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Evaluation of TPM initiatives in Industries: Case Study

Rishav Arora¹, Sanjeev Gupta², Akshay Sharma³, Amanish Sharma⁴, Shivanchal Sharma⁵

U.G. Student, Department of Mechanical Engineering, Government College of Engineering and Technology, Jammu,
J&K, India¹

HOD, Department of Mechanical Engineering, Government College of Engineering and Technology, Jammu,
J&K, India²

U.G. Student, Department of Mechanical Engineering, Government College of Engineering and Technology, Jammu,
J&K, India³

U.G. Student, Department of Mechanical Engineering, Government College of Engineering and Technology, Jammu,
J&K, India⁴

U.G. Student, Department of Mechanical Engineering, Government College of Engineering and Technology, Jammu,
J&K, India⁵

U.G. Student, Department of Mechanical Engineering, Government College of Engineering and Technology, Jammu,
J&K, India⁶

ABSTRACT: TPM is a method which encourages us in keeping up and enhancing creation framework through machine, process, and worker which increase the value of the association. TPM has been created to meet the new upkeep needs by keeping the gear in top condition in order to maintain a strategic distance from breakdown and postponement underway. This paper concentrating on figuring the general gear viability in Rolling Mill, and it additionally examine what called the enormous six misfortunes in any industry (the quality, accessibility and speed). A contextual analysis has been taken in the moving plant and the principle target of this is to think about the assembling procedure and the issue happens amid the creation procedure which causes stoppage. The information brought fifteen working days. Subsequent to figuring the OEE of the organization an outcome organization accomplished 93.48% in quality factor of general hardware viability condition and 70.90% in accessibility where in execution it got 90.03% and the outcome is contrasted and the World class OEE. Recommendation is given to organization to enhance their support strategies and enhance the profitability.

KEYWORDS : 5-S, Six Big Losses, TPM Pillar, Kaizen, JishuHozen, Benefits of TPM, Case study.

I. INTRODUCTION

In current assembling and administration businesses, enhanced nature of items and administrations progressively rely on the highlights and states of the association's gear and office. With a specific end goal to survive each industry needs to take a stab at enhancing efficiency in all circles of exercises. Thus it is intelligent to use the assets like apparatus, men, and material as ideally as could be allowed. Upkeep of offices and hardware in great working condition is basic to accomplish indicated level of value and unwavering quality and effective working. Plant upkeep is a critical administration capacity of a proficient creation framework. It helps in keeping up and expanding the operational productivity of plant offices and accordingly adds to income by diminishing the working expenses and expanding the viability of generation. TPM has been ended up being fruitful for expanding the efficiency and general gear adequacy.

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The ideas of TPM has been presented and created by Japanese in 1971. TPM is about Total plant Maintenance. The Underlying ideas are, whether you appropriately keep up plant apparatus there will see a sharp decrease in machine breakdowns, security and quality issues. There is rising need of TPM usage in the Indian business and need to create TPM Implementation practice and procedures. TPM ought to advance better group working in the working environment, as the administrator will enable the support to group with their assignment. The point of the TPM is to unite administration, bosses and exchange association individuals to make fast medicinal move as and when required. Thus, tpm can be considered as the medicinal study of machines.

Need of TPM in the contemporary Manufacturing scenario

The following as aspects necessitate implementing TPM in the contemporary manufacturing scenario;

- To become world class, satisfy global customers and achieve sustained organizational growth.
- To improve productivity and quality.
- To improve organizations works culture and mindset.
- To make the job simple and safer.
- Need to change and remain competitive.
- Need to critically monitor and regulate work-in-process of manufacturing process.
- Regulating inventory levels and production lead-times for realizing optimal equipment available time.
- Ensuring more effective use of human resource through adequate training and multi-skilling.
- Refining preventive and predictive maintenance activities.

