt industry. The study identifies the major losses that took place in the industry and the bottlenecks of the processes are also found. The results show that there is a significant effect after the implementation of TPM initiatives. The study also shows the achievement and critical success factors were identified on TPM implementation in the manufacturing industry.

I.P.S. AHUJA AND J.S. KHAMBA [2] have studied the TPM implementation in manufacturing organisation in an Indian industry. The study shows the contribution of TPM initiatives of a manufacturing industry which leads to performance improvement of the organisation to meet the global challenges. The results show that TPM proactive maintenance approach has a significant effect in the efficiency and effectiveness of the organisation.

S. KUKLA [3] has given a research study on implementation on Total Productive Maintenance on foundry line. The study has given a modern technique for maintenance which is connected with Total Productive Maintenance. The results show that TPM system is used as tool enabling the maintenance activities hence achieving reduction of operational cost and increase of productivity.

I.P.S. AHUJA AND J.S. KHAMBA [4] has also given a detailed literature review and directions for Total Productive Maintenance. The paper shows the framework, implementation practices, barriers and critical success factors of TPM which contributes the improvement of manufacturing performance. The author concludes that a TPM initiative has become a management paradigm and it can focus on all problems related to maintenance activity with view to optimise equipment performance.

3. METHODOLOGY

The TPM proactive approach implementation was done with set of methodology and shown in Fig -1 as followed in the study.

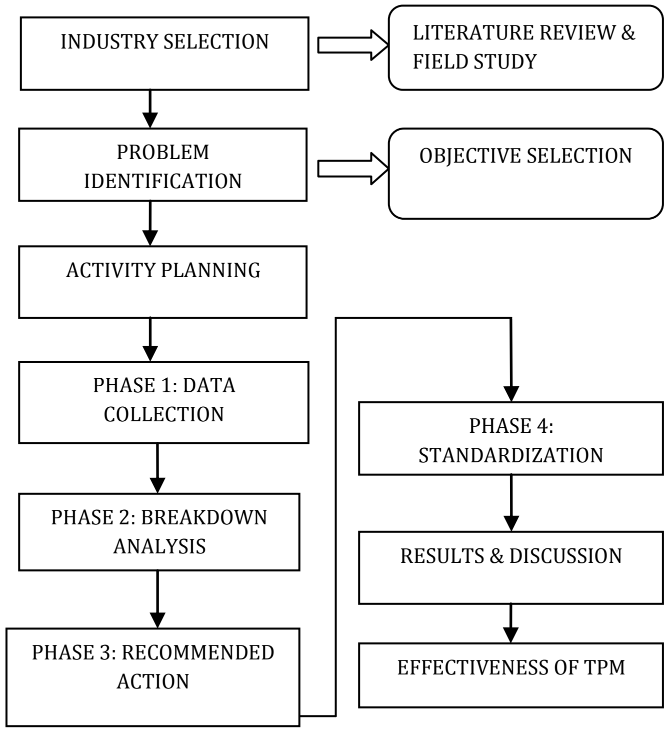

Fig -1: Methodology

4. DETAILED REPORT

Maintenance is said as one of the non-value added activity in functions of business organization. After the industrial revolution the manufacturing industry has faced a challenging environment in the maintenance of the equipment after the 20th century, Indian manufacturing industry alone could not escape from the technological development and globalization. The study is done on a manufacturing industry in Coimbatore. They are the supplier of automobile parts. In the study it was found that that the breakdown hours was high when compared to the target set by the industry for breakdown hours. The study aims to implement TPM proactive approach i.e. Preventive maintenance, Corrective maintenance, Predictive maintenance with pillars of TPM such as Autonomous maintenance, planned maintenance. The problem was found in the industry and the activity for the entire study has been planned in several phases and explained in detail.

4.1 PHASE 1: COLLECTION OF DATA

In this phase, the project is studied and data is collected related to the project. The data is collected from January 2016 to June 2016. The sand plant consists of 1 maintenance head, 1 facilitator sand plant, 3 technicians and 6 labours. The team formation is done with above members.

This phase also includes some presentation on Total productive maintenance and proactive approach to the Head, facilitator and the technicians. The data collected for six months from January 2016 to June 2016 are shown in the Table -1 and Table -2.For the first three months the data is shown in the Table -1.

