

Implementation of Total Productive Maintenance (TPM) in a Milk Plant

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Abstract-- Purpose:- the purpose of this paper is to implement the Total Productive Maintenance (TPM) in the Milk Industry. The paper aims to develop a methodology to increase production rate by minimising the downtime of machines and chances of breakdown and increasing the availability that will enhance Overall Equipment Efficiency.

Design/Methodology/Approach :- the methodology is based on analysing the reliability of data of a milk plant . where the steps could be traced to implement the TPM through Autonomous Maintenance that will further improve the maintenance policies of the mechanical equipment. Also the continuous and thorough inspection of production process is achieved though management of overall equipment efficiency.

Finding:- the goal of development methodology is to bring competitive advantages, such as increasing the productivity; improving the quality of the product; and reducing the cost of production line and wastage due to breakdowns in machines.

Practical Implementations:- TPM in milk industry will as increase in productivity, improve the quality of the product, reducing the cost of production line and wastage due to breakdowns in machines and providing a healthier and safe work environment. It can help to improve the design and operation of the production line .

Originality :- this paper presents the implementation of TPM in a Verka Milk Plant (Hoshiarpur) to generalising the process of implementation of TPM in Milk Plant.

Keywords – TPM, OEE, Reactive or Breakdown Maintenance (RM), Preventive Maintenance (PM) , Predictive Maintenance (PdM), MAINTENANCE MANAGEMENT

I. INTRODUCTION

I. Company Profile: Milk Union, Hoshiarpur was registered under Punjab Coop. Societies Act, 1961 vide Regn. No.141 dated 22.2.1973 in the name and style of “The Hoshiarpur Distt. Cooperative Milk Producers Union Ltd;” The foundation stone of Milk Plant, Hoshiarpur was laid down by the Hon’ble Chief Minister, Punjab, Giani Zail Singh. The Milk Plant was set up with financial assistance of Rs. 15.00 lacs as subsidy from Marginal Farmers and Agricultural Laborers Development Agency(MFALA) and Rs. 1.02 crore from National Cooperative Development Corporation(NCDC), New Delhi.

Geographical structure of the Hoshiarpur Distt. falls in Kandi, Submountaneous and Beit Area covering 1592 villages in 3372 sq. kms. consisting of 12 blocks out of which two blocks namely Balachaur and Saroya were transferred to newly formed district of Nawanshahar but these blocks remained the part of Milkshed Area of Milk Union, Hoshiarpur.

Currently, MU Hoshiarpur is having 3 Nos. of Milk Chilling Centres at Dasuya, Padrana and Balachaur with handling capacity of 20000, 10000 and 10000 LPD respectively. As on date, MU Hoshiarpur had organised 357 nos. of Milk Producers Coop. Societies (MPCS). Besides this 246 Nos. of Farms are functional at present. Total enrolled membership of the Milk Union is 33176, out of which 7593 nos. are female members. Milk Union, Hoshiarpur has organised 65 women D.C.S., under Punjab Women Dairy Project (STEP) and these societies are supplying approximately 14000 litres of god quality milk per day.

32 nos. of Single A.I. and 33 Nos. of Cluster A.I. Centers are currently operating in Milkshed area of Milk Union, Hoshiarpur, covering 220 villages. MU Hoshiarpur had installed 106 Nos. of Automatic Milk Collection Stations and 161 Nos. of Electronic Milk-testers to bring transparency and to build up confidence among milk producers. Hoshairpur dairy is currently supplying Verka Milk, fresh Milk Products and other bottled cum tetra pack products to the following reputed Institutions in Hoshiarpur District i.e. International Tractors Ltd (Sonalika), GNA Axles, GNA Duraparts, District Jail, Modern retail stores of MORE & Easyday in Hoshiarpur district, Swami Sarwa nand Giri Punjab University Regional Centre, Rayat Bahra University, Police Recruitment Training Centre (PRTC), Border Security Force (BSF), JCT Industries, Punjab Alkelies chemical Limited (Nangal), Jawaharlal Navodaya Vidyalaya (Hoshiarpur) and Jawahar Navodaya Vidyalaya (Pojewal), Luminous Industries (Amb), Sonalika (Amb), ABC Quantum Papermill, Army camps in Kangra/Palampur and many other institutions.

