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Synergistic Impact of Total Quality Management and Total Productive Maintenance on Manufacturing Performance

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Abstract

Objective: To study the impact of synergistic application of TQM and TPM on manufacturing performance of an organization. **Method:** In the present work, six parameters (productivity, quality, cost, delivery, safety, morale) of manufacturing performance have been identified and attempt has been made to devise a correlation between these parameters when these two business activities are applied synergistically. This study has been done on the basis of implementation of TPM and TQM in Mahindra and Mahindra, Swaraj Division, SAS Nagar. **Findings:** It has been concluded that less visible improvement in manufacturing performance is achieved when TPM approach is implemented individually but substantial results become visible when it is implemented in association with TQM. In fact, TPM and TQM models extend over each other's domain for building structure of product quality. **Improvement:** Order of manufacturing performance parameters should be prioritized for every company.

Keywords: Kaizen, Manufacturing Organizations, Manufacturing Performance, Total Productive Maintenance (TPM), Total Quality Management (TQM)

1. Introduction

The competition in the market is getting stiffer day by day as globalization has provided a common platform to both the domestic and international players to launch their products. Thus, it is a big challenge for domestic manufacturers to compete with multinational companies for their survival. The challenge ahead is not only to locate new customers but also to retain the old ones. Due to rapid change in management practices, expectations of clients, supplier attitude, level of competition and process as well as product technologies, the manufacturing sector has been going through exceptionally prominent state of transformation from last three decades[1]. The scenario has changed from customer satisfaction to customer delight. Expectations of customers from manufacturers have got increased exponentially. This has led to adoption of new techniques and business practices to improve the manufacturing performance.

The manufacturing organizations are progressively adopting business strategies like TPM and TQM in order to beat the tough competition in market created by globalization. Adoption of techniques of TPM and TQM has led to improvement in terms

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of quality, productivity, safety, morale, cost and delivery. The timing of introducing the concept of TQM and TPM is also very critical. Management has to take decision whether to start with TPM and then introduce TQM or vice versa. Although, these business strategies are supplementary to each other but simultaneously starting the methodologies of TPM and TQM is bound to leave adverse effects. Management must be fully prepared and do its homework properly before starting TPM and TQM. Management must take all the employees in confidence and create proper environment. In addition to this, management must have sufficient funds, trained manpower and full commitment. Initially, during implementation stage, the manufacturing performance may go down, but management must be fully committed to adopt and sustain new business strategies. Adoption of technique of TPM or TQM alone cannot deliver substantial increase in manufacturing performance so as to ensure survival and growth of organization. But only recently, impact of synergistic approach of TPM and TQM has been given weightage.

The concept of TQM and TPM has been discussed in the next part of the study. Then parameters of manufacturing performance have been enumerated. In last part of study, results have been discussed.

2. Total Productive Maintenance

The vice chairman of Japanese Institute of Plant Engineers (JIPE), Seiichi Nakajima, is known as the father of TPM due to his contribution in promotion of TPM in Japan. The overall efficiency and effectiveness of equipment can be improved by using TPM and setting up an all-inclusive productive-maintenance system spanning the complete life cycle of the device, covering every field relevant to the apparatus (planning, operation, maintenance etc.), by involving every employee in the scalar chain right from top to bottom, volunteering activities in small teams and using motivation as a powerful tool to encourage productive maintenance[2].

Involvement of all the employees at every level is must for successful implementation of TPM. Foolproof strategy has to be made for starting TPM activity. Initially, some machines are selected for initializing TPM process. These machines are called model machines. In first phase, it can be started on two or three machines. For each machine, separate team is constituted comprising of members of different departments viz. production, maintenance, quality and industrial engineering etc. Once the experiment is successful on model machines, then TPM is formally launched. But before formal launching of TPM, machines are categorized as A, B, C and D category machines such that 'A' category is the most critical and 'D' category is the least critical. Breakdown data of each machine has to be known for past three years. This acts as reference point for finding out the improvement after successful implementation of TPM program. TPM has to be launched phase wise covering each category of machines. Overall TPM program can be covered in three to five years depending upon various factors.

