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Upgrading Operational Capabilities with the Implementation of TPM Initiatives in an Indian Industry: A Case Study

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***Abstract*—** The purpose of this paper is to present a case study to demonstrate the TPM implementation methodology and to highlight the benefits achieved after TPM in an engineering industry XYZ Ltd. (name changed) situated in Mohali, Punjab. The improvements in key performance indicators (PQCDSM) after implementing the TPM proved that its implementation helped the company significantly to achieve higher productivity, customer satisfaction, morale and profits. The manufacturing cost reduced by 30%, overall equipment efficiency increased from 63% in 2010 to 84% after three years and productivity improved by 67%. The Company has won the TPM Excellence Award, Category-A in 2013 and after that continued implementing second phase of TPM. The findings of the study govern that the strategic TPM implementation can significantly contribute for the realization of operational excellence in almost all types of industry.

***Keywords*—** Continuous Improvement, Manufacturing Excellence, Overall Equipment Efficiency, Productivity, Total Productive Maintenance,

I. INTRODUCTION

Many organizations have implemented TPM to improve their equipment efficiency and to obtain the competitive advantage in the present scenario of competitive global market especially in terms of cost, quality, delivery reliability and flexibility. There are three main reasons why TPM has spread so rapidly throughout Japanese industry and why companies outside Japan are becoming interested. It guarantees dramatic results, visibly transforms the work place and raises the level of knowledge and skill in production and maintenance workers. People everywhere are beginning to realize that implementing TPM, a business strategy is the only way of achieving high productivity, excellent quality, low cost and short lead times. TPM is a unique Japanese philosophy which has been devolved based on productive maintenance and methodology. The 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 of 1971. TPM is an innovative maintenance approach that optimizes equipment effectiveness, eliminate breakdown and promote the autonomous maintenance by operators. It describes the synergic relationship among all the organization functions, particularly between production and maintenance. Presently TPM has become a plant improvement methodology which enables continuous and rapid improvement of the manufacturing process through the use of employee involvement, employee empowerment and closed looped measurements of results. Total Productive Maintenance (TPM) is a well-defined and time-tested concept for maintaining plants and equipment globally. There is emerging need for TPM implementation in an Indian industries and need to develop TPM implementation practices and procedure.

Nakajima is credited with defining the fundamental concepts of TPM and seeing the procedure implemented in hundreds of plants in Japan; the key concept being autonomous maintenance. TPM initiative is targeted to enhance competitiveness of the enterprises and encompasses a powerful structured approach to change the mind-set of employees thereby making a visible change in work culture of the organizations (Heston, 2006). The goal of TPM is to continually maintain, improve and maximize the condition and effectiveness of equipment through complete involvement of every employee, from top management to shop floor workers (Ireland and Dale, 2006). TPM initiatives in production help in streamlining manufacturing and other business functions, and garnering sustained profits (Ahuja and Khamba, 2007). In TPM the ultimate aim is to achieve significantly reduced breakdown levels through developing autonomous maintenance teams (Thomas et al., 2008). The author studied that the role of maintenance which is not highly recognized (Imad A. et al 2009). A good number of TPM researchers are keen to address the difficulties faced by industry management to implement TPM, improve its implementation methodology and promote TPM in industry. In this paper, a case study on TPM implementation and the achievements after implementing TPM successfully in an engineering industry ABC Ltd. (name changed) situated in Mohali, Punjab are highlighted. The real life improvements in TPM effectiveness indicators (PQCDSM) after implementing TPM highlight the impact of TPM implementation in Indian manufacturing industries.

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II. TPM JOURNEY IN XYZ LIMITED – A CASE STUDY

The vision of the company was "To be within top two brands in India", and to achieve this vision the company adopted TPM as business tool to counter both the external and internal business challenges. The following were the reasons to choose TPM to attain manufacturing excellence in comparison to other management approaches:

- TPM approach is a scientific & logic based methodology to optimize resource utilization to achieve Manufacturing Excellence, which is imperative for our vision realization.
- It is based on participative principle, which is a good fit with Indian culture and psyche.