II. LITERATURE REVIEW

Kathleen E. McKone et al. [1] In this paper the creator research the connection amongst TPM and assembling execution through basic Equation Modeling (SEM). Manu Dogra et al. [2] In this paper the creator talk about the detail execution of TPM neglected moving factory. Harsha G. Hegde et al.[3] The paper reports a contextual analysis for enhancing OEE with the assistance of TPM and 5s strategy utilizing an orderly approach .The outcome acquired from the TPM approach demonstrated that the OEE was enhanced from 43% to 72% which show the coveted level. Ranteshwar Singh et al. [4] In this paper the creator actualized a TPM procedure in the machine shop having a CNC turning of various limit and dispose of the misfortunes, enhance the use of CNC Machine. OEE is utilized to gauge accomplishment of TPM execution. Jihnasha P Acharya et al.[5] in this paper the creator display the writing survey of TPM and is utilized to take care of the assembling issue, this paper additionally clarify the outline of TPM column. NitishMundhada et al.[6] In this the analyst utilizes a lean which point is to diagnosing the generation procedure , expelling/decreasing procedure squander , cleaning the creation condition , enhancing plant format and association workstation by utilizing a 5s. SarangKatkamwar et al.[7] In this the creator study and review of TPM usage in Indian turning Industries and utilizations a JH-check sheet, PM-Check Sheet, OPL to enhance the OEE and legitimate execution of TPM. Ajit buddy singh ,MelesseWakajiran et al.[8] this the creator center around critical commitment of TPM execution process and furthermore center around the TPM column for progress and furthermore it did a contextual analysis in control plant industry to discover the OEE when TPM and is contrasted and world principles. Prof. pradeep Kumar et al.[9] In this a specialist utilizes a TPM strategy which went for amplifying the viability of office and furthermore completed an effective execution of work writing audits was done and conveyed an investigation at printing press machine and bundling in light of continuous information and examination was done to acquire achievable outcomes and ascertain OEE and take care of issue to builds OEE. G .Ananth, DR. B.K Vinayagam et al.[10] In this scientist point is to augment the accessibility and Overall Equipment viability of the steam power and warm productivity of a plant by actualizing of TPM. Mr. ranjeet M. Jadhav et al.[11] In this the analyst ponder the execution of TPM program in an Indian history utilizing JH Check sheet , PM Check sheet , OPL for appropriate usage of the TPM and in the wake of actualizing both immediate and roundabout advantages are appeared. Osama Taisir R. Almeanazel et al.[12] In this a group is shaped to discover the advantages of development of a group from various dept. To dispose of any limits between a dept. what's more, influence support to process all the more viably and furthermore receive the independent upkeep and furthermore propose to execute TPM to enhance their support method and

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efficiency after estimation of the OEE. I.P.S Ahuja et al.[13] The reason for this paper is to survey the writing on TPM usage honed embraced by the assembling association. It likewise center looks to progress factors for dispensing with boundary in fruitful TPM usage.

Types of Maintenance

1. **Planned Maintenance** - It is a composed upkeep work completed according to recorded techniques having control.
2. **Breakdown Maintenance** - It is a crisis based approach in which the plant or gear is worked until the point that it bombs and afterward it is brought once again into running condition by repair. The upkeep staffs find any mechanical, electrical or some other blame to adjust it instantly.
3. **Corrective Maintenance** - This is a composed support work planned to reestablish a fizzled unit. It incorporates distinctive sorts of activity like normal changes in accordance with upgrade of types of gear. It is a one time work and every restorative upkeep movement attempted ought to be finished completely. Every remedial support employment may vary from the other. The accentuation in restorative support is on getting full data of all breakdowns and their causes. Endeavors are made to distinguish and take out the reason by exercises, for example, enhancing support works on, changing recurrence of systems for upkeeps benefits and enhancing process control strategies.
4. **Opportunistic Maintenance** - At the point when a hardware or framework is brought down for support of one or few worn parts, the open door can be used for changing/keeping up different parts which are destroying despite the fact that they have not yet fizzled.
5. **Routine upkeep** - It is a least complex type of arranged support, which is extremely basic. Routine support implies completing minor upkeep occupations at general interims. It includes minor employments, for example, cleaning, oil, investigation and minor change.
6. **Preventive Maintenance** - Preventive support is an arranged upkeep of plants and types of gear keeping in mind the end goal to avert or limit the breakdown.
7. **Predictive Maintenance** - Predictive Maintenance as the name infers just means foreseeing the disappointment before it happens, distinguishing the underlying drivers for those disappointments side effects and disposing of that reason before they result in broad harm of the hardware.
8. **Condition based upkeep** - In this technique, the state of the hardware or some basic parts of the gear are ceaselessly observed utilizing refined checking instruments with the goal that disappointment might be anticipated well before it happens and restorative advances are taken to avert disappointment.
9. **Reliability Centered Maintenance** - It is a process to ensure that assets continue to do what their users require in their present operating context. It is generally used to achieve improvement in fields such as the establishment of safe minimum levels of maintenance, change in operating procedures and strategies and establishment of capitals maintenance regimes and plans. Successful implementation of RCM will lead to increase in cost effectiveness, machine uptime, and a greater understating of level of risk that the organization is managing.
10. **Design-out Maintenance** - It is a plan situated therapeutic implies went for correcting an outline imperfection began from uncalled for strategy for establishment or poor selection of materials and so forth. It require the solid plan and support interface.

