TAF
Journal of Advances in Technology and Engineering Research
JATER
2021, 7(2): 27-38

Check for updates

PRIMARY RESEARCH

Implementation of total productive maintenance methodologies on a textile industry

Safi Ur Rehman [1], Muhammad Asif [2], Asad A. Zaidi [3*]
[1, 2, 3] National University of Sciences and Technology (NUST), Islamabad, Pakistan

Keywords
Laser coloring
Stainless steel
TPM
Autonomous maintenance
Textile industry
Fish bone analysis

Abstract
The quality of any product is closely associated with maintenance strategies of any industry. Total Productive maintenance is a unique tool to enhance the performance of a manufacturing industry by producing quality product due to reduced downtime. The purpose of this paper is to evaluate the output results of implementing Total Productive Maintenance techniques in a Yunus Textile Mill industry. Effectiveness of TPM implementation is validated and evaluated through Overall Equipment Efficiency. The study proved that the company has strong potential to enhance its performance and overall product quality through successful implementation of TPM methodologies.

Received: 03 August 2021
Accepted: 14 October 2021
Published: 18 December 2021

I. INTRODUCTION

A. *Total Productive Maintenance*

To strive better and ace the competition in the industrial world, organizations are forced to produce cost effective and quality products which forces them to adopt superior production process and maintenance regimes in order to keep their plants running at full capacity therefore increasing productivity at reduced cost. Increased production leads to increased maintenance cycle as organization's product cost also variates due to plant maintenance as it plays an important role and contributes to 15-60% of manufacturing cost [1]. As per globally published literature it is evident that due to poor maintenance, the downtime of equipment has increased which as effected both productivity and quality of the product of an organization, thus pushing it over the edge in this competitive world. Therefore, in order to meet customers heightened demands and expectations, drastic changes have been adopted in management regimes, product and process technologies because the competition has led the manufacturing industries to experience an unprecedented degree of change, forcing them to improve at a much faster rate in every aspect in order to keep leading in the industrial sector. So in order to achieve desired goals, manufacturing organizations are forced to adopt new manufacturing philosophies which will improve Overall Equipment Effectiveness OEE that is derived from availability and performance of equipment. One of the widely adopted approach is called Total Productive Maintenance TPM, which is innovative, effective and has been recognized as a new manufacturing model ever since [2, 3]. The concept of TPM was laid down by Seiichi Nakajima of M/S Nippon Denso Co. that actually was a spare part supplier to M/S Toyota Motor Company LTD, in Japan 1971. It's a distinctive Japanese philosophy that was developed on the basis of maintenance concepts and methodologies that helps to optimize equipment efficacy, reduces or eliminates machinery breakdowns and promotes autonomous maintenance that actually involves operators to carry out daily maintenance routines which also put their knowledge to test [4, 5].

*Corresponding author: Asad A. Zaidi
†email: asadali@pnec.nust.edu.pk

B. TPM A 'Necessity'

In the modern manufacturing setup implementation of TPM has been essential component of an organization based on following steps:

1. To be a world class organization that satisfies customers globally and achieve sustained growth.
2. To increase productivity and improve quality.
3. To train all employees thus improving organizational work culture and mindset.
4. To create a task/ job that is simpler and safer.
5. Keep a competitive behavior and if required then change.
6. Continuously monitor and regulate Need to critically monitor and regulate WIP of manufacturing process.
7. Regulate spare supportability therefore inventory levels and production lead-times for realizing prime equipment available time.
8. Professional training to be imparted on multiple forums and use human resource effectively through multi-skilling.
9. Refining preventive and predictive maintenance techniques.

C. TPM Eight Pillar Approach

The Total Productive Maintenance program basically helps to improve efficacy of equipment and processes by empowering operators, team leaders and mangers to apply proactive approach for maintenance. By laying 5S methodology (Sorting, Setting, Shining, Standardization and Sustaining) as foundation and after successful implementation of 8 Pillars of TPM, above mentioned targets/ goals can be archived. A case study will be discussed in which 3 pillars of TPM are implemented and its effect on OEE of the organization determined in the ensuing paragraphs [6].