Table.1

Sr. No.	MILK HANDLING AND PRODUCT CAPACITIES - MILK UNION HOSHIARPUR	
1	City Supply	50000 Liters per day
2	Dahi	4 MT/day
3	Lassi	4 MT/day
4	Paneer	600 KGs per day
5	Kheer	500 KGs per day
6	Ghee	5 MT/day
7	Powder plant	7 MT/day
TOTAL MILK HANDLING CAPACITY 100000 Litres per day		

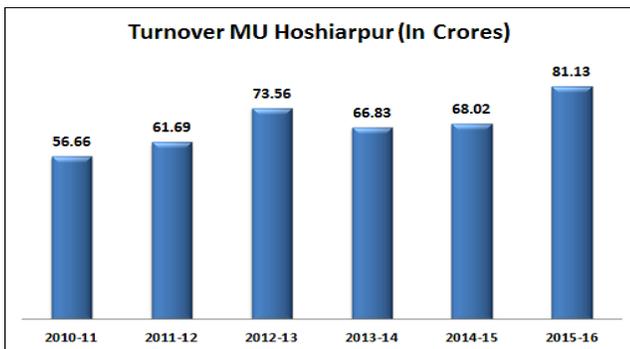


Figure. 1

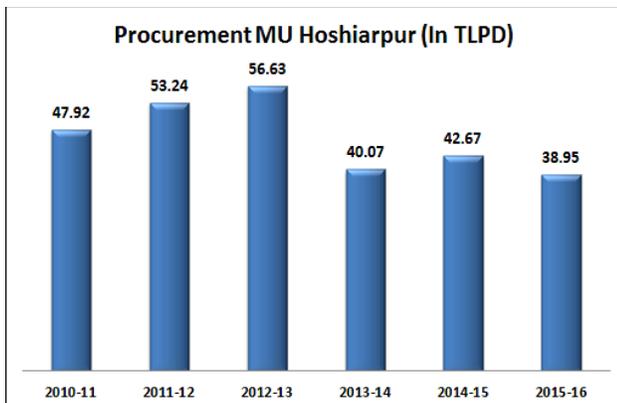


Figure 2

II. TPM : The current behavior of the markets requires companies to develop strategies for achieving improvements in order to remain competitive. In this context, Total Productive Maintenance (TPM) Model is an innovative approach to company maintenance that optimizes equipment efficiency, eliminates faults and promotes autonomous maintenance between operators, through day-to-day activities involving the entire force work (Nakajima et la 1988). TPM tools as taking part of eight pillars or TPM elements called:

- 1- Autonomous maintenance
- 2- Focused maintenance
- 3- Planned maintenance
- 4- Quality maintenance
- 5- Education and training
- 6- Safety and environment
- 7- Administrative TPM
- 8- Improvement management.

Total productive maintenance integrates production and maintenance people and processes in order to achieve ideal manufacturing conditions through efficient equipment and employee engagement. Multi skilled operators are given the autonomy to do maintenance on the machines they operate. This practice is also referred to as autonomous maintenance. The purpose of autonomous maintenance is to develop operators so that they are able to take care of small maintenance jobs on their equipment. This frees time for skilled maintenance technicians to concentrate on value-add activities and complex technical repairs (Venkatesh 2009).

TPM requires the mastery of 4 equipment maintenance techniques:

- 1) Preventive Maintenance to prevent breakdowns;
- 2) Corrective Maintenance to modify or improve an equipment for increased reliability and easier maintenance
- 3) Maintenance Prevention to design and install equipment that are maintenance-free
- 4) Breakdown Maintenance to repair equipment quickly after they break down.