Six Big losses

One of the real objectives of TPM and OEE programs is to decrease or potentially dispose of what are known as the Six Big Losses – the most well-known reasons for proficiency misfortune in assembling. Following are the six major misfortunes which happens amid the creation procedure which are as per the following, Breakdown losses: -

1. This kind of misfortunes is happens because of the disappointment of parts, which causes stop of generation.
2. Setup and adjustment losses: - This kind of misfortunes happens amid to change underway process, for example, change of segment, change working condition, beginning of various move, change of item.
3. Minor stoppages losses: - Minor stoppage happens because of sticking, machine sitting.
4. Speed losses: - These misfortunes are because of diminishment in speed of the gear.
5. Quality defect and rework losses: - These misfortunes are because of the deficient item delivered amid the

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generation procedure and in this way modify must be done to expel the deformities.

TPM Pillars

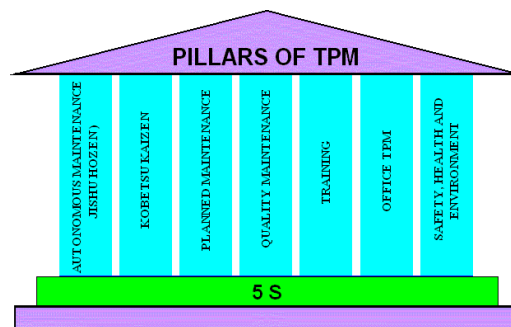


Figure 1:- Shows the TPM Eight Pillar

Pillar 1

5S:- It's an efficient procedure of housekeeping to accomplish a decent situation or a perfect and clear in the work environment. Following are the part of 5s.

Terms	Features
Sort	Sort out unnecessary items from the shop floor and remove them.
Set in order	Arrange necessary items in good order so that they can be easily picked up for use.
Shine and check	Clean the workplace completely to make it free from dust.
Standardize	Maintain high standard of work place.
Sustain	Train and motivate people to follow good housekeeping disciplines autonomously.

PILLAR 2 Autonomous Maintenance

Independent Maintenance implies keep up one's own particular gear by one self. In this the administrator are dependable to upkeep their gear on regular routine to keep it from disintegrating. The variations from the norm are dispensed with by utilizing the method, for example, irregularity sheet, CLITA, OPL, Inspection, and Lubrication Sheets.

PILLAR 3- Planned Maintenance

This column pointed toward to have an inconvenience free machine and types of gear for enhancing the dependability and practicality and furthermore for add up to consumer loyalty for the items.

Benefits:

- Optimum upkeep cost.
- Reduce saves stock.
- Improve Reliability and viability

PILLAR 3 Kaizen

In this KAI signifies "change" and ZEN signifies "great". For the most part kaizen is for little change and it includes all individuals from the association. The rule behind kaizen is that "an expansive number of little change is more powerful in an association than a couple of change of vast esteem.