Table -1: Data collection for first three months

BREAKDOWN	JAN 16 (HRS)	FEB 16 (HRS)	MAR 16 (HRS)	AVG HRS/MONTH
MECHANICAL	55	75	63	64
ELECTRICAL	24	42	24	30
TOTAL HRS	79	117	87	**94**

Table -2: Data collection for next three months

BREAK DOWN	APR 16 (HRS)	MAY 16 (HRS)	JUN 16 (HRS)	AVG HRS/ MONTH
MECHANICAL	76	61	60	65
ELECTRICAL	33	24	28	28
TOTAL HRS	109	85	88	**93**

The data shows that for first three months and next three months the avg. hrs/month is 93 - 94 hours/month. The target for breakdown hours/month in the industry is 8 hours but the status of the breakdown hours in the industry was 93-94 avg. hrs/month.

4.2 PHASE 2: BREAKDOWN ANALYSIS

In this phase, the break down analysis is done to find the root cause for the breakdown. The Breakdowns are classified into

- Mechanical breakdown
- Electrical breakdown

The breakdown analysis is done through brainstorming with the help of maintenance head and the facilitator of each department. The analysis show that the major breakdown took place in the foundry of the manufacturing industry and the analysis also show that one of the major contributors for the breakdown in foundry is sand plant so the study aims to reduce the breakdown hours in the sand plant. The list of breakdowns are taken and shown in the Table -3.

Table -3 List of breakdowns

S.NO	BREAKDOWNS	MINS
1	Bucket elevator	720
2	Mixer wheel	1080
3	Cleaning	80
4	Underground sand spillage cleaning	110
5	Belt contractor failure	80
6	Sensor failure	160
7	Low water level	50
8	Distribution belt	55
	TOTAL MINS	**2335**

The root cause of the breakdown is found with the help of Pareto diagram and the chart 1 & 2 shows the major contributor in the sand plant.

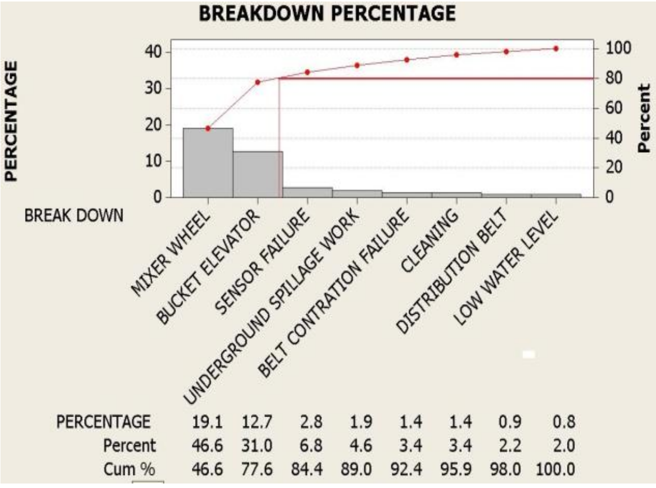

Chart -1: Breakdown Percentage

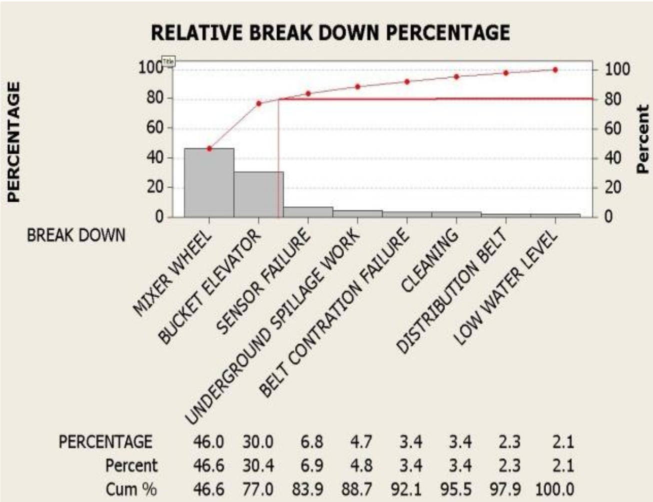

Chart -2 Relative Breakdown Percentage

The major contributors for the break downs are found by 80/20 rule and as follows:

1. Bucket elevator
2. Mixer wheel
3. Sensor failure

The causes for the major breakdown are also found and shown in the table -4

Table -4: Cause of breakdown

S.NO	BREAKDOWN	ROOT CAUSE
1	Bucket elevator	Drum wear out
2	Mixer wheel	Bearing failure
3	Sensor	Frequent damage

The reason for the causes of the break down are given in the table -5

Table -5: Reasons for Breakdown

ROOT CAUSE OF THE BREAKDOWN	REASONS FOR THE BREAKDOWN
Drum wear out	Misalignment of the belt due to overload of return and prepared sand
Bearing failure	Sand and dust accumulation
Sensor	Due to bearing failure

4.3 PHASE 3: RECOMMENDED ACTION

In this phase after finding the root cause of the breakdown related to the major contributor, the recommended actions have been given. The given recommended action are based upon the TPM proactive approach such as preventive maintenance, corrective maintenance, predictive maintenance according to the pillars of Total productive maintenance such as autonomous maintenance, Planned maintenance. This phase also aims at implementing the pillars of Total Production Maintenance i.e. autonomous maintenance and Planned maintenance. The recommended actions are given through the following steps:

- Corrective maintenance action
- Preventive maintenance action
- Predictive maintenance action

The breakdown analysation report is given with the corrective maintenance action in the Table -6.

Table -6: Breakdown Report

S.NO	MACHINE	BREKDOWN	ROOT CAUSE	CORRECTIVE MAINTENANE ACTION
1	Sand plant	Bucket elevator	Drum wear out	Belt alignment to be monitored regularly
2	Sand plant	Mixer wheel	Bearing failure	Time based maintenance plan
3	Mould track	Sensor	Frequent damage	Change of control voltage and supply voltage board

4.3.1 PREVENTIVE MAINTENANCE ACTION

The preventive maintenance action check sheet has been prepared with the help of maintenance engineer and the facilitator head. This preventive maintenance check will be done by the operators in daily and weekly basis. The preventive maintenance check sheet is shown in Table -7 and Table -8. A preventive maintenance suggestion has been given. The suggestions for bucket elevator are

- Plumber block designs changing for encloser tube and extra oil seal fixing.
- Bearing should be changed every 9 months.

The suggestions for mixer wheel are

- Oil seal and bearing cup design change.
- Bearing should be changed every 1 year.

Table -7: Daily checksheet

Daily basis check list	date
Check for belt alignment	
Check for belt condition	
Sensor work condition	
Check for sand leakage in bearing	
Check bearing temperature	

Table -8: Weekly checksheet

Weekly basis check list	1st week	2nd week	3rd week	4th week
Check bearing temperature				
Oil level checking				
Belt alignment checking				
Bearing temperature below 50 C				

4.3.2 PREDICTIVE MAINTENACE ACTION

The predictive maintenance check list is prepared and this maintenance check will be done by the facilitator head in the sand plant. The check sheet is given in the Table -9

Table -9: Monthly checksheet

MONTHLY BASIS CHECK LIST	JUNE	AUGUST	SEPTEMBER
Bearing lubrication			
Bearing temperature			
Belt alignment to check if needed change the belt			
Oil seal wear out			
Bearing vibration and noise			
Muller bearing cup check if needed change the cup			
Noise checking			
Gear box temperature			
Sensor rod distance			
Oil level			
Cleaning dust and sand			
Check sand spillage in the bearing			

4.4 PHASE 4: STANDARDIZATION

In this phase it deals with the standardisation of procedures. The maintenance activities that are suggested must be standardised and the activities should be done regularly that leads to reduction of breakdown hours in the foundry. In this phase, kaizen will be implemented for improving continuously.

5. RESULTS AND DISCUSSION

The result in total loss of hours is compared with before and after the implementation of Total Productive maintenance from January 2016 to November 2016. The comparisons of the results are shown in Table -10 and in chart 3.

