CHAPTER - 5

TOTAL PRODUCTIVE MENTAINANCE
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TOTAL PRODUCTIVE MAINTENANCE

Manufacturing Renaissance

Can India be a manufacturing hub? This question has been asked endlessly in recent years as Indian industry tries to take stock of its inherent competitive advantages and eliminates its weakness with infrastructure taxation and high raw material costs. Working against Indian manufacturing, many businessmen have concluded that our real competitive advantage lies elsewhere.

However, the advent of Total Productive Maintenance [TPM] a Japanese system shows that there is life in Manufacturing. With strong support from confederation of Indian Industries and Japan Institute of Plant Maintenance Tokyo (JIPM) the TPM club of India now boasts a membership of around 250 members and is growing. Mr. Sueo Yamguchi is the advisor, Senior Counselor of TPM Club India. His leadership in giving the directions for making TPM a movement has helped the TPM Club India a lot. The TPM gospel as preached by JIPM is based on zero loss concepts in operations, zero breakdowns, zero defects and zero accidents. This helps factories achieve a high level of reliability and flexibility on equipment and reduce costs by minimizing waste of man-hour, raw material and energy.

What TPM does is help companies achieve high level of productivity by developing self-managing abilities in workers and managers, which in turn improve skills and work practices. In the Process, Company can benefit by cutting costs and raising production simultaneously. The movement is catching on. While the automotive sector has been one of the earlier to catch on the idea of improving shop floor productivity and efficiency, Hindustan Lever has pioneered the

This is interesting because FMCG companies traditionally have invested more in marketing, brand building and supply chain initiatives and not so much in manufacturing. But the benefits are already showing. Hindustan Lever Limited [HLL] experience suggests that for rupee invested in TPM; the benefits can vary from 10 to 15 times that. That is a very high return on investment.

What HLL has done is to make TPM the central focus of its manufacturing operations. While 4 strategic factories have already received excellence award from JIPM, another four are well on their way to doing so.

The essence of TPM is business process improvement through working teams. These teams are improved and supported by suitable training and other inputs. They handle the entire process of:

1. Problem Identification
2. Suggestions for Improvement.
3. Implementation of the solution in a collaborative fashion.

The results of TPM are there for all to see from an era of uncomfortable relationship with unions and workers, the company is moving towards workers empowerment and high levels of motivation through TPM.

At the very outset, it will be interesting to note the HLL- TPM story, to understand the importance of these 3 letters TPM.
Total Productive Maintenance

In any other factory worn out machine parts would have been tossed into the crash can. As Hindustan Lever’s Silvassa detergent factory and many others - workers collect failed parts as if they were collector’s items. They put them up on charts and frame them proudly in a museum ‘black treasures’. The reason – anything that fails can be looked upon as a gift if it helps you understand what went wrong and avoid future mistakes. There is little chance of anyone learning from failures if worn out machine parts are earmarked for the dustbin.

Result – Less machine downtime or failures.

A few years ago, if any Hindustan Lever factory manager was told that due to changes in the market offtake, he would have to make Rin Detergent in 125 GM bars & not 250 GM bars, he would have shuddered. Changing a line from one size to another would have meant stopping production for a whole shift leading to tosses and idle work time.

Not any more, today having rehearsed and broken down all the actions involved in changing a line to a few simple moves, most of the work to changeovers can be done even before an existing line is stopped. Result – Line changeover time is down to 25-30 minutes. A Lever factory in Aneli managed closed to 40 changeovers in 26 weeks.

Faster response to market conditions.

If you were to tell a senior workman that he knows less about his job than someone else who is his junior, you may be courting trouble on the shop floor. Seniority counts a lot in conventional set up. At a personal product factory in Daman, though there is a huge board, where the skill levels of workers are noted for everyone to see. If you do not know how to align a motor or pump everyone knows that you do not know. It then becomes your job to find a worker - teacher to show you how - whether he is junior to you or not is immaterial. If needed, you may have to collect 2 or
3 more co-students to team with you. Once you do that your skills, improve.

**Result** – Higher morale higher productivity.

When you are setting up a new factory, you buy the best machinery there is, wait for the package to arrive, set it up & then start the operations. At HLL, they do not do this. When they need a new machine, employees from the company, head straight to machinery manufacturer’s factory to make him incorporate all the design changes needed to make a new machine perform at the highest level of operational efficiency as soon as it is set up. It is called Vertical start up & it provides a huge east advantage to H Levers.