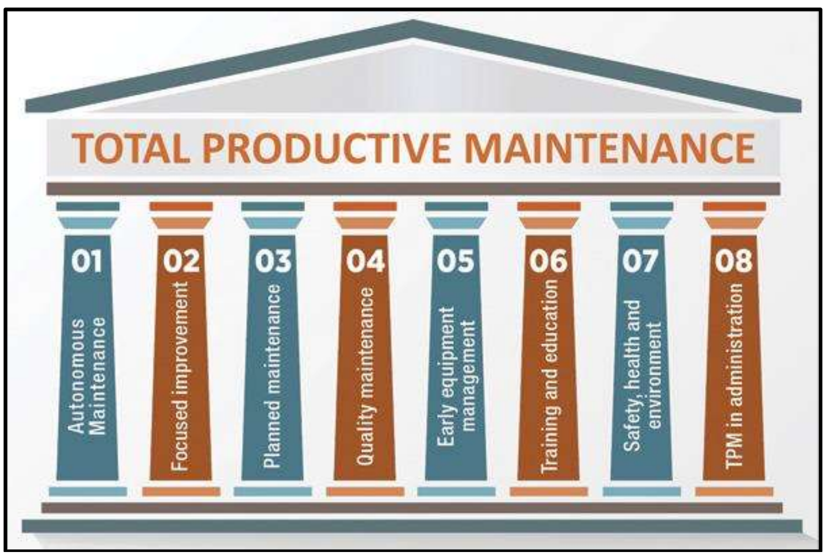


Fig. 1. Eight pillars of TPM

II. YUNUS TEXTILES – CASE STUDY

A. Yunus Brother Group

Established in 1962, Yunus Brother Group YBG has gained position as prominent business leader in Pakistan. The profile journey was started by forming the fabric trading business house, which later turned into one of the largest firms in Pakistan within a period of four decades. Since then, Yunus Brothers Group has successfully established numerous other business concerns in textiles, cement, construction, and power generation sectors and has proved its business standing in local and international markets by virtue of its exceptional triumphs. It proudly owns one of the largest cement manufacturing facility and the largest yarn manufacturing unit in the country—Yunus Brother Group has an annual turnover rate of 1.5 billion USD. Following the successful footsteps of its parent company, Yunus Textile Mills Limited started its operations in 1998 and within a short span of time frame the company has transformed itself from a basic bedding product supplier to a world's renowned supplier of Home Textile products to top tier brands across United States and Europe.

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

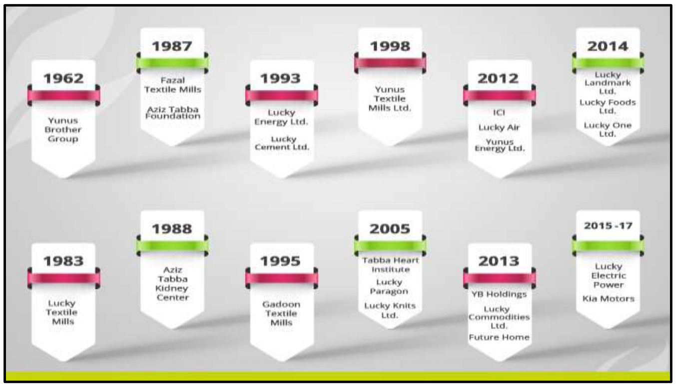


Fig. 2. YBG success profile

B. Yunus Textile Mills

Yunus Textile Mills is a part of Yunus Brothers Group. The 20 year history of the company is based on hard working labor and providing quality in Home Textile products. Since the beginning we have persistently worked to maintain a distinction among its competitors, transformed from basic bedding products to world renowned supplier. We are one of the largest vertically integrated textile setup in Pakistan. In a short duration, we became the leading player in each product segment in which it operates and contributes 13% of total export share of Pakistan's home textile. From market intelligence, product concept, design, production, to supply chain management categories, we are providing end to end product manufacturing solutions. With the help of our customer, we are widening product range and customer portfolio. Our global subsidiaries are present in USA and France. Yunus Textiles produce a wide variety of products which are as follows:

1. Sheet sets
2. Bed in bag
3. Comforters
4. Duvet Covers
5. Coverlets
6. Quilts
7. Decorative bedding
8. Curtains
9. Linens

C. Capabilities of Yunus Textiles

The Yunus Textiles is divided into 7 sections to form a quality product from wool to final embroidered fabric, brief description of their capabilities is as follows which are further explained in ensuing paragraphs:

1) Spinning: Currently installed capacity of 80,000 spindles. Sister companies' has 300,000 spindles.

2) Weaving: 384 Wider width Air jet and Sulzer looms producing 10 million meter per month.

3) Printing: 4 wider widths Reggiani rotary machines, 01 Reggiani Flatbed machine & 01 Durst Digital machine producing 5.0 million meters per month.

4) Dyeing: 2 wider width Thermosols, 1 Pad steam and dyeing Infra-Red Stenter machine, total output 4.0 million meters per month

5) Stitching: Capcity of 10 million meters per month. Manual and Automated Texpa Machine. They have both automated (Texpa) and manual machines for quality stitching.

6) Quilting: Total capacity of 200,000 pieces per month. 48 Machines (Single Needle) and 3 Machines (Multi Needle). Polyfil capacity of 15000kgs per day with 2 polyfil plants.

7) Embroidery: The embroidery department has 25 bourdon machines and 4 embroidery machines.

8) Power generation: Yunus Textile Mills has its own power generation unit that produces 14 megawatt through natural gas fired captive power generation plant, enough to meet all its electrical power requirements.

D. Spinning process

The process of spinning of natural fiber to yarn comprises of 7 steps and is described briefly in following steps [7]:

1) Bale management section: In this section, the raw fiber collected from farms is stocked at cotton plant and is processed to remove large particles such as soil, plant leaf and other impurities from the fiber. Finally, fiber bale is made and is a compressed lint after ginning which is tied with wire.

2) Blow room section: In this section, the compressed lint is further refined through a series of machines that pluck the cotton that laid down. Then the cotton is passed through rollers with spikes for separating any dust particles left, passed through hoppers to achieve homogeneity, then again passed through a series of rollers installed with light sensor to remove color contamination and for fiber sheets.

3) Carding section: The fiber sheet or lap is then passed through series of rollers of varying dias with spikes to remove entangles mass of fiber or short fiber to avoid pilling formation in future and form thick untwisted ropes of fiber called sliver.

