

Total Productive Maintenance

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Abstract These days, customers anticipate that makers should give phenomenal quality, solid conveyance and focused estimating. This requests the producer's machines and procedures are profoundly solid. So as to have profoundly dependable machines to ensure smooth assembling process, numerous associations have actualized Total Productive Maintenance (TPM) as the empowering instrument to expand the adequacy of hardware by setting and keeping up the ideal connection among individuals and their machines. Overall Equipment Effectiveness (OEE) is utilized as a measure when assessing the aftereffect of TPM. This Case Study expects to discover the Comparison between the Cleaning, Lubrication, Inspection, Tightening and adjustment (CLITA) Time, Breakdown of Machine and decrease in real gear misfortunes when the execution of TPM and contrast among when the TPM usage to OEE results. This investigation is completed to see the distinction that TPM can bring to an association. Components that comprise the OEE condition will be investigated so as to distinguish which one that influences OEE result. In the wake of distinguishing, improvement will be made on that component so that OEE result will be improved at last.

Keywords- *manufacturers, machines, Total Productive Maintenance, Overall Equipment Effectiveness, Lubrication.*

I. INTRODUCTION

Productivity and viability of hardware assumes an overwhelming job in present day fabricating industry to decide the exhibition of the authoritative generation work just as the degree of accomplishment accomplished in the association. Total productive maintenance (TPM) is a strategy that plans to expand the accessibility of existing hardware subsequently decreasing the requirement for further capital speculation. In light of expanded competency levels and request of value items at lower costs, organizations needs an exhaustive framework to accomplish ideal yield from the gear/machine. TPM is an arrangement, which focuses on absolute inclusion of everybody from top administration to all workers to actualize a complete support program for all hardware for a mind-blowing duration. This arrangement brings about most extreme viability of hardware, tidier, slick and clean work spot and ethically supported representatives. TPM has been perceived as one of the huge task procedure to recapture the creation misfortunes because of gear wastefulness. TPM is an exceptional Japanese arrangement of upkeep, which has created by the Japan Institute of Plant Maintenance (JIPM). It has been significant instrument for hardware escalated fabricating divisions; it is a key methods for expanding machine accessibility. The benefit of sending TPM is generally perceived, especially in current market situation where economy is in retreat, introduced limit is more prominent than interest, quality is essential, developing challenge, and selling cost is directed by the market, assorted hardware, brought together control and couple of administrators in the plant.

TPM is a support procedure created for improving efficiency by making forms progressively dependable and less wasteful. TPM is an expansion of TQM (Total Quality Management). The target of TPM is to keep up the plant or gear in great condition without meddling with the every day procedure. To accomplish this goal, preventive and prescient

upkeep is required. To execute TPM the generation unit and upkeep unit should work together.

II. MAINTENANCE AND ITS STRATEGIES

There are plenty of maintenance management approaches and strategies. However, here discuss some name of these strategies which are more commonplace.

Breakdown or Reactive Maintenance (BM):

Failure-driven maintenance (FDM), which is also named as run-to-failure maintenance (Moubray,1997), is a reactive maintenance approach to run the equipment until failure. Breakdown maintenance is also at times referred to as repair maintenance. The basic concept behind breakdown maintenance is not to do anything until and unless the machine ceases to function. The only attention the machine receives is at the time of failure. This can be justified when the impact of failure is inconsequential or the investment in preventive measures exceeds the expected benefits of improved reliability or higher availability. However, an important aspect is that the failure of a component from a big machine may be injurious to the operator. Hence breakdown maintenance should be avoided.

Preventive Maintenance:

First developed at General Electric. PM is undertaken in advance of the interruption of production and major breakdown and strives to keep production flow continuously running. It is defined as the planned maintenance of plants and equipment in order to prevent or minimize breakdowns and depreciation rates. It is the procedure adopted in most of the companies to maintain desirable and reliable operating conditions of equipment and machinery.

Periodic Maintenance (Time Based Maintenance):

In time-based maintenance (TBM) or periodic preventive maintenance (PPM), the maintenance activities are scheduled

in advance to prevent failure. This concept focuses on preventing failures through replacing components at particular times. This is suitable for repeatable degradation modes, e.g., wear processes or constant rate corrosion. The strategy has some advantages like: a more effective use of time and spares are only ordered as required. PPM advocates replacement or repair at a fixed time after installation, independent of its condition. The time period used to construct a maintenance schedule can be either calendar time or component running time. A component is replaced at a fixed time T, or at failure, whichever occurs first. PPM works well provided that it is acknowledged that some failures will occur. The majority of the failures will be pre-empted, but some will still occur because of uncertainty about the underlying failure distribution of the plant/component life, which is occasionally shorter than the maintenance interval. The most effective use of time-based PPM will be in equipment that has a very predictable life, e.g., components that are designed to wear.