The TPM initiatives were initiated in the industry to overcome the following business challenges:

i. Old plant and ageing machines
ii. Higher number of breakdowns
iii. Increased losses and higher tooling cost
iv. Lack of quality improvement in the product/equipment
v. No involvement of operators in the up keep of machines
vi. Less employee engagement & rigid mindset
vii. No formal system for preventive & predictive maintenance
viii. No structured system for skill enhancement of cell members
ix. Unsafe working environment

XYZ Ltd. initiated the TPM journey for achieving – zero breakdowns, zero losses, zero defectives and zero accidents.TPM starts with 5'S and its practice started well before initiating TPM. It is a systematic process of housekeeping to achieve a serene environment in the work place involving the employees with a commitment to sincerely implement and practice housekeeping. 5S is in practice in the company on continual basis along with implementation of all the TPM Pillars. TPM implementation program was implemented in XYZ Ltd. in the following four stages and twelve steps:

I. Introduction-preparatory stage: Steps 1 to 5
II. Start of introduction: Step 6
III. Introduction-execution stage: Steps 7 to 11
IV. Established stage: Step 12

Step-1: Top Person's announcement to Introduce TPM

To achieve a competitive advantage and remain on leading edge the management of XYZ Ltd. decided to implement Total Productive Maintenance (TPM) philosophy in both the tractors manufacturing plants. The management announced its implementation in early 2008.

Step-2: Initial Training

To carry out the TPM activities, a company needs persons with strong maintenance and equipment related skills. This is because one of the important goals of TPM is to raise workers' skill levels and this only can be done if there is thorough and continuous training. For individual excellence, training programs were held in depth for the understanding of technical knowledge and a broad range of skills. The training programmes on TPM, its advantages and challenges to adopt it, implementation plan and how to calculate OEE, 5S, 16 major losses, etc. were organized in different modules.

Step-3: Formation of TPM promotional organization

TPM has 8 pillars of activities, each being set to achieve a zero target. TPM Pillars committees were formulated in the beginning with one pillar chairman heading the committee under TPM plant promotion management committee chairman. Members from various departments were nominated as Pillar Representatives. Regular meetings were conducted and pillars chairmen used to present the monthly progress to the TPM Head. Pillar Chairman used to provide all necessary support and guidance to his pillar members.

Step-4: Setting of TPM policy, objectives and targets:

a) TPM Policy was formulated based upon the vision of the company 'To be in top two brands in India by 2013' as:

i. Maximize reliability of plant & machinery by aiming at zero breakdowns, zero defects, zero losses and zero accidents.
ii. Nurture team work & continual improvement through total employee involvement.
iii. Promote healthy, clean & cheerful working environment.
iv. Cultivate 'My machine, My work place' work culture for the overall improvement in the organization.

b) TPM objectives

i. To enhance productivity and quality of the product
ii. To establish a structured preventive & predictive maintenance schedule.
iii. Focused approach for the restoration of the basic condition of the machines rather than attending only breakdown failures
iv. Develop machine ownership among cell members
v. To create safe and hazard free environment

c) TPM Targets

Striving for achieving - zero breakdowns, zero losses, zero defectives and zero accidents

Step-5: Preparation of master plan for implementing TPM

Detailed master plans for all the eight pillars to be implemented in respective plants were prepared. These master plans were followed strictly by all the pillar heads for the successful TPM implementation.

Step-6: TPM Kick-off

For the motivation of all employees, initially TPM initiatives were implemented only on Manager Model Machines before companywide deployment of all the eight pillar activities. Five machines – machining centre (LMS), two machining centers (HMS), internal grinding machine (LMS) and CNC turning machine (LMS) were identified as Manager Model Machines for the TPM implementation from three plants. First only three steps (Step 1, 2, 3) of Jishu Hozen were implemented on Manager Model Machines. After their successful implementation up, other important themes of Kobetsu Kaizen Pillar were implemented. After deployment of Kobetsu Kaizen Pillar activities, all other pillars activities were also implemented in parallel on them. The progress of improvement in Manager Model Machines was audited by the consultant from time to time till this improvement obtained to his satisfaction level. After successfully implementing TPM pillar activities on Manager Model Machines, TPM Kick-off

ceremony was held on 18.06.2008 and companywide deployment of all the eight pillars of TPM with their activities, were started from July, 2008.