Oath taking ceremony is the first step which is performed by all the employees during formal launch of TPM ceremony. Proper organization wide framework is made for successful implementation of TPM. Pillar wise approach is followed. Pillar formation may differ from organization to organization. Basic purpose of this is to involve all departments of organization. Five 'S' activity is carried out in entire organization.

For TPM implementation in Mahindra and Mahindra), entire organization was divided in nine pillars i.e. Jishu Hozen (JH), Planned Maintenance (PM), Kobetsu Kaizen (KK), Tool Maintenance (TM), Quality Maintenance (QM), Education and Training (E & T), Safety, Health and Environment (SHE), Development Management (DM) and Office TPM (OT) pillars. TPM structure followed at Mahindra and Mahindra has been shown in Figure 1.

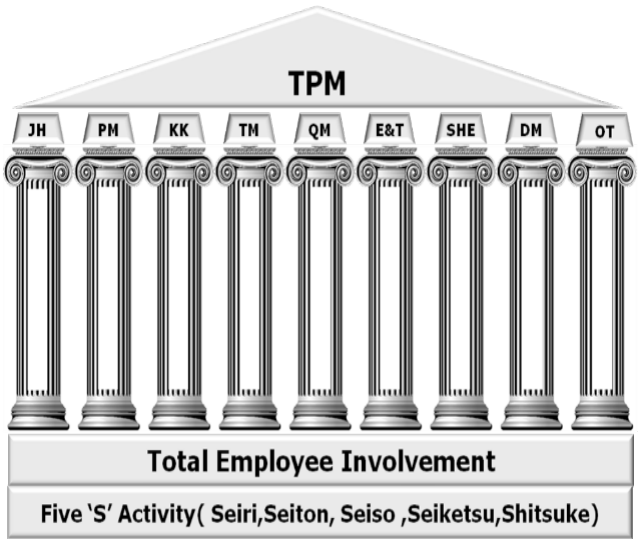

Figure 1. TPM structure at Mahindra and Mahindra (Swaraj Division).

Before the finalization of number of pillars, need analysis of the organization is carried out. After collective brain storming, various broad objectives or needs are enumerated. Need Analysis of Mahindra and Mahindra was carried out and has been depicted in Table 1. Based on that, various pillars are formed. Each pillar is having one broad objective. For every pillar, one pillar head is made accountable. Each pillar head constitutes its team and every team sets up its targets which are in consonance with the organization objective. Every pillar head reports to Plant Head. Regular audits are carried out by inside as well as outside agencies for performance monitoring.

Table 1. Role of different pillars based on need analysis at Mahindra and Mahindra (Swaraj Division)

Pillar	Role
JH	To reduce forced deterioration
PM	To reduce natural deterioration
KK	To eliminate/reduce the losses
TM	To eliminate/reduce losses related to tool
QM	To eliminate the defects
E & T	To enhance the skill and knowledge
SHE	To eliminate the accidents
DM	To develop first time right product
OT	To improve office productivity

In TPM process, JH, PM and KK pillars are the most crucial pillars. Main focus in TPM is on the improvement of Overall Equipment Effectiveness (OEE). For improvement in OEE, various objectives for different pillars were set. In Mahindra and Mahindra, additional objectives of JH pillar were: to achieve zero minor stoppage, to develop ownership and to develop equipment competent operator. PM pillar has lot of work to do and proper co-ordination among PM and JH is the basis of success of TPM program. Activities which were finalized for PM pillar in M & M are as follows:

- Support to JH Pillar
- Breakdown reduction activities
- Preventive Maintenance system development
- Predictive Maintenance system
- Maintenance information system development
- Spare cost Management
- Lubrication Management
- Maintenance skill Upgradation

The most important activity of PM pillar is to work on reduction of equipment breakdown and for this; zero breakdown strategy has to be devised. Role of PM pillar is very critical for achieving zero breakdowns. JH pillar has to work on finding out the abnormalities and classifying them by using white and red tags. White tagged abnormalities have to be worked upon by production department on its own and red tagged abnormalities have to be rectified by maintenance department. Flow chart for approach to zero breakdowns was developed in Mahindra and Mahindra and has been shown in Figure 2.