Condition-Based Maintenance (CBM):

One drawback of PM policy is that some components may be over maintained, i.e. replaced prematurely. However, if the condition of the item can be monitored continuously or even frequently, PM actions will be implemented only when failure is judged that is about to happen. This is the basic concept of CBM. Performance-parameter analysis, vibration monitoring, oil analysis, etc. are some condition monitoring techniques that are involved in CBM. Each of these methods discloses a specific type of fault. For example, vibration-monitoring can be employed to detect wear, imbalance, misalignment, loosened assemblies or turbulence in plant with rotational or reciprocating parts.

Reliability-Centered Maintenance (RCM):

There are various formal definitions of RCM. Some of which are as the following:

Moubray has defined RCM as “a process used to determine what must be done to ensure that any physical asset continues to do whatever its users want it to do in its present operating context”. According to Agrawal et. al RCM is “A process used to determine what must be done to ensure that any physical asset continues to fulfill its intended functions in its present operating context”. Rausand gives the following definition “RCM is a system consideration of system functions, the way functions can fail, and a priority based consideration of safety and economics that identifies applicable and effective PM tasks”. What RCM is maintaining is the system function. It may well be required to redesign or modify a physical asset to maintain its system function in the case of a change in its operating context.

Productive maintenance:

In productive maintenance the trait of preventive maintenance were retained, but with an emphasis on productivity. Maintenance prevention and reliability engineering was used to increase on productivity of equipment from start and profitability verification becomes part of maintenance. Essentially productive maintenance was the stepping stone for Nakazima to develop TPM.

Corrective maintenance (CM):

The concept of corrective maintenance was developed in 1957. It improves equipment and its components so that preventive maintenance can be carried out reliably. Equipment with design weakness must be redesigned to improve reliability or improving maintainability.

III. LITERATURE SURVEY

Total Productive Maintenance is a unique Japanese philosophy, which has been developed based on Productive Maintenance concepts and methodologies. This concept was first introduced by M/s Nippon Denso Co. Ltd. of Japan, a supplier of M/s Toyota Motor Company, Japan in the year 1971. TPM is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns and promotes autonomous maintenance by operators through day-to-day activities involving total workforce. TPM is a proactive maintenance philosophy that brings a radical departure from corrective maintenance (fix it when it breaks). It aims to reduce failures, setup losses and other causes of poor or reduced production by involving the operators in the maintenance of their respective machines, which is a requirement of TPM application.

TPM is an important world class manufacturing programme introduced during the quality revolution. TPM is a highly influential technique that is in the core of ‘operations management’ and deserves immediate attention by organizations across the globe (Voss, 2005). TPM supports the other strategies most often associated with World Class Manufacturing: Just-in-Time (JIT) manufacturing, TQM and Employee Involvement (EI) (Cua et al., 2001). According to (Steinbacher and Steinbacher 1993), the benefits of various components of TPM make it an extremely powerful management tool to reduce costs of equipment management and such reductions provide greatest returns on investment. It is also argued that TQM has only limited influence on machine performance and TPM fills this gap by providing more focus on equipment (McKone et al., 1999). TPM is considered to be an effective strategic improvement initiative for improving quality in maintenance engineering activities (Prمود et al., 2007). TPM addresses the vital area of equipment management, which is a major determinant of process performance in today’s manufacturing companies (Yamashina, 2000). TPM addresses entire production system over the entire life cycle and builds a concrete, shop floor-based mechanism to prevent various losses and wastes (Sharma et al., 2006).

TPM has been widely recognized as a strategic weapon for improving manufacturing performance by enhancing the effectiveness of production facilities (Dossenbach, 2006). TPM can only succeed in an organization that is committed to provide the necessary training and time to monitor the success or failure of the ensuing improvement initiatives. TPM initiatives in production help in streamlining manufacturing and other business functions, and garnering sustained profits (Ahuja and Khamba, 2007). TPM initiatives are targeted to enhance competitiveness of organizations and encompass a powerful structured approach to change the mindset of employees, thereby making a visible change in the work culture of an organization (Heston, 2006). TPM is a manufacturing-led

initiative that emphasizes the importance of (i) people with a 'can do' and continual improvement attitude and (ii) production and maintenance personnel working together in unison. In essence, TPM seeks to integrate the organization to recognize, liberate and utilize its own potential and skills.