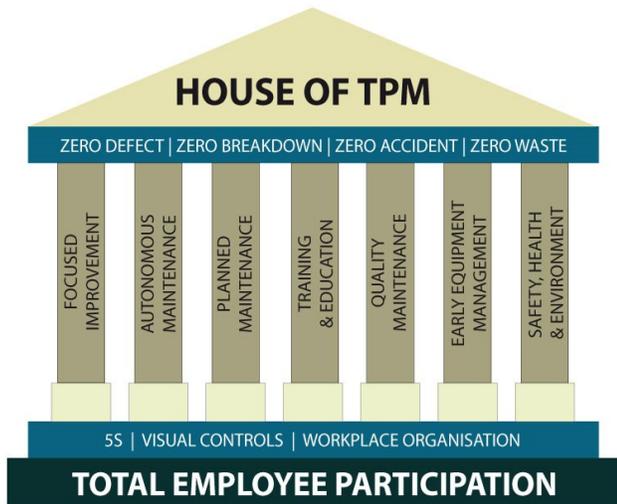


Figure 3

II. LITERATURE SURVEY

TPM describes a relationship between production and maintenance that aims to achieve continuous improvement in product quality, operational efficiency, safety and maximum capacity (Seiichi 1988). Nakajima states that without TPM, the Toyota production system could not function. In their 2001 study on the factors that influence the implementation of TPM and its impact on manufacturing performance, McKone et al found that through just in time (JIT), TPM had a positive direct and indirect relationship with low cost, high levels of quality and strong delivery performance (McKone, Schroeder et al. 2001).

A successful maintenance management program is measured by the elimination or reduction of the six big equipment related losses (Kyōkai 1996). The reduction of breakdowns (1) and setups (2) results in very low equipment downtime and high availability. The elimination of small stops (3) and reduced equipment speed (4), results in the increase in productivity and process yields. The elimination of start-up delays (5) and production rejects (6) results in a dramatic improvement in product quality. The goal of any well-run maintenance organisation is to have the lowest cost of the sum of two quantities; that is, maintenance labour and material as well as production loss (Kelly 1997; Moubay 1997). Production loss includes inability to produce due to equipment break downs and producing low quality products due to inefficient equipment. The elimination and reduction of the six equipment-related losses increases equipment efficiency and lowers maintenance and production losses.

Geraerds describes maintenance as all activities that are aimed at keeping equipment in, or restoring it to, a physical state necessary for it to fulfill its production function (Geraerds 1983).

III. MAINTENANCE MANAGEMENT

I. Traditional maintenance

The function of maintenance management team is to identify appropriate maintenance policies to control the condition of equipment in line with the objectives of the organization, which certainly include minimization of Maintenance costs. Maintenance tries to lengthen the operating life of equipment as long as possible in order to maximize the returns on investment. The main problem maintenance attempts to address is to minimize plant failure as far as possible to ensure maximum reliability and availability of plant hence facilitate optimum productivity and profitability. Any money saved due to improved productivity of maintenance goes straight to profits.

II. Condition-based plant maintenance

Of the three traditional plant maintenance methods, condition-based plant maintenance is the one that enables the service life to be leveraged optimally and economically. In condition-based maintenance, a maintenance task is required only if a specific level of wear and tear has been reached. To enable condition-based plant maintenance to be carried out, the actual condition of the system component must be measured precisely by means of regular inspections. Condition monitoring systems are effective when they become part of an overall planned maintenance strategy. In this there is scheduling of the work, planned stock control, adequate documentation and allowance for emergency maintenance. Not all plant failures can be predicted.

III. Total productive maintenance (TPM)

The main characteristic of TPM is that the tasks formerly planned and carried out by central PM departments are transferred gradually to the machinist. TPM means that operators are empowered to maintain continuous production on totally efficient lines. Within the scope of TPM, the actual PM department analyses the PM tasks carried out by the operating personnel. The PM department also carries out strategic planning, administration of maintenance task lists and maintenance plans, as well as cost control.