Step-7: Establishment of a system for improving the efficiency of the production facilities with the execution of following four pillars as mentioned below:

Step-7.1 Jishu Hozen (JH) Pillar Activities: The aim of JH pillar was to develop equipment competent operators so that equipment should be well maintained with improvement in work place. To achieve the above mentioned targets, the following activities were performed under JH pillar initiatives:

1. Carried out 1S-2S activities
2. Selected manager model machine and initiated JH activities on model machines
3. Initial training on TPM activities were given to the operators.
4. Implemented JH Steps 0-5

Step-7.2 Kobetsu Kaizen (KK) Pillar activities: The aim of Kobetsu-Kaizen (KK) pillar was to identify losses, allocate resources for eliminating these losses on a continual basis through the use of several TPM tools and techniques. The following KK pillar initiatives were performed to achieve the desired KK pillar targets:

1. Selected manager model machines.
2. Loss capturing and analysis was done on all machines.
3. Prepared loss cost matrix and prioritized losses.
4. Kaizen projects carried out to overcome the losses.
5. Implemented of Kaizen projects findings.
6. Monitored saving achieved and horizontal deployment of Kaizen projects findings
7. Calculated of OLE and OPE and improvement in OLE and OPE

Step-7.3 Planned Maintenance (PM) Pillar Activities

The goal of PM pillar was to achieve the zero breakdown by ensuring the equipment conditions at their best with minimum maintenance cost and to sustain it with the help of continual improvement activities. PM pillar included all the necessary maintenance tasks which were required for the proper up keep of equipment. The following activities were carried out under PM pillar initiatives to meet above targets:

1. TPM awareness program was carried out for all employees.
2. Formation PM teams to carry out PM activities on manager model machines.
3. Carried out 1S-2S activities in entire plant.
4. Initial training and awareness on PM initiatives imparted to all the employees.
5. Established maintenance planning management and maintenance information management systems.
6. Developed modules for spare parts and lubrication management.
7. Predictive maintenance system was deployed.
8. Maintenance skill and knowledge level of all operatives were up graded.

Step-7.4 Education and Training (E&T) Pillar Activities: The aim of E&T pillar was to build employee's capability by upgrading their knowledge and skills. E&T pillar initiative improves individual and team performance, thereby enhancing the morale of the employees. The following activities were carried out under E&T pillar initiatives to impart education and training to employees:

1. E&T pillar objectives and its promotional programmes
2. Set up technical training centre for machine shop and assembly shop
3. Identify skills and competency level for staff and cell
4. Modules were prepared and training was delivered as per needs
5. Evaluation of training was carried out

Step-8 Deployment of Initial Control Pillar Initiatives

The aim of DM pillar was to upgrade existing products, develop new products and improve process capability. It mainly focuses on production of right products in first time thereby meeting customer requirements. The following activities were carried out under DM Pillar initiatives to enhance manufacturing performance:

1. Captured customer needs to upgrade existing products
2. Identified area of improvement in existing products and design improvements required in existing products
3. Introduced improvements in existing products and analyzed gaps.
4. Identified & introduced new models.
5. Analyzed existing product development process.
6. Reduced machine installation time
7. Initiated life cycle costing (LCC)
8. Reduced vertical startup time

Step-9: Deployment of Quality Maintenance Pillar Initiatives

The QM pillar focuses towards delighting customers by offering defect free tractors. The aim was to achieve zero defects by supporting and maintaining equipment conditions. The following initiated the following activities:

1. Post customer complaints data analysis and theme up activity
2. Defects Outflow Prevention activity-Poke yoke, etc.
3. In-process defects data analysis and theme-up activity.
4. First Piece and Last Piece control system.
5. Quality control audits.
6. Maintenance and Control audits