4) Combing and draw section: In this section, the silver is passed through a series of rollers with rubber surfaces and are rotating at different RPMs. The first roller has low rpm as compared to the last, which is rotating at the highest rpm. This section produces more parallel, straight, uniform and even carded sliver called combed sliver.

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

5) Simplex/Speed frame: In this section, the combed sliver is fed to pimple machine in order to reduce linear density through creeling, drafting, twisting, winding, building and doffing. Main purpose to slightly increase the strength and produce low twist roving.

6) Ring frame: The roving is then hung on the ring frame and passed through a series of rollers just like in combing section but here the dia reduced from 1 cm to 1 mm (as per requirement) and is twisted at the end to increase the overall strength of the yarn produced.

7) Auto coner: The yarn is then fed to auto coners (SAURER Auto Coro) to wind the final product on cones of various sizes and lengths which is then supplied to the user in a single batch.

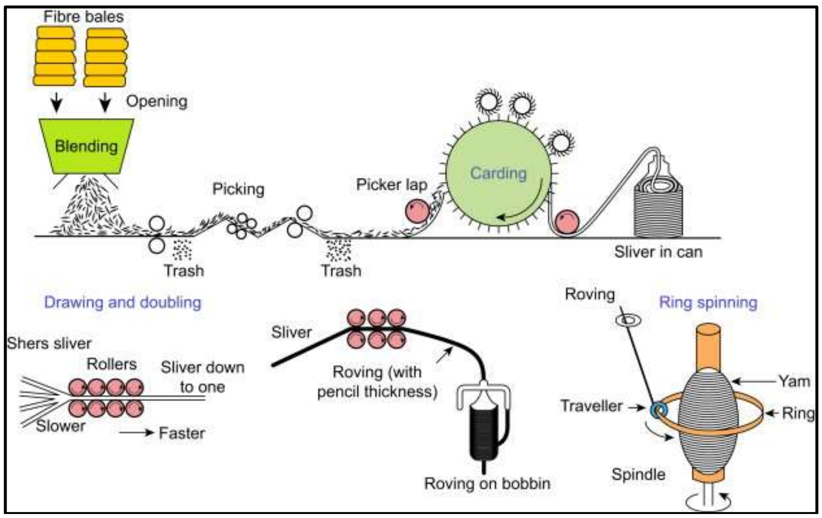


Fig. 3. Spinning process

III. MAINTENANCE STRATEGIES

A. *Current Maintence Plan*

Yunus Textile Mills's currently follows centralized maintenance plan comprising of three independent departments that overlook the overall maintenance of the equipment and machinery. Moreover humidity factor play an important role as it effects the strength, elasticity, weight produced and friction. Therefore it's necessary to maintain desired humidity levels in different sections through humidifiers and AC Plants in order to achieve quality product.

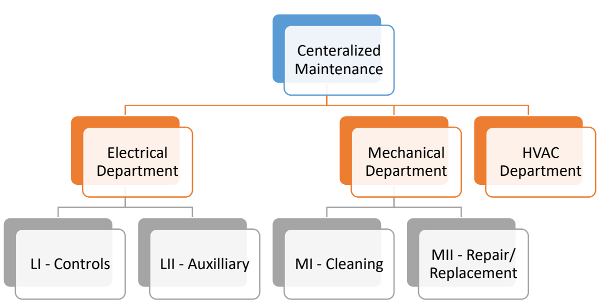


Fig. 4. Current management organization

These departments currently carry out two types of maintenance

1. Breakdown Maintenance

2. Preventive Maintenance

The above mentioned maintenance program is practiced when the equipment undergoes any breakdown or routine maintenance is being carried out. Therefore any oil change routine, cleaning routine, or any part replacement routine.

B. *Overall Equipment Effectiveness*

Overall Equipment Effectiveness is the strategic tool to monitor, evaluate and improve effectiveness of a manufacturing process through measuring the quality, availability and performance of any industry. OEE basically helps us to visualize and understand our manufacturing process therefore by quantifying and assessing all losses incurred during production or due to machinery [8, 9]. It not only gives a breakdown of what was produced from available resources but what we could have produced by understanding the true potential of our industries. The simplest formula to calculate OEE is as follows

OEE = Availability x Performance x Quality

Based on above mentioned maintenance program, the average OEE calculated for a week is 55.38%, details of which are attached as Appendix A, which is way below world standards which is 85% and can be termed as low OEE [10].

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

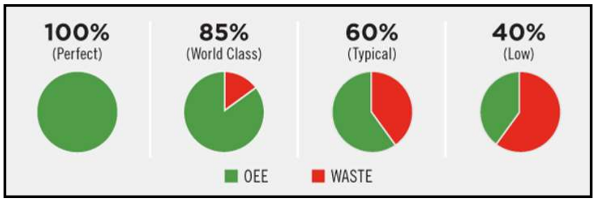


Fig. 5. OEE Benchmark

C. Implementation of TPM

Following is the brief description of TPM implementation activities which is carried out by devising a master plan which involves manufacturing and maintenance management including union reps. In this process scope of TPM program is decided based on equipment used and their performance data collected, to achieve desired organizational goals [11].

