Study of total productive maintenance & it's implementation approach in steel manufacturing industry: A case study of equipment wise breakdown analysis

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Abstract - *The purpose of this paper is implementation of total productive maintenance by performing machine wise breakdown analysis. A total productive maintenance (TPM) is a medical science of machine which improves the performance of maintenance activity, product and process quality, employee morale and job satisfaction. The study establishes that focused on section wise breakdown analysis, breakdown types wise and equipment wise breakdown analysis to avoid delay in manufacturing process.*

Key Words: **Total Productive Maintenance, TPM Pillar, Implementation, Overall Equipment Effectiveness, Autonomous preventive maintenance.**

1. INTRODUCTION

Total Productive maintenance is an expansion of lean manufacturing system. The goal of TPM is to optimize zero breakdown zero accident, and zero loss. If machine uptime is not predictable and then industry unable to produce velocity of sales. Therefore, a critical adjunct to assuring supply is a proactive system. With the help of proper training and autonomous preventive maintenance (PM), companies have been able to increase the *Overall equipment* effectiveness and to reduce the machine breakdowns. TPM is based on the permanent search for the improvement of the efficiency of the processes and the means of production, for a concrete and daily involvement of all the people who participate in the productive process. Zero defects, zero accidents, zero stops.

1.1 Need for breakdown analysis

In the steel manufacturing industry breakdown is a major issues which will indirectly affect the manufacturing process and the production delay occur. Machine breakdown has always contributed towards machine down time. Hence breakdown analysis methodology is suggested for improvement in manufacturing process. Through this analysis availability of machine increases maintenance cost decreases.

2. LITERATURE REVIEW

Wakjira, Melesse Workneh et al.[1] In this paper the author investigate manufacturing performance by reducing downtime and increases the overall equipment effectiveness. Manu Dogra et al.[2] discussed detail implementation of TPM in the cold rolling mill. Blanchard. B.S et al.[3] uses the enhanced approach for TPM implementation. Bamber,C.J sharp et al.[4] discussed factor affecting successful implementation of TPM in united Kingdom(UK) Manufacturing. By viewing the reason and factors, an organization will know where and how to pay attention while implementing TPM. Mehmet Emin Baysal, Mehmet Onur Sümbül et al. [5] evaluates overall resource effectiveness (ORE) in the insulation sector turkey. Abdul Talib Bon, Mandy Lim et al.[6] identifying issues and effectiveness for automotive industry and help to increase productivity of the company. Bupe. G. Mwanzaa, Charles Mbohwa[7] designing a model for effective implementation of in a chemical manufacturing company and identified the gaps in the maintenance system, determined the key performance indicators to be included his TPM model.

3. TPM Implementation road map:

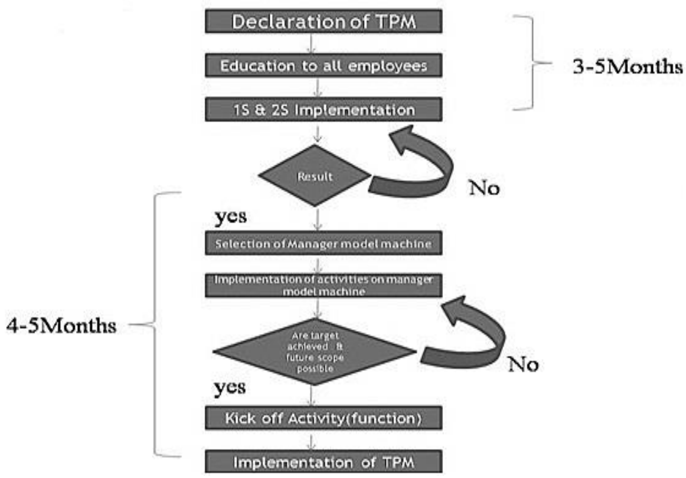


Fig -1: TPM implementation road map

In order to initiate the application of TPM concepts in plant maintenance activities, it is necessary for workers to find out that the management of the highest level has a serious commitment to the program.

Implementation Step:

STEP1: Declaration of TPM

The first step in this effort is to declaration of TPM. The entire edifice of TPM is built and stand, on eight pillars (Sangameshwran & Jagannathan, 2002).