IV. STAGES OF TPM IMPLIMENTATION

Seichi Nakajima, father of TPM and vice president of JIPM defines TPM inclusive of the following five key elements

1. TPM targets at maximizing equipment efficiency.
2. TPM implements a preventive maintenance system for the overall life of equipments.
3. TPM is an integrated system implemented by different departments of an organization (engineering, operation, maintenance and management).
4. TPM involves all personnel of an organization.
5. TPM is based on deploying preventive maintenance encouraged by management and autonomous Small Work Groups (also known as Small Group Activity- SGA).

The above said elements can be achieved by the properly implementation of TPM in any organization passes through various stages. According to Nakajima, 1988. These are divided into four stages. Which are discussed subsequently.

1. Preparatory Stage

Preparatory stage includes the following sub stages

Announcement by Management to all about TPM introduction:

Proper understanding, commitment and active involvement of the top management is needed for this step. Senior management should have awareness programs, after which announcement is made to all. Publish it in the house magazine and put it in the notice board. Send a letter to all concerned individuals if required.

Initial education and propaganda for TPM:

Training is to be done based on the need. Some need intensive training and some just an awareness. Take people who matters to places where TPM already successfully implemented.

Setting up TPM and departmental committees:

TPM includes improvement, autonomous maintenance, quality maintenance etc., as part of it. When committees are set up it should take care of all those needs.

Establishing the TPM working system and target:

Now each area is benchmarked and fix up a target for achievement.

A master plan for institutionalizing:

Next step is implementation leading to institutionalizing wherein TPM becomes an organizational culture. Achieving PM award is the proof of reaching a satisfactory level.

2. Introduction Stage:

This is a ceremony and we should invite all. Suppliers as they should know that we want quality supply from them.

Related companies and affiliated companies who can be our customers, sisters concerns etc. Some may learn from us and some can help us and customers will get the communication from us that we care for quality output.

3. Implementation stage:

In this stage eight activities are carried which are called eight pillars in the development of TPM activity. The activities are carried out for establishing the system for production efficiency, one for initial control system of new products and equipment, one for improving the efficiency of administration and are for control of safety, sanitation as working environment.

Instituonalising Stage:

By all their activities one would has reached maturity stage. Now is the time for applying for TPM award. Also think of challenging level to which one can take this movement.

V. IMPLIMENTATION OF TPM AT MAHINDERA & MAHINDERA SWARAJ DIVISION (A CASE STUDY)

Mahindra & Mahindra Swaraj Division is formerly known as a Punjab Tractors Ltd. It was established on 27th June 1970. Punjab Tractors Ltd. Company, is India's first large-scale project based company with a totally indigenous design, knowledge and technology. PTL started with an annual capacity of 5000 tractors and with a capital of Rs.3.7 cores. It went into commercial production in the year 1974. Its first production was 26.5 BHP tractors, which was given the name "SWARAJ-720". Ever since company did not look back. Besides tractors, it has added a lot of other products to its range, which includes harvesting combine, fork lifters, automotive castings etc.

- Mahindra embarked on its journey in 1945 by assembling the Willy's Jeep in India.
- Over 66 years of service to the Nation.
- Employees more than 1, 44,000 people in over 100 countries.
- US \$ 14.4 Billion Indian Multinational.
- Forbes has ranked Mahindra Group in its Top 2000 list of the World's most Powerful Companies in the world.
- For four years in a row, Mahindra has featured in the Forbes Asia's Fab 50 List of the 50 best publicly traded companies in the Asia-Pacific regions.
- Dun & Bradstreet also ranked Mahindra at No. 1 in the automobile sector in its list of India's Top 500 Companies.

Overall Production Processes:

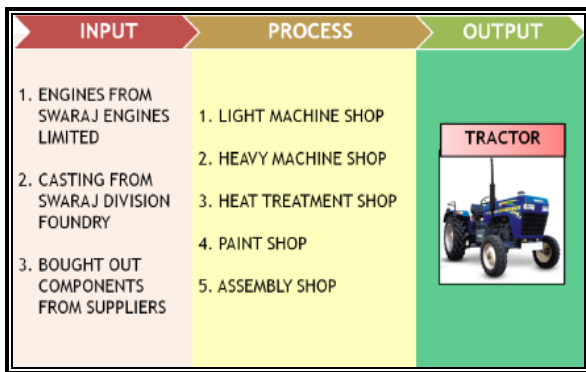


Figure 1: Overall Production Processes

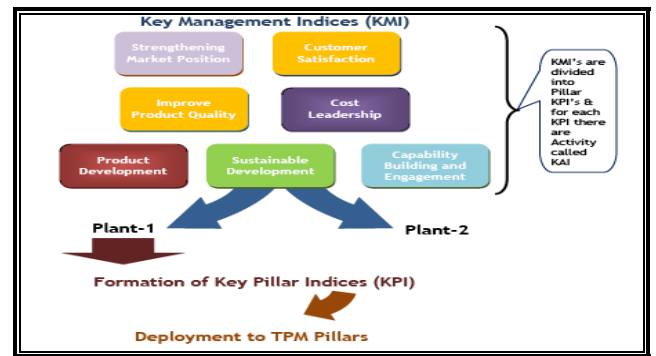


Figure 4: KMI, KPI and KAI Deployment

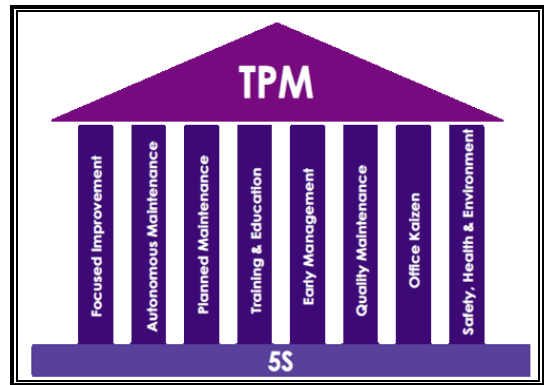
Main Products:

Range of Products:

Plant has the facilities to produce any model of Swaraj Product mix. At present Plant are making 5 models & 41 variants.



Figure 2: Range of Product



VII. IMPLEMENTATION OF JISHU HOJEN PILLAR:

Machine Status



Figure 5: Wires and Pipes not routed

Organization Structure of Swaraj Division:

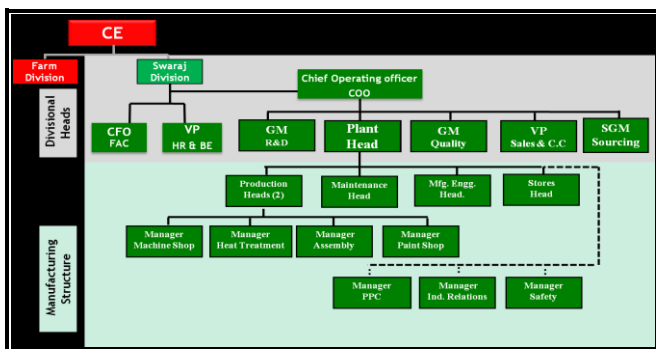


Figure 3: Organization Structure of Swaraj Division

VI. TPM OBJECTIVE:

To meet the identified External & Internal Needs & achieve the Key Management Indices, We have adopted TPM as a tool with the primary purpose to satisfy customers by offering best quality products, at an affordable cost to attain the overall objective of:-

- Zero Break down
- Zero Accident
- Zero Defects
- Zero Health Hazards

KMI, KPI and KAI Deployment:



Figure 6: Oils, Chips, and Dusts on Machine

Need of Pillar



Figure 7: Need of Pillar

Relationship with Other Pillars:



Figure 8: responsibility of pillar

JH Audit System:

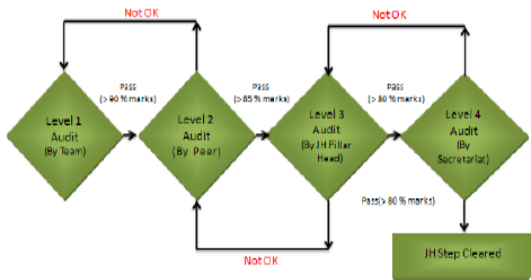


Figure 9: JH Audit System

Block Diagram of Machine:



Figure 10: Block Diagram of Machine

VIII. IMPROVEMENTS IN OVERALL EQUIPMENT EFFECTIVENESS (OEE)

OEE stands for Overall Equipment Effectiveness. Essentially, it is a single figure that signifies the utilization of a machine. This can be at a job level, shift level, overall plant or enterprise level. OEE is the best way to monitor and improve the efficiency of the manufacturing processes (i.e. Machine, Manufacturing, Cell and Assembly lines). The OEE is probably the most important tool in the TPM improvement program. OEE is simple and practical. It takes the most common and important sources of manufacturing productivity loss, place them into three primary categories and distills them into matrices that provide an excellent gauge for measurement and improvement. OEE is frequently used as a key metric in TPM and gives a consistent way to measure the effectiveness of TPM by providing an overall framework for measuring production efficiency (Nguyen et al. 1989). The purpose of OEE is to identify sources of waste and inefficiencies or process losses that reduce availability (downtime), performance efficiency (rate/speed) and quality (defects) so corrective action can be taken to improve the process.