Table -10: Comparison of total loss

Before implementation 2016		After implementation 2016	
Month	**Total loss in hrs**	**Month**	**Total loss in hrs**
January	79	July	91
February	117	August	85
March	87	September	80
April	109	October	77
May	85	November	75
June	88		

The table -10 shows there is slow reduction of breakdown hours

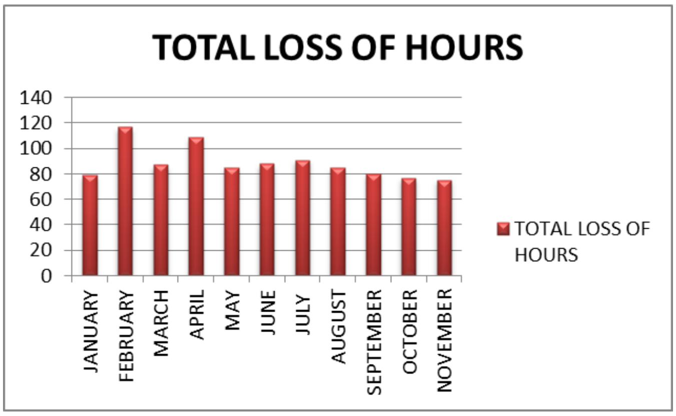

Chart -3: Total loss of hours

Reduction of breakdown time in the sand plant is compared in the table -11 and pictorial representation is shown in chart -4.

Table -11: Comparison of breakdowntime

S.NO	BREAKDOWN	BEFORE IMPLEMENTATION	AFTER IMPLEMENTATION
1	Bucket elevator	720	385
2	Mixer wheel	1080	505
3	Cleaning	80	60
4	Underground sand spillage cleaning	110	40
5	Belt contractor failure	80	65
6	Sensor failure	160	70
7	Low water level	50	29
8	Distribution belt	55	50
	TOTAL MINS	**2335**	**1204**
	Total hrs	**39**	**20**

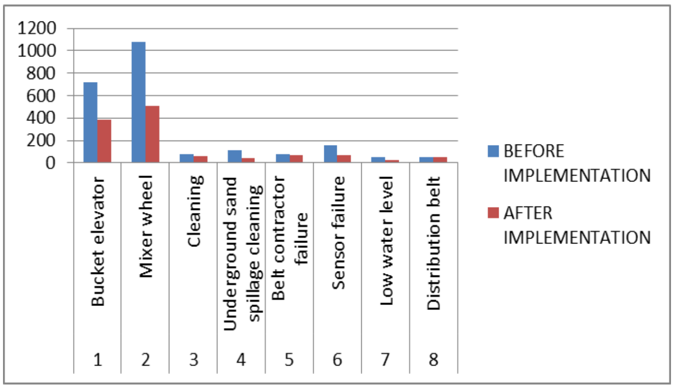

Chart -4: comparison of breakdown time

The chart -5 shows the reduction of total hours in breakdown time before and after implementation.

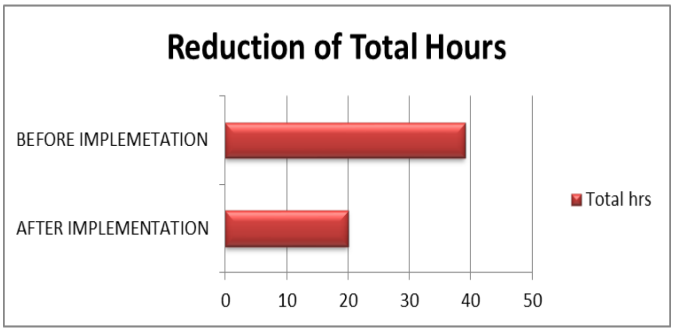

Chart -5: Reduction of total hours

The result obtained from the figure 7 shows that there is a reduction of 19 hours in the breakdown hours after implementing Total Productive Maintenance.

6. EFFECTIVENESS OF TPM

The effectiveness of TPM implementation is

- Development of autonomous maintenance.
- Development of planned maintenance.
- Reduction of breakdown hours in foundry
- A culture of operator's involvement in maintenance activities.
- Improving operator's morale and work place culture.

7. CONCLUSION

Thus Total Productive Maintenance is done for the breakdown time reduction. The breakdown hours is reduced to 20 % of the total breakdown hours that took place in the industry.

As a preventive measure a suggestion is given to the industry to develop an auto lubrication to the bearing and to develop a plate near sand filters which prevents the sand and dust to settle near the bearing.

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