PILLAR 4 – Quality Maintenance

This column pointed toward accomplishing the client necessity through most elevated Quality through deformity free assembling through centered change, imperfection the procedure in the wake of recognizing the parameters of machine which essentially influence the items. Progress is from Quality control to Quality Assurance.

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PILLAR 5- Training and education

This column pointed toward creating multiskill representatives whose confidence is high and who has anxious to come to work and play out all required capacity adequately. In this an administrator is teach according to required. With the goal that he/she will have the capacity to take care of the issue.

PILLAR 6- Office TPM

This column ought to be begun after its effective enacting of four mainstay of tpm which are JH, KK, QM, PM office tpm must be taken after to enhance profitability and productivity of the authoritative capacities. Due dissecting procedure and methodology towards expanding in the workplace computerization.

PILLAR 7- Safety, Health and Environment

This column centers towards to make a protected work environment and an encompassing zone with the goal that our procedure does not harmed that zone.

III. IMPLEMENTATIONSTEPS

- Step 1. Announcement of TPM-Top administration needs to make a situation that will bolster the presentation of TPM..Step 2. Launch a formal Education Program-This program will illuminate and teach everybody in the association.
- Step 3. Create an Organizational help structure-This gathering will advance and manage TPM exercises once they started and incorporate individuals from each level of the association.
- Step 4. Establish fundamental TPM arrangements and quantifiable objectives Analyze the current conditions and set objectives that are particular, Measurable, Attainable, Realistic and Time-based.
- Step 5. Outline a point by point ace sending design This arrangement will recognize what assets will be required and when for preparing, gear reclamation and changes, upkeep administration framework and new advancements.
- Step 6. TPM commence Implementation will start at this stage.
- Step 7. Improve the viability of each bit of hardware Project groups will investigate each bit of gear and make important change.
- Step 8. Develop a self-governing support program for administrators Operators routine cleaning and investigation will help balance out conditions and stop quickened disintegration.
- Step 9. Develop a preventive support program-make a calendar for preventive upkeep on each bit of gear.
- Step 10. Conduct preparing to enhance task and upkeep aptitudes The support office will go up against the part of instructors and advisers for give preparing, guidance and hardware data to the groups.
- Step 11. Develop an early hardware administration program-Apply preventive upkeep standards amid the plan procedure of gear.
- Step 12. Continuous change As in any lean activity, the association needs to build up a consistent change attitude.

OVERALL EQUIPMENTEFFICIENCY

TPM utilizes OEE as a quantitative metric for estimating the execution of a beneficial framework. OEE is a center metric for estimating the achievement of TPM usage program. The general objective of TPM is to raise the general gear efficiency.OEE is figured by getting the result of accessibility of the hardware, execution proficiency of the procedure and rate of value items.

Overall Equipment Efficiency = Availability x Performance efficiency x Rate of Quality. Where,

Availability: - Available Time required to produce a finish product.

Availability = (Required availability – Downtime) / (Required availability) *100.

Performance: - It can be defined as the design cycle time to produce the item multiply by the output of the equipment and then divided by the operating time.

Performance = (design cycle time*output)/ (operating time)*100 Quality = It is the ratio of production output to the

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production input. $Quality = output/input$.

IV. BENEFITS OF TOTAL PRODUCTIVEMAINTENANCE

1. Productivity Improvement - Productivity is improved through fewer losses in the company.
2. Quality Improvement - Quality is improved as a result, that the failures and malfunctions is reduced.
3. Cost Reduction – The cost is reduced because the losses and other not value added work is reduced.
4. Employee Ownership - Ownership of equipment by operators through Autonomous Maintenance
5. Employee Confidence - "Zero failure", "zero defect" and "zero accident" conditions builds employees self-confidence.
6. Improved working environment - Clean working conditions provides a good working environment.
7. Increased Plant Reliability.
8. Customer Satisfaction - TPM leads to high delivery performance and customer satisfaction.