D. Autonomous Maintenance

Autonomous maintenance can be defined as a maintenance strategy in which, after essential training, operator can continuously monitor their equipment, perform desired adjustments and carry out minor maintenance tasks on own. This in terms reduces downtime and is cost effective as no special technician is assigned to carry out designated routine maintenance program.

Autonomous maintenance is the First pillar of TPM strategy. In this type of Maintence the operator is fully capable of carrying out a routine nature maintenance therefore cleaning, lubrication, general inspection for any abnormalities and also takes full responsibility of it equipment and surroundings. For this purpose the operators are trained and are put to skill testing in order to carry out autonomous maintenance. Therefore, a Autonomous Maintenance strategy is devised for Yunus Textiles following seven steps for implementation in each section discussed in former paragraphs (attached at Annex B) and keeping in view the core principles.

There are two core principles of Autonomous Maintence:

- To avoid machinery deterioration and degradation through proper operation and;
- Maintaining' Like New' status of equipment through proper restoration process and exercising professional management

E. Focused Improvement

Focused Improvement is the second pillar of TPM strategy, in which functional teams from all departments of an industry assembled with a main working agenda therefore identification of problematic equipment and suggesting improvement plans to rectify the highlighted issue. The reason behind assembling all functional teams is to have wide number of suggestions through different experiences. Above in view, a maintenance committee was held comprising of individuals from all sections and departments of Yunus Textile Mills to discuss, identify and suggest improvement techniques to increase OEE of the company. For this purpose Phenomenon-Mechanism Analysis and Cause-Effect Analysis that serve as unique tools to reduce recurring defects.

F. P-M Analysis

P-M Analysis concept was designed by Kunio Shiroshe of Japan Institute of Plant Maintence JIPM. 'P' is the phenomena to understand the deviation from normal to abnormal state where as' M' is the mechanism which explains the occurrence of the abnormal behavior of the machinery. The maintenance committee carried out a detailed P-M Analysis of the SAURER AutoCad machine to verify the phenomena and mechanics behind the drop of CoV of the yarn thus compromising quality of the product. In doing so, suggestions were also presented to chair of committee to rectify such abnormal behavior. The detailed P-M Analysis Chart of the SAURER AutoCad is in Fig. 7, which is verified by Cause-Effect Analysis through Fish Bone diagram:

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

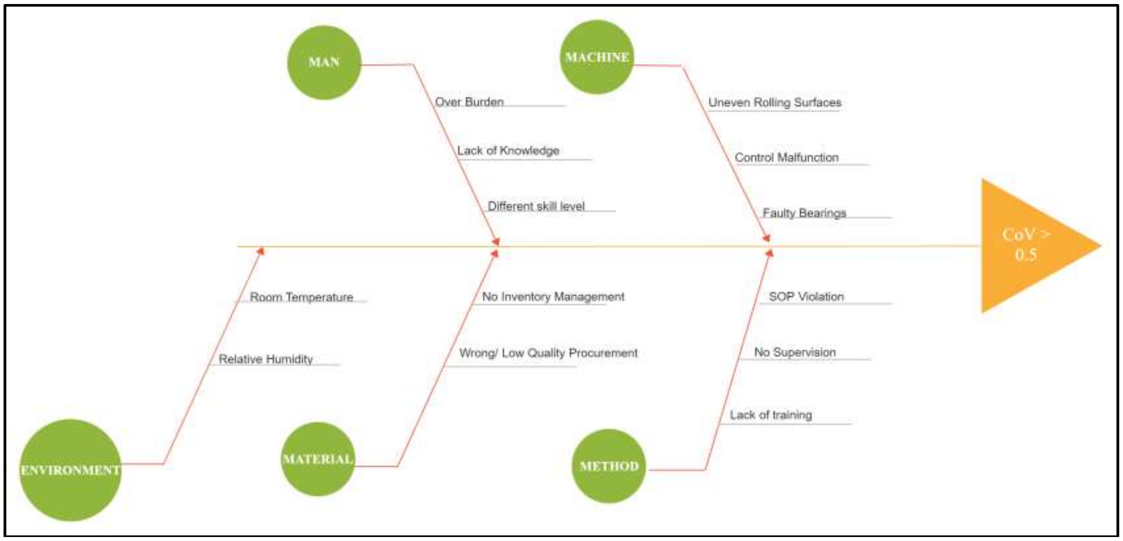


Fig. 6. Fish bone diagram of auto comb

P-M Analysis Chart		Machine Model: SAURER AutoCard			
S.No	**Stages**				
1	**Phenomenon Classification**	Yarn CoV is greater than 0.5 therefore loss of homogeneity			
2	**Physical analysis**	The speed variation of the rollers is out of calibration			
3	**Constituent Conditions**	Metal roller surface deformation	Deterioration of rubber pads on the roller	Control system malfunctions for adjusting roller speed	Degradation of roller bearing
4	**Production Input Correlation**	**Man**	**Machine**	**Method**	**Materials**
		1. Overburdening of operators 2. Variation of skill-level of operators of same machinery 3. Lack of sufficient knowledge/ training	1. Uneven roller surfaces 2. Control system malfunction 3. Faulty bearings	1. Lack of adherence to SOPs 2. Absence of supervision 3. Lack training causing increased downtime	1. Spares procured from Local Market instead from OEM 2. No inventory management system established
5	**Set Optimal Conditions**	**Mechanism**	**Sub-assemblies**	**Components**	
		Roller speed is variation is not as per OEM technical manual	1. Roller 2. Rubber pad 3. Control system	1. Metal roller 2. Roller bearing 3. Speed sensors 4. MTA (Micro-short Term Auto levelling system)	
6	**Causal Factor Survey**	Deterioration of rubber pads are the major cause for variation in CoV			
7	**Abnormalities that need to be addressed**	Other abnormalities are roller bearing found faulty, MTA system PCB malfunctions, Speed sensor faulty or damage to metal roller			
8	**Improvement Proposal**	1. Proper training to be imparted to operators to detect abnormality in time to avoid major defect 2. Maintence regime oversight 3. Recalibrate sensors and control cards 4. Refer to IPL and technical manuals provided by the OEM			