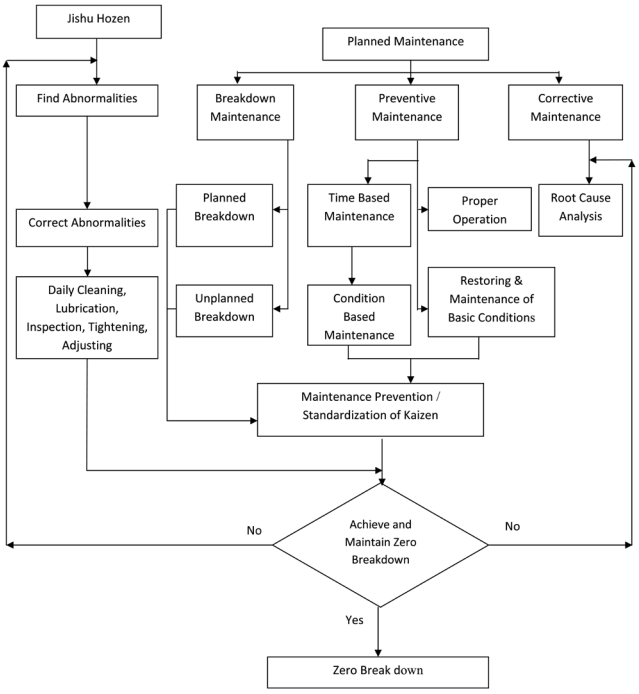

Figure 2. Approach for zero breakdown at Mahindra and Mahindra (Swaraj Division).

Kobetsu Kaizen (KK) pillar has to work on capturing and reducing losses, improving productivity, reducing manufacturing cost and focused Kaizen approach. In this way, role of each pillar is interdependent on other pillars. The origin of TPM has been predestined to strengthen the cooperation between already entangled manufacturing and maintenance activities by implementing a perfect combination of creating an ideal work environment, promoting team spirit and creating an atmosphere for constant improvement[3]. TPM is being recognized as one of the most promising approach for attaining success in view of the extremely dynamic trends of the market by improving

maintenance performance[4]. Vital transformation in the shop floor in the organizations by integration of technology, ethnicity and process is being made by implementing the most emerging operational framework known as TPM[5].

3. Total Quality Management

TQM can be described as an exhaustive organization-wide strategy which ensures the involvement of every person in the company to implement quantitative techniques in order to bring about continuous improvement in the three major elements of the organization: processes, products and services for meeting the ever increasing customer demands and expectations[6]. Introduction and implementation of TQM framework in the organization requires consistent support from top management as executives play a vital role by providing a conducive and encouraging work environment which results in client satisfaction, participation of employees and continuous improvement[7].

TQM has much broader focus on improving the overall effectiveness of the organization by and large. The crux of TQM is that focus is given on development of systems for improvement. Maintaining and improvement of quality is not only quality department job but this has to be implemented organization wide. Above all, the role of quality department is not only quality inspection but quality assurance without reduction in output. Involvement of every employee is must for successful TQM program. In TQM, there has to be common goal for quality, common language of quality and common methods of quality. TQM must ensure achieving quality economically along with satisfying customer needs. TQM principles can be applied to manufacturing as well as service sector. TQM approach is a scientific and logic based methodology for achieving excellence with a view to satisfy all the stakeholders. The most positive aspect of this approach is that it is based on one of the very important characteristics of Indian culture and psyche that is participative principle.

Implementation of TQM program was studied in Mahindra and Mahindra (Swaraj Division) in detail. Here TQM was chosen as transformation approach for improving manufacturing performance. Since the start of concept of TQM in 1980s, many organizations throughout the world have embraced it. Just like TPM pillar formation, Pillar formation was done for successful implementation of TQM. Figure 3 shows the pillar structure of TQM in Mahindra and Mahindra.