STEP2: Education of employees

It is aimed to skilled employee through proper training whose morale is high and who has eager to work and perform the required function effectively and independently.

STEP3: 1S and 2S implementation

Eliminating unnecessary item from the work place and Keeping parts / accessories in the allocated place.

STEP4: Selection of manager model machine

After implementation of 1S and 2S. On the basis of their cost and their efficiency. A manager model machine is selected for the implementation of of TPM. If the machine efficiently perform and target achieved then we implement to all machine in the entire plant if target not achieve then Implementation continued by CLIT (cleaning , lubrication, inspection & tightening).

4. PILLARS OF TOTAL PRODUCTIVE MAINTENANCE

The Japan Institute of plant maintenance propose the introduction of TPM program. The TPM initiatives classified in to eight TPM pillars to optimize plant and equipment efficiency such as Jishu Hozen; Kobetsu Kaizen; Planned Maintenance; Quality Maintenance; Education & Training; Initial Flow Control; Office TPM; Safety health & environment.(Ireland & Dale,2001;Shamsuddin et al., 2005; Rodrigues & Hatakeyama,2006).

PILLAR1-JISHU HOZEN (JH)

This is a unique seven-step methodology which converts the operator (in small manageable steps) into a maintenance man who can take care of his machines basic required maintenance. The touch and feel of the machine and its parts helps in creating the bond between the operator and the machine. This converts him from operator to a care taker of the machine. Because operator knows maximum about the machine or equipment without any doubt these are not qualified engineer, experienced fitter but the operator who operates the machine knows maximum about the machine.

AIM:-

1. To avoid uninterrupted operation of equipment or machine by maintaining four basic condition ie; cleaning, lubrication, inspection & tightening.
2. Qualified operators to operate the machine or equipment.
3. Eliminating the defects at source through active employee participation.
4. Stepwise implementation of JH activites.

There are following seven basic steps for jishu hozen:

STEP1: Initial cleaning

It helps in identifying the abnormalities on the machines. Through Initial cleaning of the machine reduces potential future breakdowns. Tags are put on the wherever abnormalities observed, then analysis and on the based upon analysis action is taken to prevent the abnormalities. Identifying the fuguai for maintaining the machine neat and clean so that the abnormalities can be checked for its recurrence again. Hence, operators are responsible to clean up the machines to prevent it from force deterioration.

Table -1: Types of Fuguai

Types of Fuguai or defects		
Classification	Category Name	Example
A	Near Miss situation(safety related)	Safety guard missing
B	Item not kept at their designated place	Unwanted items
C	Force deterioration	Nut, bolt missing
D	Component not able to full fill it's specific function	Pressure regulator not working
E	Not user friendly	Cable not properly dressed
F	Hard to access area	Hard to clean, Hard to lubricate

STEP 2: Counter measures against the sources of contamination and hard to access areas

The contaminating sources from where dust, oils comes and mixed with the other lubricant or dust creates the abnormalities in the machine which leads to future breakdown. The identification of these sources (coolants, lubricants etc, are necessary and cannot be eliminated; but needs to be contained), by analyzing them and taking action such as implementation of localized guards, Open-close window not only helps in maintaining the machine neat and clean but also makes many of the accessible parts accessible for cleaning, inspection, lubrication and tightening of loosened parts (this is implementation of basic maintenance required which is often missed out leading to numerous breakdowns).

STEP 3: Implementation of tentative standards

Tentative standards are created with the help of maintenance personal, operates, qualified engineers, experienced fitters. Monitored by operators to ensures that these abnormalities do not creep up again.

STEP 4: General inspection

Only the trained operator performs inspection on the sub systems of the machines such as pneumatic, lubrication system, fasteners, etc, so that abnormalities specific to the operation are easily identified, analysed and addressed.

STEP 5: Autonomous inspection

A check list is prepared so that inexperienced personal can also perform the same job independently as per check list. The purpose of autonomous inspection is to implement visual control and take measure to prevent careless error.