Fig. 7. P-M analysis chart (autocomb)

G. Planned Maintenance

Planned maintenance is the 3rd pillar of TPM strategy and is basically combination of two different strategies namely proactive and preventive maintenance. This type of maintenance helps to achieve zero break down and follows a structured approach to establish a management system that extends the equipment reliability at optimum cost. The Yunus Textile Mills was already carrying out Planned Maintenance but there was no audit whether the routine was carried out or not, which was a great concern. The committee

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

was tasked to device a Maintenance Management System MMS for auditing the training and conduct of routines by relevant staff. A revised maintenance plan for generators was also devised in accordance with seven steps of implementation (attached at Appendix C) to reduce fluctuation issues in order to reduce damage to control circuits [12].

TABLE 1
GENERATOR MMS PLAN

S No.	Item	Job Description	By Whom	Period
1.	Engine operation	1. Check engine oil level 2. Visually check engine for leaks and check general engine condition 3. Check intercooler drain (if fitted) Check air filter maintenance indicator 4. Check coolant pump relief bore(s) 5. Check for abnormal running noises, exhaust discoloration and vibrations 6. Drain water and contamination from fuel prefilter (if fitted) 7. Check fuel prefilter restriction indicator (if fitted)	Operator	Daily
2.	Engine oil filter	1. Drain oil sludge and inspect for metallic residue 2. Replace filter inserts when changing oil or at the latest after limit years	Operator	250 Hrs
3.	Emergency air shut-off flaps	Check electric operation of emergency-air shutoff flaps	Operator	250 Hrs
4.	Centrifugal oil filter	Centrifugal oil filter (if fitted): Check thickness of oil residue coating, clean, and replace filter sleeve	Operator	250 Hrs
5.	Valve gear	Check valve clearance	Operator	1000 Hrs
6.	Air filter	Clean air filter, empty dust bowl (if fitted)	Operator	1000 Hrs
7.	Lubrication points	Lubricate lubrication points	Operator	1000 Hrs
8.	Fuel filter	Replace fuel filter or fuel filter element	Operator	1000 Hrs
9.	Battery-charging generator	Battery-charging generator: Check carbon brushes and coupling	Operator	2000 Hrs
10.	Combustion chambers	Perform endoscopic examination of combustion chambers	Operator	2000 Hrs
11.	Exhaust turbocharger	Overhaul exhaust turbocharger	Repair Agency	10,000 Hrs
12.	Cylinder head	Overhaul cylinder heads and visually inspect piston crowns and running pattern of cylinder liners	Repair Agency	10,000 Hrs

IV. DISCUSSION AND CONCLUSION

A. Discussion

The TPM template for Yunus Textile Mills is devised by implementing three out of eight pillar of TPM strategy. Following are the reasons and remedies taken to increase the OEE calculated for the month of Nov 18:

1. Operator knowledge was insufficient due to which Autonomous Maintenance was adopted. Senior technicians were offered foreign courses of relevant equipment and machinery. Same conducted inland workshops in order to enhance skill set and train rest of the employees.
2. Although Planned Maintenance was carried out but there

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

was no Maintenance Management System MMS to carry out audit of routines being conducted, same of established. In addition a detailed maintenance plan was devised so that power fluctuations can be avoided thus maintaining overall quality and performance of the machinery.

3. In addition Focused improvement was carried out to further analyze the causes of low OEE which revealed that the quality of yarn was also hampered due various reasons same were rectified.

B. Conclusion

The best way to determine the effectiveness of TPM implementation is to calculate and compare the OEEs for the month of Nov 18 and Nov 19. The average downtime was 226 minutes in Nov 18 and Nov 19 it reduced to 148 minutes. Thus contributing better availability of the machinery to produce maximum products and thus increasing company profits. The results revealed a great success with respect to profits gained, reduced downtime and improved product quality. The percentage difference of 9.6% (attached at Appendix D) is a result of successful implementation of new maintenance regimes.

REFERENCES

[1] R. Smith and R. K. Mobley, *Rules of Thumb for Maintenance and Reliability Engineers*. Oxford, UK: Butterworth-Heinemann, 2007.