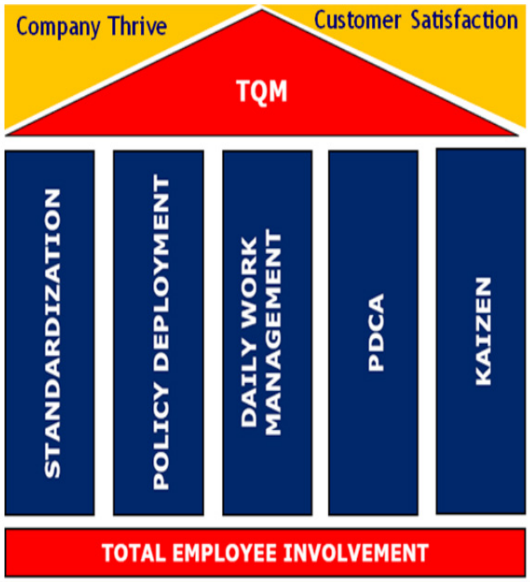

Figure 3. TQM structure at Mahindra and Mahindra (Swaraj Division).

Base of the pillar structure is Total employee involvement whereas customer satisfaction and company thrive have been kept at top. Company aimed to achieve TQM success through Standardization, Policy deployment, Daily work management, PDCA and Kaizens. Rapid deployment of TQM was initiated with well-planned milestones for three years. Education and training were planned based on the skill matrix of all the employees.

The basic objective was to develop TQM way of working and change the mindset across the organization. TPM activities already initiated helped a lot in this. Training objectives were finalized. The list of training objectives along with training topics has been enumerated in Table 2.

Table 2. Organization wide training objectives and training topics at Mahindra and Mahindra (Swaraj Division)

Training Objective	Training Topics
Improve basic working conditions	Training on 1S and 2S
Breakdown Reduction	TPM Training
Improve problem solving capabilities	Quality circles, QC story (yellow belt and green belt projects), Design of Experiments (DOE)

Improve quality of processes and inbuilt prevention in the system for consistent results	Standard Operating Procedure (SOP) Statistical Process Control (SPC) Measurement System Analysis (MSA) Production Part Approval Process (PPAP) Failure Mode and Effect Analysis (FMEA) – This includes PFMEA and DFMEA Quality Function Deployment (QFD) Policy Deployment Daily Work Management (DWM)

As in TPM, work is started by adopting model machines. In TQM, model areas are developed for carrying out 5 'S' activities with clear ownership. Training on CLITA (cleaning, lubrication, inspection, tightening and adjustment) standards is given to all shop floor persons. All officers were covered for training of TQM awareness, Daily Work Management (DWM) and Standard Operating Procedure (SOP). All officers of manufacturing and quality assurances were provided training on Statistical Process Control (SPC) and Measurement System Analysis (MSA).

Training of Production Part Approval Process (PPAP) and Process Failure mode and Effect Analysis (PFMEA) was given to concerned employees as well as to suppliers. All R & D employees were trained in Quality Function Deployment (QFD) and Design Failure Mode and Effect Analysis (DFMEA). After providing extensive training, Quality circle formation and QC story projects were started for incremental improvement. Formation of Standard Operating Procedures (SOP), Quality Control Process Charts (QCPC) and structured system for Statistical Process Control (SPC), Work on PFMEA, DFMEA, Quality Posts and DWM was started. Even regular upgradation of SOP and QCPC was carried out. Quality Post (QP) is basically process of No fault forward system in Assembly line. Whenever there was any fault, these were regularly shared with concerned workmen and officers on daily basis, Resolution of defects was done through QC story or Kaizens and accordingly SOP as well as QCPC was modified. DWM had great role to play to have control on quality, production, cost, delivery safety and absenteeism. DWM boards were displayed at all production shops and at the start of each shift, meeting was held in DWM area for feedback and concern sharing.

4. Manufacturing Performance

The most challenging task in the selection of manufacturing performance parameters is that it needs to be a comprehensive one. Both the tangible and intangible effects need to be included in it. The output of the TPM and TQM program entirely depends upon this selection and any negligence in this matter may affect the success of this approach. Normally, productivity and cost are taken as primary parameters for measuring manufacturing performance. But even in productivity and cost, lot of parameters has to be included. In Mahindra and Mahindra, monitoring of manufacturing performance was done broadly on six parameters which had tangible effects. These were Productivity, Quality, Cost, Delivery, Safety and Morale abbreviated as PQCDSM. Objectives under each head were finalized as given below.