IV. REACTIVE OR BREAKDOWN MAINTENANCE (RM)

This is one of the most inefficient maintenance strategies for reliability. It is a very high-cost strategy in terms of maintenance costs and production losses. In reactive maintenance equipment is repaired only after it fails or its performance has severely declined. The strategy was widely used in the 1940s. It has the disadvantages of unplanned stoppages, excessive equipment damage, spare parts problems, high repair costs, excessive waiting and maintenance time and high trouble shooting problems (Ben-Daya 2009). Despite the cost and inefficiency of the strategy, studies show that it is the most widely used in most manufacturing organizations. More than 55% of maintenance activities and resources are spent on reactive maintenance, 30% on preventive maintenance and 12% on predictive maintenance

(Gulati, Smith et al.2009),

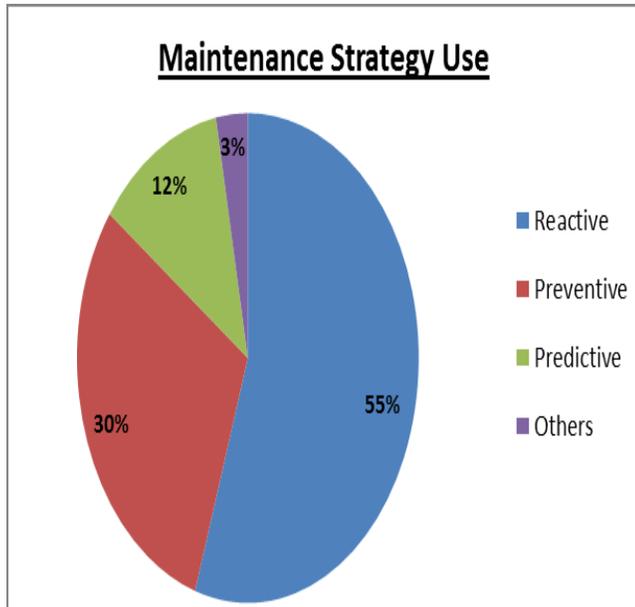


Figure 4 - Maintenance Strategy Use Distribution

V. PREVENTIVE MAINTENANCE (PM)

Preventive maintenance started to emerge in the early 1950s as a new and improved development from reactive maintenance. Rather than run equipment to failure, preventive maintenance aims to increase equipment availability and reliability by preventing breakdowns and prolonging equipment life. In the execution of this strategy, maintenance activities are undertaken after a specified period of time or amount of machine usage (Gits 1992).

Planning maintenance activities to avoid production disruptions and maintaining equipment before it completely breaks down reduces maintenance costs like labour, parts, downtime and quality. Some of the activities associated with preventive maintenance are planning, inspections, cleaning, adjustments, lubrication and parts replacement. As more preventive maintenance is carried out, the costs of PM rises, but the cost of reactive maintenance falls. The total maintenance costs also goes down until it reaches an optimum level, where increasing PM activities starts to have a negative effect on the overall maintenance cost. Figure 4 shows maintenance cost versus increase in PM and decrease in RM activities. The cost-effective point of balance between preventive and reactive maintenance activities is within range L. (Levitt 2003). Studies indicate that these savings can amount to as much as 12% to 18% on the average over a reactive maintenance strategy (Gregory, Aldo et al. 2004). As much as preventive maintenance is a better strategy than reactive maintenance, it has its own short comings like; it requires more resources to carryout regular PM activities. The strategy cannot eliminate unexpected equipment failures. The carrying out of some PM activities maybe unnecessary and could result in service errors that lower equipment life.

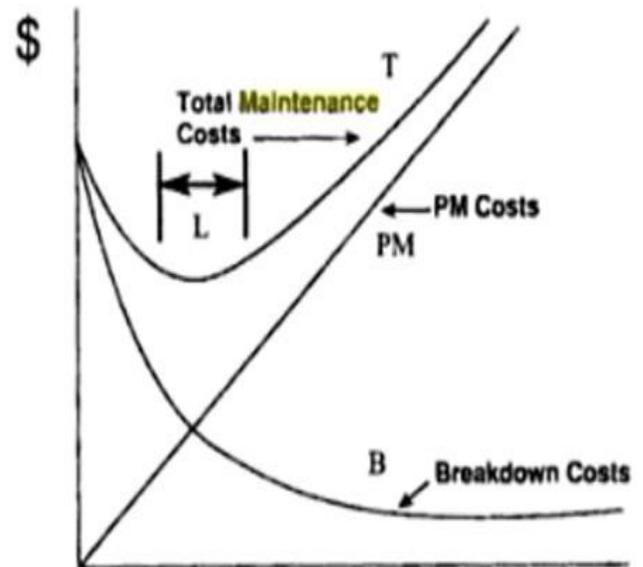


Figure 5 - Total Maintenance costs due to lowering RM and increasing PM.