At its Mangalore factory, a form fill seal machine was brought in during the noon shift & by night, it was in operation.

**Result** – Faster payoffs on projects & investments.

In sourcing -- Time was when companies outsourced. Production to cheaper third party producer so that they can concentrate on distribution & marketing the higher ends of the value chain.

At Hindustan Lever Limited, the various manufacturing sites compete on costs to be a part of the corporate production cost. Factories quoting the lowest conversion costs bag the most in house orders.

The Sumerpur factory in Uttar Pradesh astonished everybody when it managed to cut costs so much that it could bring back production of a particular product earlier outsourced to a third party outfit.

**Result** - Greater internal competition & cost efficiency.
### Table 5.1
HLL’s TPM Costs & Benefits over three years

<table>
<thead>
<tr>
<th>Manufacturing sites</th>
<th>Investments (Rs. crore)</th>
<th>Benefits (Rs crore)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silvassa</td>
<td>1.50</td>
<td>21.00</td>
</tr>
<tr>
<td>Chhidwara</td>
<td>0.80</td>
<td>2.40</td>
</tr>
<tr>
<td>Yavatmal</td>
<td>0.60</td>
<td>6.00</td>
</tr>
<tr>
<td>Oral</td>
<td>0.45</td>
<td>6.00</td>
</tr>
<tr>
<td>Raipur</td>
<td>0.42</td>
<td>6.20</td>
</tr>
<tr>
<td>Mangalore</td>
<td>0.62</td>
<td>11.10</td>
</tr>
<tr>
<td>Daman</td>
<td>1.00</td>
<td>13.90</td>
</tr>
<tr>
<td>Sumerpur</td>
<td>0.20</td>
<td>2.30</td>
</tr>
</tbody>
</table>

Ever since the mid 1990s, Rs. 11000 crore FMCG juggernaut has been moving relentlessly forward to squeeze out costs from every possible area. It has struck gold in its factories. Once seen as the breeding ground for union troublemakers, Hindustan Lever’s manufacturing locations have become laboratories for worker empowerment, innovation & cost efficiency.
How? The answer lies in three letters TPM. The Japan Institute of Plant Maintenance (JIPM), Tokyo, pioneers the concept of TPM for operational excellence.

What TPM does, is, help companies achieve high levels of productivity by developing self-managing abilities in workers & managers, which in turn improves skills and work practices. In the process, the company can benefit by cutting cost & raising production simultaneously. According to HLL Chairman M.S Banga – The essence of TPM is business process improvement through working teams cutting across organizational layers.

These teams are empowered & supported by suitable training & other inputs. They handle the entire process of problem identification, suggestions for improvement and implementation of the solution in a collaborative fashion.

A TPM factory is unbelievably superior to a non-TPM one. On an average we have doubled the productivity through TPM and in some cases taken it up to 3 times the original levels.

Gurdeep Singh, director (HR & Technology) of HLL & A TPM enthusiastic puts the benefits simply. He says – TPM is the only business initiative where our returns have been 8 to 12 times investments. The reason why this happens – Before TPM, the worker was seen as having a pair of hands. After TPM, he acquires a head as well. He can think creatively. This is the most important benefit for us. There are no problems related to industrial relations in these factories. There is communication between employees on day-to-day basis so trust & relations are developing.

In any TPM factory success depends on how the ‘base’ of workers responds to initiatives & takes ownership of change. It would be interesting to look at the typical TPM factory org. at HLL. At HLL, every worker belongs to at least one TPM circle. In Silvassa a detergent factory e.g. there are around 20 circles with a leader usually an officer at HLL- At the next level, are the pillar heads usually managers focusing on 8 pillars of
TPM (which deals with issues such as, autonomous maintenance, quality education and training and office TPM). About this we have a group of technical heads of HLL, TPM head and factory managers. At the apex is the corporate TPM steering committee is headed by the HR director. While the factory level circles meet weekly (usually twice) pillar heads meet monthly and corporate level meetings review progress once a quarter.