[2] M. Jasiulewicz-Kaczmarek, ``SWOT analysis for planned maintenance strategy-a case study,'' *IFAC-PapersOnLine*, vol. 49, no. 12, pp. 674-679, 2016. doi: https://doi.org/10.1016/j.ifacol.2016.07.788

[3] C.-Y. Lee, J.-Y. Lin, and R.-I. Chang, ``Improve quality and efficiency of textile process using data-driven machine learning in industry 4.0,'' *International Journal of Technology and Engineering Studies*, vol. 4, no. 1, pp. 64-76, 2018. doi: https://dx.doi.org/10.20469/ijtes.4.10004-2

[4] Z. A. Shah and H. Hussain, ``An investigation of lean manufacturing implementation in textile sector of Pakistan,'' in - *International Conference on Industrial Engineering and Operations Management,* Kuala Lumpur, Malaysia, 2016.

[5] S. Wakeel, S. Bingol, M. N. Bashir, and S. Ahmad, ``Selection of sustainable material for the manufacturing of complex automotive products using a new hybrid goal programming model for best worst method--proximity indexed value method,'' *Proceedings of the Institution of Mechanical Engineers, Part L: Journal of Materials: Design and Applications*, vol. 235, no. 2, pp. 385--399, 2021. doi: https://doi.org/10.1177/1464420720966347

[6] M. W. Wakjira and A. P. Singh, ``Total productive maintenance: A case study in manufacturing industry,'' *International Journal For Technological Research In Engineering*, vol. 3, no. 9, pp. 1-9, 2012.

[7] C. S. Sethia, P. N. Shende, and S. S. Dange, ``A case study on total productive maintenance in rolling mill,'' *International Journal of Scientific Development and Research*, vol. 1, no. 3, pp. 60-66, 2016.

[8] A. Iqbal, M. N. Bashir, A. Alam, M. B. Asif, I. Arshad *et al.*, ``Implementation of lean methodology on the main assembly line of an automotive plant to enhance productivity,'' *Journal of ICT, Design, Engineering and Technological Science*, vol. 4, no. 1, pp. 16--22, 2020. doi: https://doi.org/10.33150/JITDETS-4.1.4

[9] M. R. Yasin, M. N. Bashir, S. A. A. Zaidi *et al.*, ``A case study in the textile industry for the reduction of cost of quality,'' *Journal of Advances in Technology and Engineering Research*, vol. 5, no. 6, pp. 219--230, 2019. doi: https://dx.doi.org/10.20474/jater-5.6.1

[10] A. Shehzad, S. S. Sadaf Zahoor and, and E. Shehab, ``Implementation of TPM in a process industry: A case study from Pakistan,'' *Advances in Manufacturing Technology*, vol. 32, pp. 511-516, 2018.

[11] F. T. S. Chana, H. C. W. Lau, R. W. L. Ip, H. K. Chan, and S. Kong, ``Implementation of total productive maintenance: A case study,'' *Internation Journal of Production Economics*, vol. 95, p. 71–94, 2005. doi: https://doi.org/10.1016/j.ijpe.2003.10.021

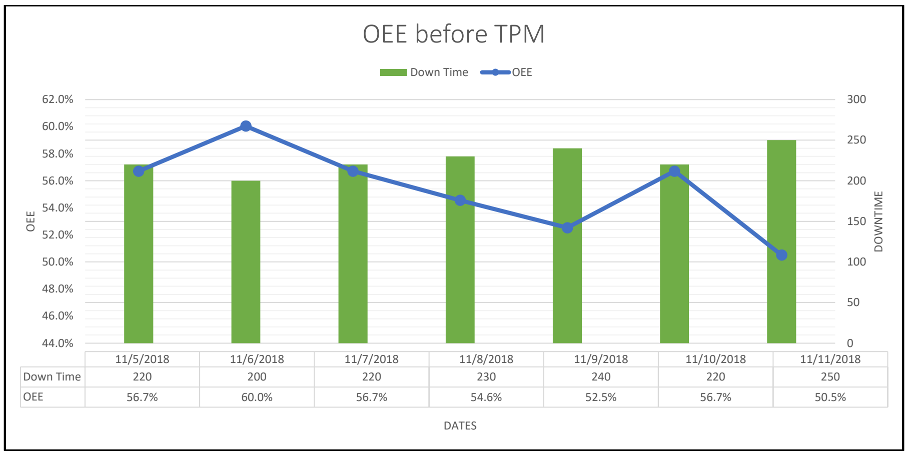
[12] M. W. Wakjira and A. P. Singh, ``Total productive maintenance: A case study in manufacturing industry,'' *Global Journal of Research in Engineering*, vol. 12, no. 1-G, 2012.

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

APPENDIX A

OEE BEFORE TPM (TABULAR REPRESENTATION)

Date	Shift Length	Down Time	Theoretical Cycle Time	Total Produced	Operating Time	Rejected Units	Availability	Performance	Quality	OEE
11/5/2018	720	220	0.005	83,333	500	1666.666667	69.4%	83.3%	98.00%	56.7%
11/6/2018	720	200	0.005	88,136	520	1674.576271	72.2%	84.746%	98.1%	60.0%
11/7/2018	720	220	0.005	83,333	500	1666.666667	69.4%	83.333%	98.0%	56.7%
11/8/2018	720	230	0.005	80,328	490	1767.213115	68.1%	81.9672%	97.8%	54.6%
11/9/2018	720	240	0.005	77,419	480	1780.645161	66.7%	80.6452%	97.7%	52.5%
11/10/2018	720	220	0.005	83,333	500	1666.666667	69.4%	83.33333%	98.0%	56.7%
11/11/2018	720	250	0.005	74,603	470	1865.079365	65.3%	79.36508%	97.5%	50.5%