IX. TPM AND OEE

TPM seeks to maximize equipment effectiveness throughout the lifetime of the equipment. It strives to maintain the equipment in optimum condition in order to prevent unexpected breakdown, speed losses, and quality defects occurring from process activities. There are three ultimate goals of TPM: zero defects, zero accident, and zero breakdowns. Nakajima suggests that equipments should be operated at 100 percent capacity 100 percent of the time. Benchmarking on overall equipment effectiveness (OEE), productivity (P), quality (Q), cost (C), delivery (D), safety (S) and morale (M) etc. can facilitate an organization to realization of zero breakdown, zero defect, zero machine stoppage, zero accidents, zero pollution, which serve as the

ultimate objective of TPM. TPM has been envisioned as a comprehensive manufacturing strategy to improve equipment productivity. The strategy elements include cross-functional teams to eliminate barriers to machine uptime, rigorous preventive maintenance programs, improved maintenance operations management efficiency, equipment maintenance training to the lowest level, and information systems to support the development of imported equipment with lower cost and higher reliability. OEE controls many performance parameters as shown in figure below:

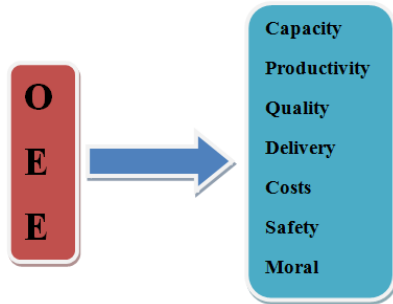


Figure 11 OEE and TPM

X. RESULT

After fruitful execution of three Pillars of TPM usage which is JH, KK and E&T for the situation organization, it is discovered that overall Equipment Effectiveness (OEE) of machine is expanded. Likewise there is significantly decrease in CLITA Time, Big Equipment losses (Breakdown loss, Rejection, arrangement loss, yield loss) , paint utilization and improvement in paint effectiveness, and furthermore it is discovered that, after E&T column execution the learning and expertise level of a representative is extensively improved which results in decrease of minor stoppage and revamp on the machine.

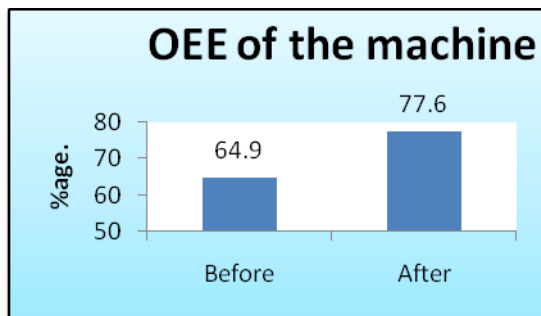


Figure 12: improvement in OEE after TPM

Sl.No.	Description	Before TPM	After TPM
1	CLITA Time	140 Minute	20 Minute
2	Rejection	26 Nos.	Nil
3	Breakdown Loss	25 Nos.	Nil
4	Tool Change Loss	78 Minute	4.7 Minutes
5	Setup Time Loss	145 Minute	35 Minute
6	Paint Consumption	11.8 Liter/Tractor	7.9 Liter/Tractor
7	Paint Efficiency	22%	55%

Table No. 1 comparison of losses before and after TPM

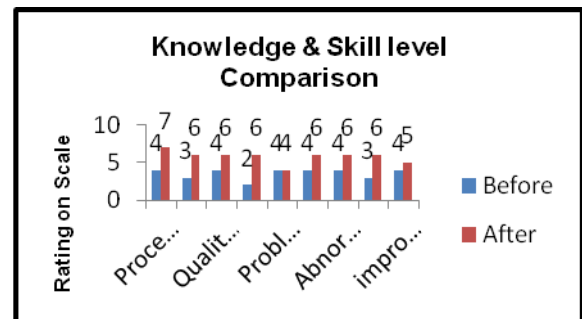


Figure 13 Knowledge & skill level comparison before and after TPM

XI. CONCLUSION

Today as each industry are moving towards globalization, to rival other overall businesses like Japan, Korea, China, America and so forth hence it is important to move the ventures towards present day pattern advancement in all divisions of enterprises including support office. So it is discovered all out gainful support (TPM) is perhaps the best apparatus for making enterprises focused and viable, in the field of maintenance. TPM might be the main thing that stands among progress and absolute disappointment for certain organizations to the extent upkeep is concerned. The usage of TPM in various areas requires various methodologies. Indeed, even executions in comparable plants of a similar association can require altogether various arrangements. Be that as it may, the created methodology for executing and assessing TPM in the Tractor assembling Company can be helpful for managing other assembling and administration associations to improve their tasks.

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