HLL does not waste too much time to convince everyone about the utility of TPM even though it is the worker who benefits most from the additional safety of machine operations, reduction of physical efforts and improved opportunities to learn new skills. In the initial days, the unions typically saw TPM as another bargaining level. HLL sidesteps all attempts to link TPM to wage settlements & bargaining by asking managers to take the leadership role in initiating new practices. As dictated in JIPM norms, they first identify the model lines and machines, which need improvements. At this stage, the results are achieved through managers and help from worker is not necessary. That cuts down the discussions & ensuing problems. Then they start implementing the training programme. After seeing visual changes in model lines, some workers start joining circles. The people start reinforcing this when they see the capability & creativity of a worker stretched by the tool (TPM) which he enjoys.

(The key to higher machine efficiency lies in spotting problems early and preventing losses of any kind)
What is TPM?

Meaning of TPM

T Total
- Total efficiency Maximization
- Total Life Cycles & Production System
- Total Manpower Coverage

P Productive
- Productivity Maximization by
  - Zero Accident
  - Zero Defects
  - Zero Break down

M Maintenance
- Maintenance covers Life Cycle of Production System
  - Individual Process
  - Plants
  - Production Management System
Definition

A set of activities for restoring equipment to the optimal condition and changing the work environment to maintain these conditions through daily maintenance activities.

The definition given by JIPM
1 TPM aims to create a corporate system that maximizes the efficiency of the production system [overall efficiency improvement]
2 TPM creates systems for preventing the occurrence of all the losses on the front line and is focused on the end product. This includes systems for realising 'zero accidents, zero defects and zero failures' in the entire life cycle of the production system.
3 TPM is applied in all sectors, including the production, development and administration departments.
4 TPM is based on the participation of all members, ranging from the top management to frontline employees.
5 TPM achieves zero losses through overlapping small group activities.

Objectives of TPM

To restructure the corporate culture, behavioral changes and equipment improvement.

Intent

To upgrade the capabilities of all company members through education, training & participation.

Purpose

To identify productivity losses and involve all members of the company in loss elimination programme.
What are the Benefits?

1. Safe work environment.
3. Reduction in cost and improved quality.
4. Increased productivity.
5. Improved Skills.
6. Optimum utilization of assets.
7. Change in work culture & Motivation.
8. Faster alignment of production with market details.
9. Creation of fast track factories.

TPM is a team effort. Smaller teams take responsibilities once handled exclusively by managers and supervisors.

All shifts of production operators, maintenance and tool personnel, unit and plant management – all join in TPM.

**Why TPM is important?**

Maintenance personnel in half of the US plant spend 50% of their time in solving problems instead of preventing them. (Source maintenance technology, Inc. 1992)

In India, this ratio is over 80% as per a year 2000 study done by TPM Club of India.

37% of equipment failures are due to poor lubrication management.

12% equipment failures are due to dirt and poor clean up habits.
Pillars of TPM

The entire edifice of TPM is built and stands on eight pillars. There are 8 pillars:

Diagram 5.1
This can also be put as –

8 Activities and Loss

Diagram 5.2
### Table 5.2  8 PILLARS OF TPM

<table>
<thead>
<tr>
<th>Name of the Pillar</th>
<th>Aim</th>
<th>Table Method</th>
<th>Who?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Autonomous Maintenance</td>
<td>Autonomous maintenance Of Equipment</td>
<td>Timely inspection cleaning up lubrication, repairs etc.</td>
<td>Operator</td>
</tr>
</tbody>
</table>
| 3. Focused Improvement      | 1. To focus or specific & increase Productivity losses, Case of Operation & Standardisation Methods  
                          | 2. To ensure adequate methods for Identification of losses & Countermining implementation.  
                          | 3. To increase ease of detecting correcting Deterioration of equipment.           | Repeated & equipment breakdown analysis & countermeasures,  
                          |                                                                                   | CAP – Do for minor stoppages      
                          |                                                                                   | CAP – Do for change over          
                          |                                                                                   | CAP – Do for Defects              | Operator & Technical service group |
| 4. Education & Training     | Raise technical skill level of operators & Maintenance men.          | Basic maintenance steps & Establishment of training system  
<pre><code>                      |                                                                                   | Activity evaluation &amp; study of Future activity method. | Operators &amp; Maintenance Men    |
</code></pre>
<p>| 5. Early Equipment Mgmt.    | Shorten the trial period for new product, Design of new equipment &amp; men-up time For Stable launching of Produe: | Set forth development &amp; design targets easy to manufacture maintain &amp; reliable equipment | R &amp; D Production Engineering Staff |</p>
<table>
<thead>
<tr>
<th>Name of the Pillar</th>
<th>Aim</th>
<th>Table Method</th>
<th>Who?</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Quality Maintenance</td>
<td>Realise zero defects through observing the Required equipment maintenance.</td>
<td>Review of design methodology Confirmation to the standards for Quality Characteristics &amp; recognize Defects Symptoms &amp; actual defects Records Investigation, analysis &amp; Kaizens for Fregui conditions. Set forth 3M conditions.</td>
<td>Staff &amp; Cell leaders</td>
</tr>
<tr>
<td>7. Safety</td>
<td>- Attain &amp; keep zero accident - Create a healthy &amp; clean working area</td>
<td>- Safety measures to protect the operators from equipment accidents - Make the operation safe - Measure to achieve environment - Attention to health &amp; hygiene protection of the employees - Improve working environment - Promotion of cheerful working environment</td>
<td>Manager &amp; Staff</td>
</tr>
<tr>
<td>8. Office TPM</td>
<td>Realise zero functional loss organise High office loss. Render services &amp; support function To service departments.</td>
<td>By 5 pillar activities</td>
<td>Members of Sales &amp; Administrative Departments.</td>
</tr>
</tbody>
</table>
From TPM of Production Department of Company vide TPM covering all company activities.

TPM Phase 1 – TPM of Production Department
2 – Company vide TPM Encompassing production development, sales & Administration.

Diagram 5.3
What do the eight pillars stand for?

1. **Autonomous Maintenance (Jishu Hozen)**
   Activities in which each operator performs timely inspection lubrication, consumable parts replacement, repairs troubleshooting checklist etc. On their own equipment.

2. **Planned Maintenance** – Aims at inquiring efficiency of Maintenance dept, to eliminate 8 major losses.

3. **Focused improvements** – The aim of this pillar is:
   - To focus on specific losses & increase productivity, ease of operation & standardization of methods.
   - To ensure adequate methods for identification of losses and countermeasure implementation.
   - To increase ease of detecting / correcting deterioration of equipment.

4. **Education & Training** – The aim of this pillar is to raise the technical skill level of operators and maintenance men.

5. **Early Equipment Management**
   The aim of this pillar is to shorten the trial period of new product, design of new equipment and make-up time for stable launching of product.

6. **Quality Maintenance** aims at realizing zero defects through observing the required equipment maintenance.

7. **Safety** – Though the aim of implementing any quality system is to increase productivity, consumer’s satisfaction & reduction in defects, it will be possible only when there is proper work environment. Safety of human asset is of utmost important in the implementation of TPM. This pillar aims at attaining and keeping zero accident level. It also aims at creating a healthy and clean working area. It targets at maintenance of peace of mind. It includes environmental management.

8. **Office TPM**- Finally indirect departments or office TPM aims at realizing zero functional loss and realizing efficiency loss. It also aims at rendering services and support to the service department.
1 Jishu Hozen signified the onset of autonomous maintenance. JH i.e. autonomous maintenance refers to activities in which each operator performs timely inspection, lubrication, consumable parts replacement, repairs etc. on their own equipment.
Diagram 5.4

TPM Roles

Establish basis  Keep operations  Prevent Machine  Improve weak
Improve
Conditions  Conditions  from  Determination  point in Design
Skill

Operators  Maintenance

Management

In Jishu Hozen [JH] the operators are to perform the activities as

1. Prevent Deterioration.
2. Measure deterioration.
3. Restore Deterioration.

Whereas maintenance group support to operators through –
1. Training & guidance in equipment structures and functions.
2. Guidance on lubrication items.
3. Assistance in locating source of contamination.
4. Improvement in hard to access areas.
5. Quick response to operator’s requests.
In JH, awareness is critical, this is ensured by taking operators to model machines, and all the activities carried out are explained to them. Section managers take the classes of TPM circle leaders who in turn take classes for the actual operators. Before JH, safety education about the equipment is given to operators. The training includes the explanation of the concept of autonomous maintenance. Employees are taught that cleaning a machine helps in discovering areas of equipment malfunction.