STEP 6: Standardization

The purpose of this step is to review the operator's role, improve all activities is being carried out, also improve maintenance and control of autonomous inspection and established a system. Implement standards and visual control check point of the equipment at workplace.

STEP 7: Autonomous Management

A machine on which these activites are carried out, will never ever perform breakdown due to force deterioration. Autonomous management activity not only prevent breakdown but also strive for zero failure, zero defects.

PILLAR 2- Kobetsu Kaizen(KK)

Kai" means change, and "Zen" means good (for the better) means Continuous Improvement. In which a small group of employee work together for improvement of the machine in terms of productivity, Quality, Cost, Safety, Delivery and morale.

The aims of this pillar to avoid 16 chronic loss.

Kobetsu Kaizen activities try to eliminate 16 chronic loss. The basis of these activities is to enhance and demonstrate the technological, analytical and KAIZEN.

AIM:- To reduce all 16 losses of a plant to zero level.

Table -2: 16 Chronic Loss

S.No	Losses	Category
1	Failure losses – Breakdown loss	Losses that impede equipment efficiency
2	Setup/adjustment losses	
3	Cutting blade loss	
4	Startup loss	
5	Minor stoppage/Idling loss	
6	Speed loss – operating at low speeds	
7	Defect/rework loss	
8	Scheduled downtime loss	
9	Management loss	Losses that impede Human work efficiency
10	Operating loss	
11	Line organization loss	
12	Logistic loss	
13	Measurement and adjustment loss	
14	Energy loss	Losses that impede Production resources
15	Die, Jig and tool breakage loss	
16	Yield loss	

PILLAR 3- Planned Maintenance (PM)

This pillar significantly reduces instances of unplanned down time when the equipment is in shut down we enable most of activities during this period . This is schedule based maintenance to measure failure rate.

Six big losses identified in TPM field are

- Breakdown losses
- Set-up and adjustment losses
- Minor Idling stoppage losses
- Reduced speed losses
- Defect Rework losses
- Start-up losses

PILLAR 4- Quality Maintenance(QM)

In order to construct this pillar, the Industry inculcates the culture of zero defect/Non conformity philosophy and specifically quality issues with improvement projects focused on removing root sources of defects.

PILLAR 5- Initial Flow Control(IFC)

In this pillar we construct a MP sheet or maintenance prevention sheet as well as life cycle casting(LCC) sheet. On the basis LCC sheet Industry purchase the equipment.

PILLAR 6- Office TPM (OTPM)

This pillar started after achieving four other pillars (JH, KK, QM, PM). This pillars extends benefit in administrative function (eg:-Order processing, procurement, scheduling). This technique is applied to reduced waste.

PILLAR 7- Education &Training(E&T)

An education is not how much to memorize or how much to know It is being able to differentiate between knowing-how and knowing-why. It is not sufficient to knowing –how they should also learn knowing why Hence training provided for employee to work in multi direction. And easily perform their job.

PILLAR 8- Safety, Health & Environment (SHE)

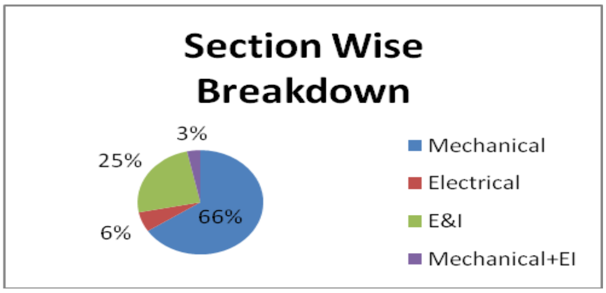
Safety is the maintenance of peace of mind, The basic purpose of SHE is zero accident, zero health damage zero pollution so that human being work in the industry with peace of mind, They should have hygienic environment.

5. CASE STUDY

A case study has been conducted in one of the leading manufacturing of Structural steel mill. The study conducted 6months to identify section wise, type wise and the particular equipment in which maximum breakdown occur .