4.1 Productivity

- Number of tractors per person per month
- Tractors manufactured per shift
- Man hours per tractor
- Number of components manufactured per machine per month
- Percentage utilization of each machine
- Breakdown hours of machines
- Breakdown incidences of machines

4.2 Quality

- Customer complaints (in percentage).
- Direct Pass ratio (This is based on percentage of tractors passed without defect at all quality posts).
- Defects per vehicle (These are to be checked in assembly line as well as of finished product (in stockyard).
- Dock Audit Score (This is based on Functional and Aesthetical checking from customer point of view).
- Rejection in PPM (this includes Rejection, Rework in production shop and Throwback in assembly line).
- Process capability index

4.3 Cost

- Tool cost per tractor
- Electricity cost (Power consumption) per tractor
- Consumables (water, Hydraulic oil , cutting oil, spare parts consumed on machines etc.) cost per tractor
- Paint cost per tractor
- Maintenance cost per tractor

4.4 Delivery

- Schedule Adherence-Model wise
- Schedule Adherence- Volume wise
- Spare parts Delivery

4.5 Safety

- Number of accidents
- Number of near miss cases
- Number of minor injuries
- Number of major injuries
- Number of man hours lost due to accidents
- Hours of work stoppage because of accidents
- Number of Poke Yoke done for safety

4.6 Morale

- Employee satisfaction index
- Gall up survey
- Attrition rate
- Number of Kaizens per man per month
- Number of quality circles running in organization

5. Results and Conclusion

As TPM and TQM are becoming very popular and are extensively used by many companies, the comparative analysis of these two approaches has been strongly attracting the attention of researchers nowadays. Miyake[8] has conducted in-depth analysis of these two techniques on basis of a set of functional and qualitative characteristics. It has been concluded that TPM and TQM models extend over each other's domain for building structure of product quality. Sethi and Tripathi[9] conducted a survey on 121 industries in India to identify the crucial factors associated with TQM and TPM, when implemented in combination with each other and if implemented individually.

The timing of introduction of TPM and TQM approach is the most crucial factor on which the success of this approach will depend upon. The implementation of this approach will definitely face a strong resistance in the introductory phase and Mahindra and Mahindra was no exception but once it starts delivering output, it becomes an inseparable part of the organization. TQM was taken as bigger sphere with TPM as nucleus. With starting of TPM activities, culture of total employee involvement had already been initiated and it further got solidified with TQM. There were lot of operational level problems but with the support of Top management and employee involvement, positive results started coming. There was substantial improvement in parameters of manufacturing performance.

Previously, main focus was only on production per shift. But with the monitoring of productivity in different ways and initiating TPM and TQM, it was seen that there was nearly 52% improvement in No. of tractors per person per month. There was nearly 50% reduction in breakdown hours and breakdown incidences. With reduction in different type of losses, substantial improvement was observed in percentage utilization of machines. Likewise on quality parameters, there was considerable reduction in customer complaints. With the introduction of quality check post points, more than 50% improvement was observed in direct pass ratio and improvement is still going on. With improvement in customer satisfaction index, market share of Swaraj increased and it reached from fifth spot to third spot in three years. Profitability of the company also increased substantially with reduction in tool cost, consumables cost, electricity and paint cost per tractor. There were nearly 30% savings in tool cost and 20% savings in electricity cost. Before launch of TPM and TQM, only sales volume of tractors was monitored, but with monitoring schedule adherence (Model wise and Volume wise both), overall sales grew. In TQM, as safety is the key focus area, with monitoring of safety parameters in different number of ways, organization grew as a safer place to work. For every accident and near miss case, proper root cause analysis was done and corrective action taken. For accident prevention, proactive approach was followed and this led to drastic reduction in number of accidents and overall manufacturing performance was increased. With increase in number of Kaizens per employee per month and engagement of increased number of employees in quality circles program, it was evident that morale of employees grew manifold. An increase in Gall up survey score also proved this point.

The conclusion of this study is that less visible improvement in manufacturing performance can be achieved when TPM approach is implemented individually but substantial results become visible when it is implemented in association with TQM. The organization achieved new heights and gained the fifth spot from third spot in the market by implementing this

approach and then targeted for second spot in market share.

6. Acknowledgement

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