V. A CASE STUDY

A relevant examination has been coordinated in one of the primary gathering of the TMT Bar in the Rolling processing plant industry. The association is a joined plant with an office to make Sponge Iron, Power, Billet and Structural Steel (TMT Bars). It is the considerable scale industry which has set up introduce day creation workplaces to meet the customer necessities for quality fundamental. (Thermo Mechanically Treated) TMT block is taken off in a champion among the most present day and totally modified Rolling Mills and further arranged on the planet's illustrated "Thermex®" development. The Thermex® TMT process incorporates 3 periods of treatment for giving the preferred quality over the ribbed bars - Quenching, Self-solidifying and Atmospheric Cooling. The examination drove along the 15 days, the association produces various size of TMT bar and uses particular size of billet as per need. Finally, the purpose of this logical examination is to measure the general apparatus adequacy of the association and find the bottleneck which causes stoppage of creation. There are a segment of the standard from the business:

- a) Three shift each shift eight hours and timing per shift is shift A 6:00-2:00, shift B 2:00-10:00, shift C 20:00-6:00
- b) The target for production of TMT Bar for each day is 400 ton and for each shift is equal to 133.33 tons.
- c) The product time process, the production line can operate at speed of 16.75 tons per hour, this speed is theoretical speed.

Problem Identify

Major industry losses were identify which are shut down, production adjustment, equipment failure, process failure, normal production loss, abnormal production loss, quality defect and reprocessing. Following are some of the losses listed which occurs during the production process:

1. Miss roll of TMT Bar.
2. Cooling Bedjam.
3. Tool break of crop and cobble shears system.
4. Jamming of material in the furnace.
5. Reduction Gear Box Problem (due to, oil contamination, low oil level, teeth damage).
6. Section change problem.
7. Wear of Roller.
8. Ejector jam.
9. Sprocket and chain fails.
10. V belts fail.
11. Pulley.
12. Guiding and transportation system.

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VI. DATA COLLECTION

Table A: - The Total Downtime and the amount of Scrap, Batch size and production/day for 15 operating days in the March 2014

DAYS	DOWNTIME (MIN)	SCRAP (TON)	BATCHSIZE (TON)	PRODUCTION/DAY(TON)
1	300	16.34	344.55	328.21
2	240	17.67	364.59	346.92
3	300	17	348.98	331.68
4	420	12.3	172.49	160.19
5	540	15.79	238.83	223.04
6	360	19.14	315.66	296.52
7	240	16.71	357.59	340.88
8	510	16.44	287.73	271.29
9	765	11.31	231.36	220.05
10	300	16.7	255.88	239.18
11	750	15.19	252.84	237.65
12	390	56.07	215.46	159.39
13	75	3.95	74.55	70.6
14	450	15.81	319.28	303.47
15	260	19.07	359.05	339.98

Table B: - Shows the Summation of Downtime, Scrap, Batch size, Production/day of all 15 operating days

TOTAL DOWNTIME (MIN)	5900
TOTAL SCRAP (TON)	269.49
TOTAL BATCH SIZE (TON)	4138.54
PRODUCTION (TON)	3869.05

In Table A the data taken direct from the production line for shift A , shift B and shift C, the batch size is the amount of tons the company starts the production with, the amount of scrap is the amount of defective steel caused by breakdown or malfunction failure. The Table B shows the summation of the Down time, Scrap , Batch size, Production/day of all 15 operating days.

VII. CALCULATING THE OVERALL EQUIPMENT EFFICIENCY

In the wake of gathering the information, we expected to gauge the OEE which will gives a sign of where we may discover the mistake or the shortcoming point. The investigation was taking amid 15 days in FEB 2018 all the days was typical working days in light of the fact that there is no occasion consider.

As there are 3 shifts/day with 8 working hours per shift

There was a stoppage of 30 min for each shift, which gives in total 22.30 hours , $360-22.30=337.30$ hours Therefore,
Available operating time = 15 days * 3 shift/day * 8 hours/shift = 360 hours.

As we know that the target for production of TMT Bar for each day is 400 ton and for each shift is equal to 133.33 tons.

Availability factors

Now the total time needed to produce the whole batch for 15 days is

= (available operating time – downtime)

= $337.30-98.33$

= 239.17hours

Therefore, the valuable operating time is 239.17 hours.