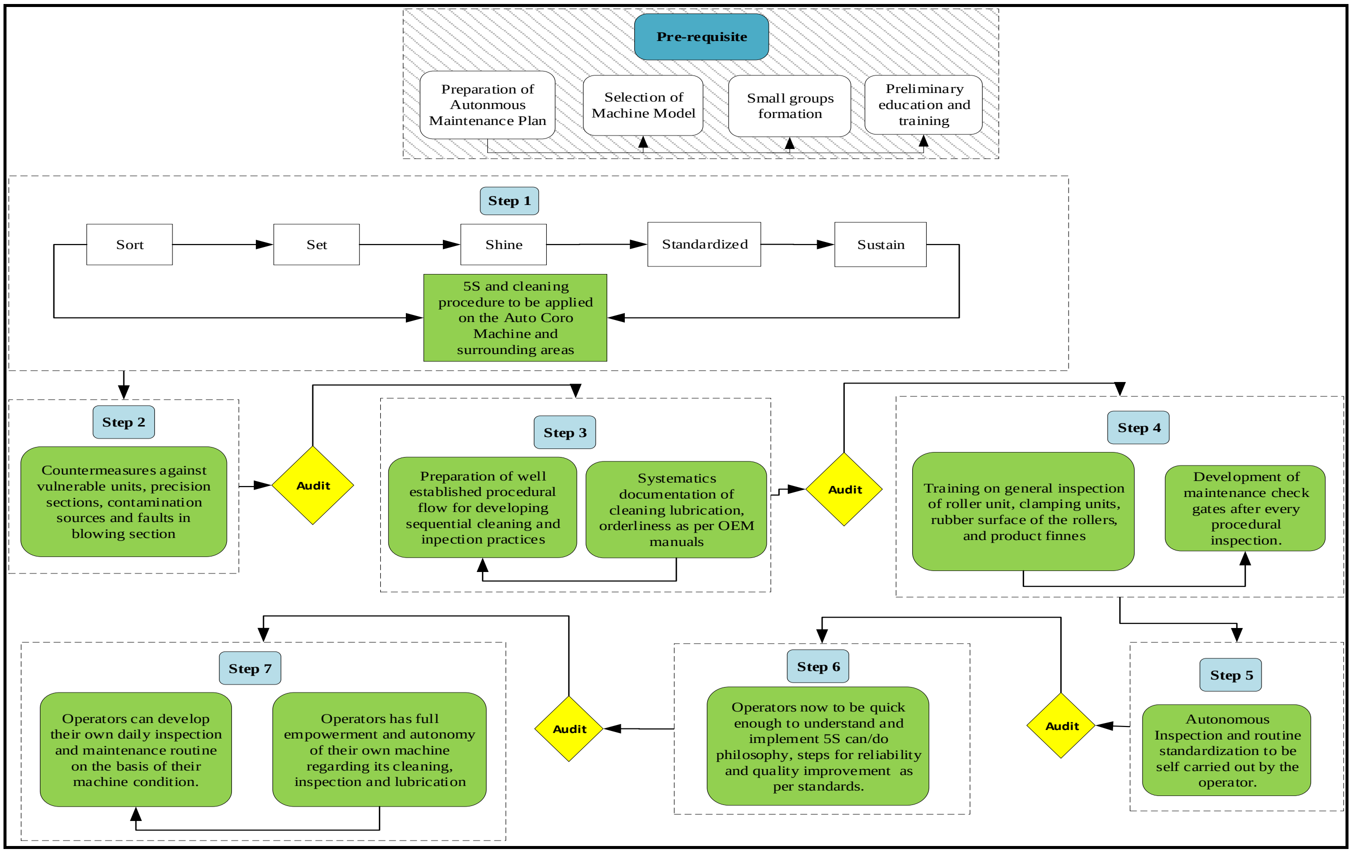


. OEE before TPM (graphical representation)