Courtesy of Complete guide to PM and predictive maintenance – J. Levitt.

VI. PREDICTIVE MAINTENANCE (PDM)

Predictive maintenance, also known as condition based maintenance (CBM), is a maintenance strategy, whose activities are initiated based on the condition of the equipment rather than on a time schedule or amount of machine usage as in preventive maintenance (Beebe 2004). This improves the use of maintenance resources in that only necessary maintenance activities are executed. Equipment will be scheduled for maintenance only when its condition starts to deteriorate. There is less production disruption as equipment can be planned to be taken out of service on evidence of deterioration. Different diagnostic techniques are used to measure the physical condition of the equipment such as temperature, noise, vibration, lubrication and corrosion (Chary 2004). These are depended on the condition that needs to be monitored. Temperature is used to detect loose electrical connections, damaged insulation or lack of ventilation. Vibration analysis is used to detect misalignment, rotation imbalance, bent shafts or damaged bearings.

VII. PROBLEM STATEMENT

To improve the operational status of a company, there are required strategies that aim to eliminate waste, ensure quality and reduce costs. The approach to Total Productive Maintenance (TPM) leads to the development of methods and management tools that promote organizational change, especially at human resources level. TPM philosophy supports a culture in which the operator develops a sense of belonging towards the equipment that he handles, getting to know them better, ensures a climate of continuing efforts towards the targets of belonging, developing skills and competencies, to continually stimulate the operators action improvement (Willmott, 1994). Development of one of TPM pillars, autonomous maintenance, is at the root of these changes. In this case, through the sense of belonging, it is promoted the interest of operators for their work and performance, providing organizational advantages at all levels. Ahmed and Siong (2007) report that TPM implementation not only improves availability and confidence in the equipment, but also provides progress and increasing in production, in product quality development and develops a team spirit culture, while it also increases work capacity among individuals. In addition to the operational performance improvement of the factory floor, there is an expansion at employees' attitudes levels.

Through the productivity model, namely the autonomous maintenance, it was an aim of this study to evaluate the feeling of belonging of operators in a particular factory section, in order to make them able to endorse, in their work environment, changes to ensure high productivity levels. The strategies adopted in this way are associated with the selection of methodologies that provide improvements in people, equipment and processes performances. Materializing this strategy, the implementation of a TPM program was set in verka Milk Plant Hoshiarpur.

VIII. OBJECTIVE

The main goal of this study is related to the development of autonomous maintenance tools. It was also sought to analyse the sense of belonging of the operators in the various sections of the plant, evaluating if the position in the section has consequences in actions that operators develop. Literature supports that the implementation of autonomous maintenance operations develops in individuals a sense of psychological belonging to the equipment they handle. This interaction promotes in individuals feelings of self-efficiency, self-identity, responsibility and territoriality (Pierce et al., 2001 and Avey et al., 2009).

1. Improving equipment effectiveness by targeting the major losses;
2. Involving operators in the daily, routine maintenance of the equipment;
3. Improving maintenance efficiency and effectiveness;
4. Training for everyone involved; and
5. Lifecycle equipment management and maintenance prevention design.

IX. DATA AND METHODOLOGY

The search for studies was carried out using various search engines, e.g., Google Scholar and websites on TPM, using key words like TPM, implementation, cases, tools, etc. The search results gave over 150 papers. This search was then refined and only the papers strictly dealing with the implementation of TPM in food manufacturing industries using certain tools were selected.

X. SELECTION OF TPM TOOLS

The implementation of TPM is reviewed through the existing literature. The authors selected several 'elements' (used here collectively for all the tools, techniques, pillars, etc.) which are used for the implementation of TPM, from various studies.