JH activities in a TPM are divided into various steps. Steps are for e.g. stands for initial cleaning of machinery & electrical or electronic parts. Matters what workers must do are decided in detail. A matter what workers must do at next step is of higher-level activity. Thus it is clear what workers must do and level up step by step. After the first step activity is over, the audit is done to check whether the step activity was good or not. Audit is done by the workers themselves or other group leaders and managers, sometimes by top management. This is useful to communicate to each other and spread activities effectively.

If the worker finds any problem, he puts a tag. Upon completion of the repairs, all tags are taken to training room and the tags & problem area are discussed. All tags are filed for future reference.

Red tag history highlights
- Recurring Problems.
- Repairs History.
- Maintenance Response.

Blue tag history highlights
- Operator Repairs & Minor Stoppages.
- Recurring Problems that need to be Red Tagged.

During this exercise, the activity board is maintained where weekly or daily report of this floor exercise is recorded. Each small group has
each own activity board on which they show their policy, target plan, present activity state, result of the activity, etc. Small group meetings are held in front of this board to know what to do with all the relevant information on the board. This board is also useful to show and disseminate their activity to the other people.

During initial cleanup operators are taught to check:

1. Loosened part. 7. Poor Wiring.
2. Breakage, deformation, 8. Rust.
   cracks. 9. Contamination.
3. Wear & Tear. 10. Oil Leaks.
4. Play, Slack. 11. Unwanted Parts.
5. Misalignment.
6. Poor Soldering.

For e.g. in the process if an employee who is cleaning an electrical panel observes that the wiring condition is 'not ok', then a red tag is put. Company uses two colors tags.

- Blue Tag - Operator responsible to repair.
- Red Tag - Maintenance group responsible for repairs.

The attendant who is authorized to change the wires immediately spots the problems and attends to it on a priority basis.

The next step includes the discovery of areas where cleaning, lubrication and inspection are difficult (like the insides of machinery parts) and improving the same.

For e.g. a machine with opaque covers is replaced by a transparent one and if it makes a sense, the cover may even be removed. Then the process shift to eliminating faulty sources, which generate chips, oil leaks and so on. Environment around the equipment is also cleaned.
All these activity sounds mundane but it is crucial to help change attitude on the shop floor as workmen and officers try to optimize the machines working.

Under JH, employers are educated about factors like abnormality & deterioration in machine conditions and are trained to look for them. As deterioration can be of two types – natural and forced – operators are given the responsibilities for eliminating forced deterioration.

**Diagram 5.5**

![Diagram](image)

- **Natural Deterioration**
- **Forced Deterioration**
- **Aging** under standard operating conditions
- **Artificially accelerated** because of non-standard operating conditions
The key points to be considered at step 2 in JH include rating the machine on criteria from bad to very good after considering whether the machine is accessible for cleaning inspection & lubrication in difficult to reach area. During this step, machine-cleaning time should show a reducing trend or it should be cleaned without actually having to be cleaned. This can be ensured by, for e.g. eliminating the sources of contamination.

Countermeasures for hard to access & source of Contamination are:

1) Relocate for better access.
2) Flexi – glass covers.
3) Windows or Guards.
4) Fill unused or unnecessary holes / grooves.

Eliminate sources that make the equipment dirty:

1) Repair or tag leaks
2) Create ways to remove slag, shaving etc.
3) Use filters where necessary.
4) Check for exhaust fan facilities.

FOR e.g. in one company Nashik where TPM is at kick off stage, HTA and SOC were located for two machines were shown on the sheet as follows--
Diagram 5.6 SOC/HTA

- HTA:
  1. Clamping force not getting released after cycle start.
  2. Wrong clamping site - Clamping both to same mechanism.
  3. Cycle time to be worked at desired depth.
  4. Sufficient stop of lubrication is not present on station.
  5. Force lamp not fitted properly.
  6. Feeding not managed properly.

- SOC:
  1. Couplings bay leakage so that base homeless.
  2. Guard is to be provided for couplings motor.
  3. Noise pollution is to be stopped by providing proper box to preserve value.

- Temp lubrication not - 1. Control limits are not provided to hydraulic tanks.