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

TAF Publishing

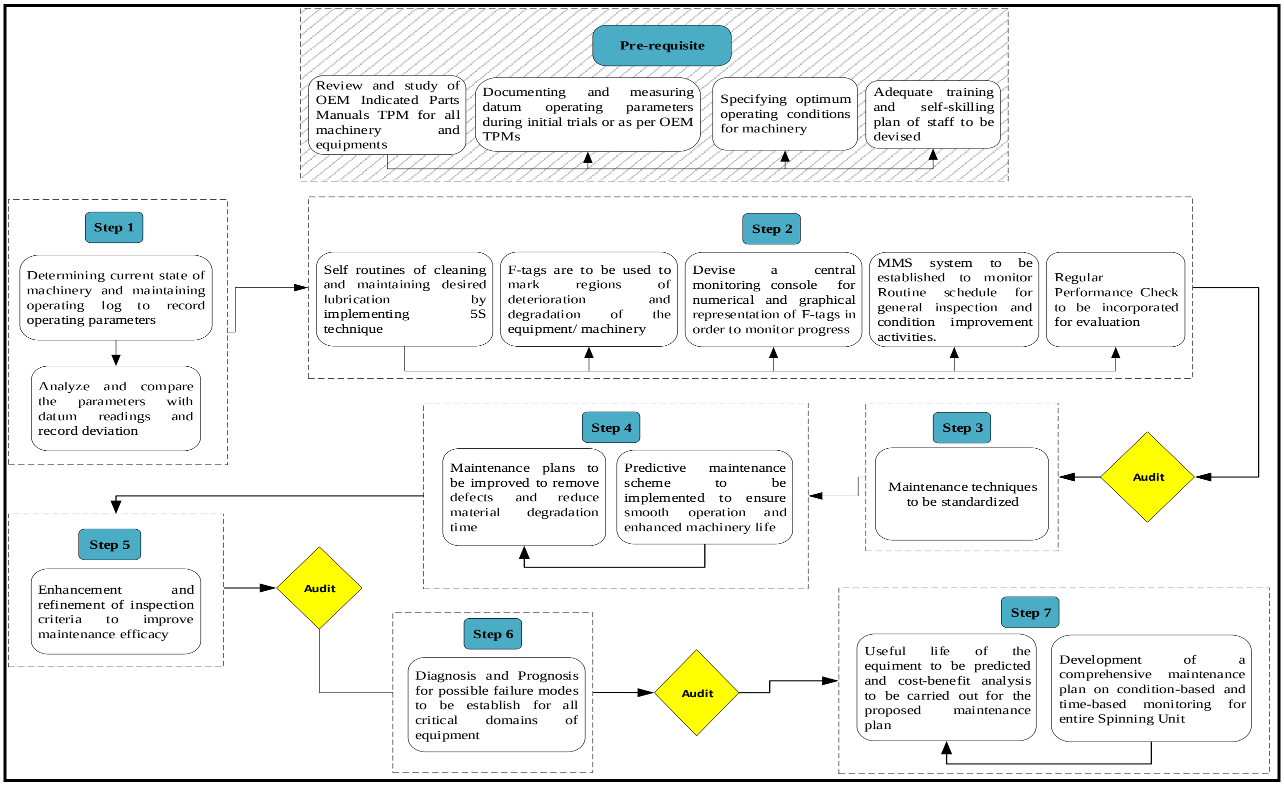
APPENDIX B



. Seven steps of autonomous maintenance

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

APPENDIX C



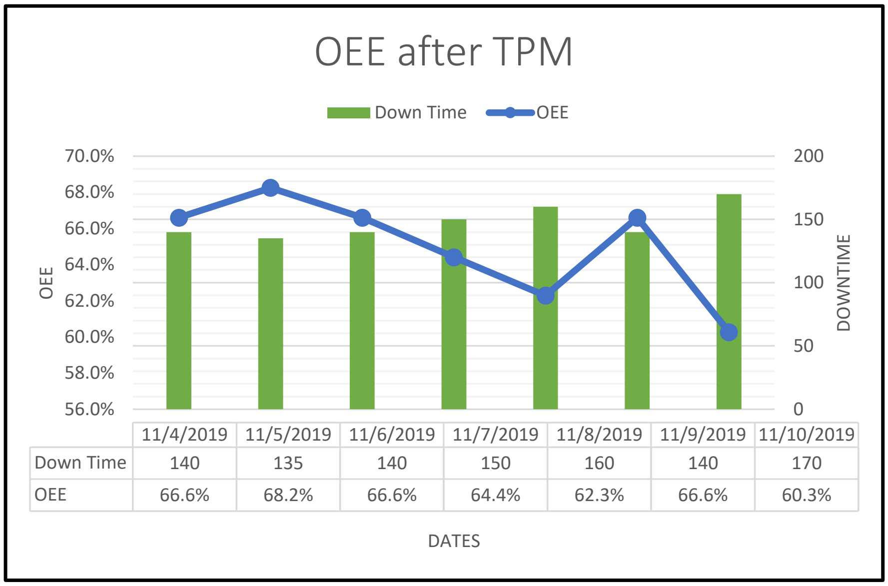
. Seven steps of planned maintenance

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2

APPENDIX D

OEE AFTER TPM (TABULAR REPRESENTATION)

Date	Shift Length	Down Time	Theoretical Cycle Time	Total Unit Produced	Operating Time	Rejected Units	Availability	Performance	Quality	OEE
11/4/2019	720	140	0.005	96,667	580	773.3333333	80.6%	83.3%	99.20%	66.6%
11/5/2019	720	135	0.005	99,153	585	882.4576271	81.3%	84.746%	99.1%	68.2%
11/6/2019	720	140	0.005	96,667	580	773.3333333	80.6%	83.333%	99.2%	66.6%
11/7/2019	720	150	0.005	93,443	570	700.8196721	79.2%	81.9672%	99.3%	64.4%
11/8/2019	720	160	0.005	90,323	560	632.2580645	77.8%	80.6452%	99.3%	62.3%
11/9/2019	720	140	0.005	96,667	580	773.3333333	80.6%	83.33333%	99.2%	66.6%
11/10/2019	720	170	0.005	87,302	550	523.8095238	76.4%	79.36508%	99.4%	60.3%



<u>OEE PERCENTAGE INCREASE</u>

9.6 %

. OEE after TPM (graphical representation)

ISSN: 2414-4592
DOI: 10.20474/jater-7.2.2