Table 2 presents the list of elements chosen. These were chosen as they were frequently repeated at many instances in the literature. The justification for selecting the tools is given by enlisting some of the studies which used the same.

Tool Name	Description
1S Seiri	Distinguishes between wanted and unwanted items and eliminates the latter.
2S Seiton	Keeping workplace in order.
3S Seiso	Keeping workplace clean.
4S Sieketsu	Standardize clean-up procedure.
5S Shiktsuke	Maintaining the 5S.
Kobetsu Kaizen	Continuous Improvement.
Jishu Hozen	Autonomous maintenance (Kaizen and group activities) performed by equipment operators after they are trained and made 'equipment skilled'.
Planned Maintenance	Establishment of a planned maintenance (predictive, preventive and productive maintenance) system to increase maintenance efficiency.
Quality Maintenance	Complete removal of faults from the machine.
SHE	All activities to achieve and maintain zero accidents.
Education and Training	Establishment of training courses to bridge the skill gaps of employees.
Office TPM	PM activities (5S, Kaizen, Jishu Hozen, etc.) in administrative and support departments.
Why Why Analysis	Ask 'Why' as many times until the answer of the problem is obtained.
Pareto Chart	Measures the frequency of occurrence of an event.
3W 1H/6W 2H	Why?, What?, Where?, When?, Who? Whom? How? How much?
Loss Tree Analysis	To analyze the various sorts of losses.
Root Cause Analysis	Reaching the root cause of the problem by considering various parameters.
Poka Yoke	Mistake proofing technique.
Performance Gap Analysis	Analyzing the gap between the current and the desired performance.
Machine Chart	Plans the interaction between the worker and machine.
CMMS/IT	Maintains a computer database of information about an organization's maintenance operations.
ECRS (Checklist) Sheet	Helps in generating practical ideas for improvement.
OEE	Evaluates and indicates how effectively a manufacturing operation is utilized.

The companies were segregated on the basis of their industry types, viz., product, process and food manufacturing industries, and metadata analysis was carried out on each one of them individually to further analyze and categorize the various cases in depth.

Table 3

Category	Most Frequently Used Tools
American Companies	E&T, PM, JH, KK, OEE
European Companies	E&T, OEE, JH, KK, PM, SHE
Product-Type Industries	JH, E&T, PM, KK, OEE, SHE
Process-Type Industries	E&T, OEE, JH, PM, KK, SHE
Food Manufactures	E&T, OEE, SHE, PM, JH
<p>Note: E&T – Education and Training; OEE – Overall Equipment Effectiveness; JH – Jishu Hozen; PM – Planned Maintenance; SHE – Safety, Health and Environment; and KK – Kobetsu Kaizen.</p>	

XI. CONCLUSION

From the above reviews and the personal visits in the plant keeping the time period as a constraint the initial implementation could involve the following tools.