Step-10: Deployment of Office TPM Pillar Initiatives

The aim of OTPM pillar was to build and maintain a highly productive and responsive office by improving the office efficiency. OTPM acts as supportive function for better plant performance by reducing inventory cost and increasing utilization of work area (offices). The following OTPM pillar initiatives were taken to improve workplace efficiency:

1. Initial cleaning by implementing 1S, 2S in workplace, along with 5S activity for continuous improvement was carried out. Also, visual management was done to enhance efficiency of the system.
2. Potential areas were identified and improvement initiatives were implemented.
3. The areas to be improved were identified and improvement initiatives were carried out to enhance process efficiency
4. Record keeping of breakdowns in PCs / Printers and subsequent improvement initiatives were carried out

Step-11: Deployment of Tool Management Pillar

The TM pillar is implemented as an additional pillar to overcome tool losses. TM pillar focuses on tool cost & tool inventory reduction through various improvement activities in cutting and assembly tools. The following activities were performed in TM pillar initiatives:

1. Tools were identified and categorized
2. Identified high consumption tools
3. Data collected for tool cost per tractor
4. Identified and implemented tool cost reduction projects
5. Improve control system for reduction in tool inventory; rationalize/standardize tools to reduce variety lead time; find out inventory levels and maintain
6. Generated monthly/quarterly reports, analyzed gaps and countermeasures were carried out respectively
7. Generated loss-cost matrix and kaizens were performed to reduce losses

Step-12: Receipt of TPM Award

XYZ Ltd. implemented TPM successfully and attained the set targets. The company cleared the first assessment by JIPM on May, 31 2012 and got awarded "Category-A" TPM Excellence Award in June, 2012 by the JIPM. This was made possible due to the total commitment of the management and active participation of all employees of the company.

III. Results of TPM Implementation

TPM implementation in XYZ Ltd. remained very successful in improving organization's competitiveness and manufacturing performance. The company is continuing with TPM initiatives for sustaining the achieved manufacturing excellence and is willing to initiate the next level of TPM Award. The study on TPM implementation highlight that it helped the company in improving productivity by making processes more reliable and less wasteful. The important tangible and intangible benefits achieved by the industry after the implementation of TPM are highlighted as:

A. Tangible Result Achieved in XYZ Ltd.

The chief tangible benefits achieved after TPM are:

I. Improvement in Customer satisfaction index:

The improvement in the customer satisfaction index occurred significantly as shown by fig. 1.

Fig.1 Improvement in customer satisfaction index

It becomes 106 in the year 2012 as compared to 76 in 2008. Improvement in Customer Satisfaction Index happened because of reduction in manufacturing cost, decrease in defects due to poor JH and poor skill/human errors, reduction in field complaints and schedule adherence.

II. Improvement in Sales Volume:

The sales volume of the company increased from 29400 tractors in 2008 to 67483 tractors in 2012 as presented by fig.2.

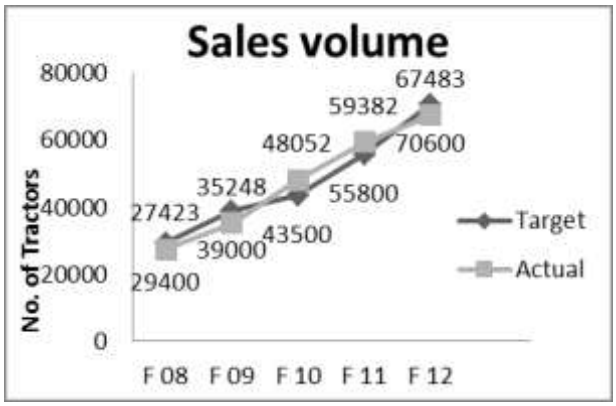

Fig.2 Improvement in sales volume

Increase in Sales Volume occurred because of enhanced OEE, decrease in defects due to poor JH and poor skill/human error, reduction in breakdown incidences, schedule adherence, capacity enhancement without new additions and decrease in production losses.