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Availability = valuable operating time / available operating time
= 239.17/ 337.30
= 0.7090
Availability factor =70.90%

Performance factors

To calculate this we need to main factors Designed cycle time = 17.77 ton / hour Total output = 3869.05 ton

Performance rate = [(design cycle time*output) / operating time]
= [(60 min / 17.77 ton)*3869.05] / (239.17*60)
= 0.9103
Performance factors = 91.03 %

Quality factors

For calculating the quality factors we need Total amount of defect = 269.49 ton
Production input i.e. Total batch size = 4138.54 ton

Quality rate = (production input – quality defects) / (production input)
= (4138.54 – 269.49) / (4138.54)
= 0.9348

Quality rate = 93.48 %

The Overall equipment effectiveness

OEE= Availability*Performance rate*Quality rate
= 0.7090*0.9103*0.9348
= 0.6033

Therefore, the Overall equipment effectiveness of Rolling Mill is 60.33 %

VIII. COMPARISON OF OEE WITH WORLDCLASS

Its can seen from the table C that the performance of the company as overall equipment effectiveness is 60.33%, where the availability of the line was 70.90% of the production time and the performance was 91.03% while the quality factor is 93.48%.

Table C: - Shows the comparison between WCM and the company

	OEE Company	OEE world class
Availability	70.90%	90%
Performance	91.03%	95%
Quality	93.48%	99%

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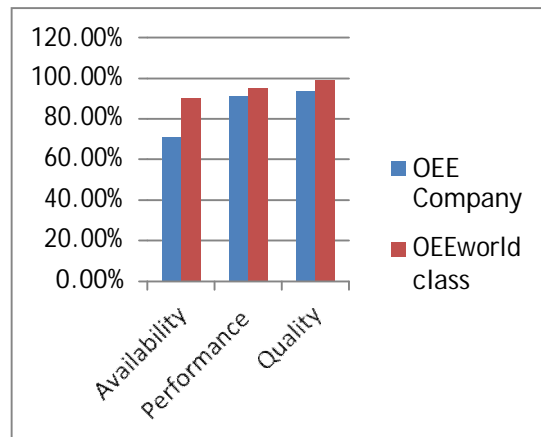


Figure 2:-shows the comparison between the OEE of company and the World standard

IX. SUGGESTION

- By Implementing the TPM strategy we can eliminate most of the waste.
- Operator should be skilled in their particular working area, so Training the operator is very much important.
- Launch of Reliability Centered Maintenance:- In this, the operator will gain the knowledge about the machine in the rolling mill, if any failure occurs he would know how to repair that machine.
- There should be flexibility in pinch roll machine, so that miss guide of the billet is reduced.
- Proper setup and adjustment of the section change is needed. For this, a good Engineer along with the worker who do this job is needed for proper guiding of each activity.
- There should be proper linearity in the guiding system i.e. through which the hot billet is passed if this done properly then the problem of the miss roll is minimized and automatically the breakdown is reduced and the efficiency of the plant is increased.
- As the section changes according to the customer order for (8, 10, 12, 20, 32mm) this should be minimized by producing bar and kept in stock so that no disturbance will occur in the system and if this is done a downtime is also reduced to some extent.

X. CONCLUSIONS

- A Manufacturing Process and the Resources available for producing TMT Bar have been studied and also the breakdown such as mechanical, electrical and other which occur during operation have been analyzed.
- From the calculation of overall equipment effectiveness it is seen that the performance of the Rolling Mill comes to be 60.33% in which the availability of the line is 70.90% of the production time and the performance rate is 91.03% while the quality rate comes to be 93.48%.
- When this i.e. (A, P, Q) of the Rolling Mill is compared with the World Class Measurement it comes to be very less, According to the World Class Manufacturing OEE should be 85% and the Rolling Mill Equipment Efficiency is reduced by 25%.
- Therefore it is necessary / very much important to implement the TPM in Rolling Mill so as to improve the productivity and Efficiency of the Equipment of the Rolling Mill by eliminating most of the waste.

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