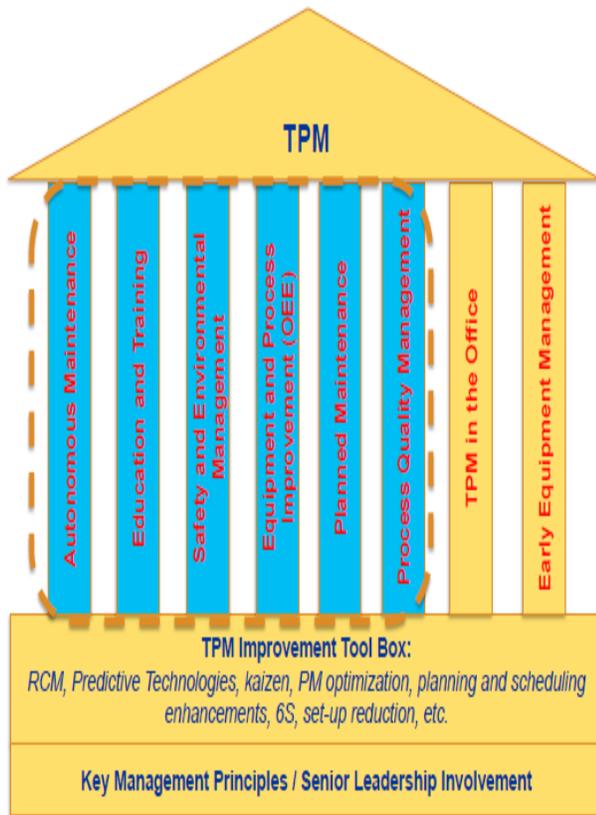


Figure 6

XII. STEPS AT A PRE-REQUISITE LEVEL FROM LITERATURE SURVEY

A cross functional TPM team is established and resourced appropriately from management. All team member have a defined role, team/individual PMO's are established and aligned, meeting frequency identified, and all team members participate consistently. A Daily walk – around checklist is developed and performed consistently for a period of 1month. Operator and technician responsibilities need to be clearly defined.

This could include

1. Daily Gemba Walk
2. Weekly OEE Review
3. Monthly Kaizen Program review

A Visual Management system is in place to capture issues identified during Pre-Flight. Daily Walk Around. An Accountability processes established to address identified issues in a timely manner. Check list, chats, alarms and flagging or tagging activities could be implemented.

12.1 We start by examining the production floor, the maintenance department(s) and the equipment. Area owners and operators provide input for an assessment, which is a systems view of where the factory is from a standpoint of maintenance excellence. We use a progression benchmark, often in the structure of bronze/silver/gold to determine the level of lean progression. The output provides parameters for priority and scope, as well as a solid reference in structuring a get-well plan.

12.2 Establishing a steering committee or ownership structure. While TPM can be described as a “bottom-up” effort (meaning without support from the top), it still requires a team to set goals and identify good measures for full implementation and sustainment. These are set as the organization establishes a “maintenance vision.” It’s remarkable that most production departments have a vision statement, but most maintenance organizations do not.

12.3 Identifying critical equipment. One of the causes of less-than-optimum TPM implementation is the enormity of the scope—and therefore the scarcity of—resources to get the work done. Using a criticality matrix and numerical scoring criteria, we take the “emotional noise” out of the identification and let the data tell us what equipment is truly critical. (Facilities equipment must be taken into account during this process). We can then focus on this list as priority No. 1 in our implementation.

12.4 Determining the condition of each piece of critical equipment. Looking at each sub-system on the equipment (hydraulics, pneumatics, controls, etc.), we can code the condition based on the current state. This not only helps with the planning of TPM improvement events, but also helps organizations plan and prioritize upgrades, overhauls, rebuilds and new equipment purchases. It is a great advantage to be able to effectively plan and predict necessary capital expense.

12.5 Conducting a maintenance skills assessment, implementing a skills matrix. Gaps in skills must be addressed. The first step is to identify what basic skills are in need of enhancement and what machine/process-specific expertise needs to be upgraded. This is also a good time to look at the structure of the department. Does your operation require PM/PdM teams and planners?

12.6 Creating a communications plan and determining initial metrics/measures. It is necessary that both maintenance and production organizations know the why/ how/when, and that changes are in store for everyone.

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12.7 Prioritizing and planning workshops/ events/training. 12.8 Implementing, assessing and improving.

XIII. RECOMMENDATIONS TO INTRODUCE TPM AT INITIAL LEVEL

- Convincing the Top Management and get approval for implementation of TPM Culture.
- Gemba Walk in the manufacturing area to get details of various activities processes and instrumentation involved in it which is also a part of focus Kaizen.
- Segregated the operation area in different zones with the help of production and engineering team applying 5S Principles.
- Divided the work force each Zone wise per Shift.
- Prepare the plan maintenance chart and SOPs and daily checksheets of various machines (which is missing in the organization till date).
- Numbering of machines and instruments (missing till date) to prepare the machine history.
- Introducing Autonomous Maintenance at operator level and recording it.
- Various training programs will be schedule to train and motivate the work force for operator level maintenance, filling of checklist, prioritizing the maintenance requirements through different colors flags and increase the sense of belongingness with the machines.
- To monitor the effectiveness of TPM the OEE will be taken in consideration.