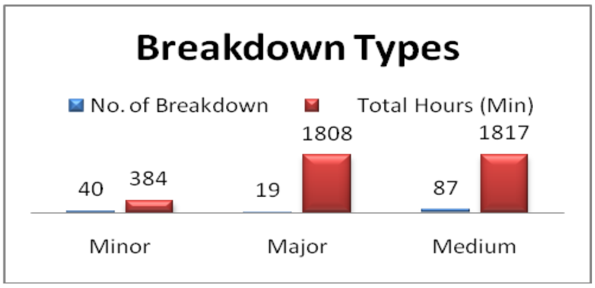
i) Section wise breakdown analysis

Section	No. of Breakdowns	Percentage(%)
Mechanical	96	65.75
Electrical	9	6.16
E&I	36	24.66
Mechanical+EI	5	3.42
	146	



ii) Type wise breakdown analysis
Minor(≤10 min), Major(≥20min), (10≤20min)

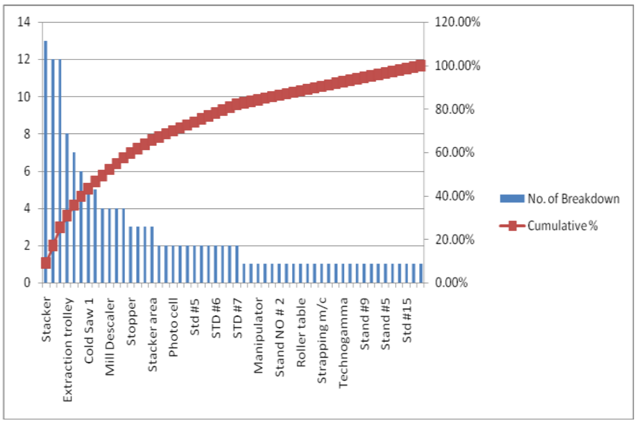
Types	No. of Breakdown	Total Hours (Min)
Minor	40	384
Major	19	1808
Medium	87	1817
	146	4009



iii) Equipment wise breakdown analysis

Name of Machine	No. of Breakdown	Breakdown Hours(Min)
Stacker	13	299
Cooling Bed	12	247
Cold saw-2	12	398
Extraction trolley	8	184
Cold saw-1	7	211
Layer Chain transfer	6	107
Cold Saw 1	5	136
Cold saw	5	104
Straightener	4	139
Mill Descaler	4	96
Cold Saw-2	4	62
STD #9	4	85
Stopper	3	52
SAW 2 Exit roller table	3	123
Furnace	3	65

Stacker area	3	57
Cold Saw 2 Wheel stopper	2	27
Secondary Descaler	2	20
Photo cell	2	10
Bend metal	2	16
RHF Hydraulics	2	30
Std #5	2	48
Finishing area	2	36
Std #14	2	31
STD #6	2	60
RHF	2	30
STD #8	2	35
STD #7	2	708
Billet Centring system in Furnace	1	32
Cold Saw 2	1	8
Manipulator	1	15
Lifting aprons	1	5
Communication Fault in Mill	1	85
Stand NO # 2	1	25
Stand NO #13	1	25
Stand NO # 1	1	8
Roller table	1	5
Main Descaler	1	11
Camera	1	15
Strapping m/c	1	22
Stand #15	1	24
Cold saw Descaler	1	25
Technogamma	1	23
RHF Exit RT	1	11
Stand#2	1	10
Stand #9	1	25
Wheel Stopper	1	15
Stand #4	1	21
Stand #5	1	26
Cold Saw#1	1	100
Std # 9	1	15
Std #15	1	12
Std #4	1	20
Mill Area LCS	1	10
	146	**4009**



6. RESULT & CONCLUSION

In this case study 6 months breakdown analysis has been performed and observed during 6 months total 146 Nos of breakdown occur maximum 66% breakdown occur in Mechanical section ie;96 breakdown out of 146. Also observed that in medium type maximum 87 Nos breakdown occur whose total hours(min) 1817 min and in equipment stacker maximum 13Nos breakdown occur whose total breakdown hours(min) 299. Hence we finally conclude that equipment wise ie; Stacker, Cooling bed, Cold saw-2 having maximum breakdown occur So, Corrective Action & Preventive action (CAPA) must require in this particular equipment to accomplishing TPM goal.

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BIOGRAPHIES

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