III. Reduction in System Cost (% to sales Revenue):

There occurred a good decrease in system cost as highlighted by fig. 3. System cost reduced significantly because of increase in productivity (OEE), reduction in field complaints, effective working capital management, reduction in maintenance cost, reduction in energy consumption, reduction in tool change loss, improvement in Skill of operatives, reduction in supplier complaints and reduction in machine shop rejection.

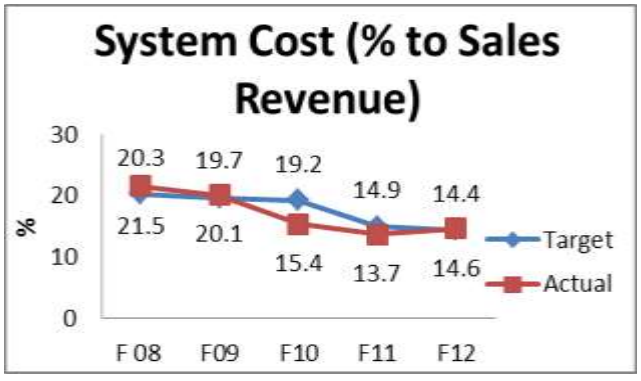

Fig.3 Reduction in system cost

IV. Improvement in Employee Satisfaction Index:

The employee satisfaction index improved from 68.3 in 2008 to 74.3 in 2012 after TPM implementation as shown in fig. 4.

Fig.4 Improvement in employee satisfaction index

Improvement in Employee Satisfaction Index obtained because of successful implementation of 5S throughout the industry, increase in number of multi-skilled operatives, decrease in number of accidents/first aid cases, knowledge/skill improvement, improvement in financial benefits and reward/Appreciation certificates.

V. Yearly plant production volume:

The yearly plant production volume enhanced from 19109 tractors in 2008 to 38200 tractors in 2012 as shown in fig. 5. Increase in plant production volume occurred because of enhanced OEE, decrease in defectives production, reduction in breakdown incidences, schedule adherence, increase in number of multi-skilled operatives capacity enhancement without new additions and decrease in production losses.

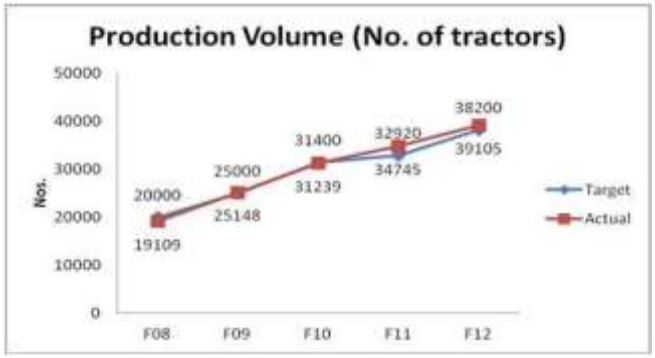

Fig. 5 Yearly plant production volume

B. Intangible Benefits Achieved

The intangible benefits obtained with the implementation of TPM are:

i) Cultural change: TPM implementation brought the following desired changes.
   a) Mind set changed
   b) Total employee involvement started taking place

ii) Achievement of following zeros:
   a) Zero Breakdown
   b) Zero Accidents
   c) Zero Defects

iii) Ownership attitude developed:
   a) Improve work culture-"My Machine" Concept
   b) I Make, I Maintain
   c) I Maintain, I Control
   d) I Control, I Manage

iv) Reduction in losses:
   a) Identified production losses & reduced them
   b) Further reduction in old losses

IV. CONCLUSION

The company successfully implemented TPM initiatives and achieved the TPM Excellence Award in 2012. This makes the company a world class manufacturing industry and globally competitive. The significant improvement in productivity, quality and morale of employees, and a good decrease in labour/maintenance/inventory costs are the prime benefits which the company achieved in the target period of three years. The customer satisfaction index and employee satisfaction index improved after TPM by 40% and 9% respectively. The sales volume and yearly plant production volume enhanced by 130% and 100% respectively. The detailed study on the implementation of TPM in XYZ Ltd. strongly recommends that the implementation of TPM initiatives are must to gain manufacturing/business excellence in industry.

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