XIV. FACTORS TO MEASURE THE TPM IMPLEMENTATION

1. Machine Availability through machine history
2. Breakdown Time
3. Maintenance Cost
4. OEE ratings
5. Overall Profitability

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REFERENCES

- [1] Hugo Pintoa, Carina Pimentela & Madalena Cunha. Implications of Total Productive Maintenance in Psychological Sense of Ownership. ScienceDirect Procedia - Social and Behavioral Sciences 217 (2016) 1076 – 1082
- [2] Abhijeet K Digalwar* and Padma V Nayagam. Implementation of Total Productive Maintenance in Manufacturing Industries: A Literature-Based Metadata Analysis. The IUP Journal of Operations Management, Vol. XIII, No. 1, 2014
- [3] Doug Kiss .8 Steps to Better Equipment Reliability,More Capacity and Sustained Improvement. © 2012 TBM Consulting Group, Inc
- [4] Ahmed, S., & Siong, S. S. (2007). TPM Implementation Can Promote Development of TQM Culture: Experience from a Case Study in a Malaysian Manufacturing Plant.
- [5] Ahuja, I. P. S., & Khamba, J. S. (2008). Total productive maintenance: Literature review and directions. International Journal of Quality & Reliability Management, 25(7), 709-756. doi: 10.1108/02656710810890890
- [6] Avey, J. B., Avolio, B. J., Crossley, C. D., & Luthans, F. (2009). Psychological ownership: Theoretical extensions, measurement and relation to work outcomes. Journal of Organizational Behavior, 30(2), 173-191. doi: 10.1002/job.583
- [7] Birger, I. (2008). Enabling Intrapreneurship and Psychological Ownership Inside Firms - A case study of a train maintenance company. Erasmus University Rotterdam, Erasmus School of Economics.
- [8] Jeswani, S., & Dave, D. S. (2012). A study on the impact of predictors of psychological ownership on turnover intention among faculty members.IJEMR, 2(2). 1-22. Acedido em <http://www.ijemr.in/A%20Study%20on%20the%20Impact%20of%20Predictors%20of%20Psychological%20Ownership%20on%20Turnover%20Intention%20among%20Faculty%20Members.pdf>
- [9] Gupta, S., Tewari, P. C., & Sharma, A. K. (2007). TPM concept and implementation approach. Patiala, Punjab (India): University College of Engineering.
- [10] Field, A. (2011). Discovering statistics using SPSS (and sex drugs and rock 'n' roll). London: SAGE Publications Ltd.
- [11] Nakajima, S. (1988). Introduction to TPM: total productive maintenance. Portland: Productivity Press.
- [12] Sharma, A. K., Shudhanshu, & Bhardwaj, A. (2012). Manufacturing performance and evolution of TPM. Journal of Engineering Science and Technology, 4(03), 854-866. Acedido em <http://www.ijest.info/docs/IJEST12-04-03-012.pdf>
- [13] Venkatesh, J. (2007). An introduction to Total Productive Maintenance (TPM). Acedido em http://www.plantmaintenance.com/articles/tpm_intro.shtml
- [14] Wrzesniewski, A., LoBuglio, N., Dutton, J. E., & Berg, J. M. (2013). Job crafting and cultivating positive meaning and identity in work. Advances in Positive Organizational Psychology, 1, 281-302. Acedido em <http://justinmberg.com/wrzesniewski-lobuglio-dutto.pdf>
- [15] Pierce, J. L., Kostova, T., & Dirks, K. T. (2001). Toward a theory of psychological ownership in organizations. Academy of Management Review, 26(2), 298-310.
- [16] Pierce, J. L., Kostova, T., & Dirks, K. T. (2003). The state of psychological ownership: Integration and extending a century of research. Review of General Psychology, 7(1), 84-107. doi: 10.1037/1089-2680.7.1.84
- [17] Willmott, P. (1994). Total quality with teeth. The TQM Magazine, 6(4), 48-50. doi: <http://dx.doi.org/10.1108/09544789410062795>
- [18] Ambrose T Mpofo . The quality of milk powder and its dependency on equipment maintenance Management. BEngTech, University of Southern Queensland, TOP New Zealand.