- One pt lesson: 1. Clamping force not getting released after cycle start.

F-Teq = 10

SOC = 3
Temp lubric - 1

Team members:
- Pandey Anirudh
- M. L. Gandhi
- S. B. Kumbhare
- V. D. Makwaha
- Morya

Tigee
### TPM® One-Point Lesson

**Theme:** Hydraulic oil level indicator

<table>
<thead>
<tr>
<th>No.</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Preparation</td>
<td>11/1/85</td>
</tr>
</tbody>
</table>

#### Classification

- Basic Knowledge
- Improvement Cases
- Trouble Cases

#### Diagram

- **Hydraulic Oil Level Indicator:**
  - High
  - Low

#### Results

- Date Executed: [Date]
- Teacher: [Name]
- Student: [Name]
The auditors usually examine how visual control (through stickers, other devices) of the whole process of cleaning, lubrication, inspection & tightening is done. Inspection is mandatory for identifying areas where malfunction of equipment could occur.

In JH, to enhance the equipment reliability & maintainability, temporary standards are prepared.

Temporary check sheets are prepared for clean up & lubrication standards & everything is marked on it like who will perform the check, what items need to be done, what to used for inspection & cleaning, where the location is to be checked & very important factor i.e. target time to complete the task. Also gauges are marked for loans and high operating ranges. Points of lubrication are color coded for quick, accurate identification.

2 Focused Improvement –

TPM stresses on the focused improvement. The main purpose of Focus improvement [Kobetsu Kaizen (KK)] or individual improvement is to move towards zero losses of all types. The steps taken here are to demonstrate ultimate production efficiency improvement.

Towards this objective 16 major kinds of losses are understood, calculations are made & goals are set for improving overall equipment efficiency (OEE) 16 major losses which obstruct production efficiency are –

(Source JIPM)
I 5 Major losses obstructing manpower efficiency.
II 3 Major losses obstructing material & energy utilization.
III 8 Major losses obstructing equipment efficiency.
I  Major losses obstructing manpower efficiency –
A  Management loss.
B  Operating motion loss.
C  Line org. loss.
D  Logistics loss.
E  Measurement & adjustment loss.

II  Major losses obstructing material & energy utilization
A  energy loss.
B  die, tool & fixture loss.
C  material loss.

III  Major losses obstructing equipment efficiency
A  equipment failure loss-
   1  Stoppage where failure occurs unexpectedly.
   2  Deterioration.
B  set-up & adjustment loss-
   1  Set-up: losses due to change over.
   2  Adjustment: Minor process adjustment.
C  Consumable parts change loss.
D  Start-up loss.
E  minor stoppages & idling loss.
F  Speed loss – slowing the equipment down to produce good quality.
G  Defect & rework loss – time & manpower lost in both types.
H  Shutdown loss – planed stoppage of equipments.

In TPM, stress is given on deciding the target of Operational Equipment Efficiency.

\[ \text{OEE} = \text{operating rate} \times \text{performance efficiency} \times \text{rate of quality products.} \]
Operating rate = function of total time vs down time

- Scheduled
- Planned maintenance
- B/down maintenance
- Change over
- Tool change

Performance efficiency = function of standard cycle time vs actual cycle time

- Operation stability
- Minor stoppages

Rate of Quality product = function of Good output vs defective output

- Rejection
- Rework

OEE is used as indicator of how well equipment is used in batch / lot of production. The OEE is obtained in relation to losses that can impede equipment effectiveness. The magnitude of stoppage loss is expressed as availability, magnitude of performance loss as performance rate and that of defect loss as quality product ratio.

OEE is not only evaluation tool but also identifying room (opportunity) to improve.

Kobetsu Kaizen

The Role of Kobetsu Kaizen

KK sub-committee has a team of upto 7-8 members in a large company representing the heads of different departments and the chairman is usually the Plant Head. The committee has following roles:
1 Recording, categorizing and analyzing 16 losses (except break down and defect loss) machine-wise, department-wise, unit-wise and company-wise.

2 Calculation/Analysis of OEE and set targets for minimizing/eliminating each loss. In some cases, companies are also including specific losses that affect their business. In other words, the formula for OEE may be different at different stages of TPM in a company and specific to the constraints a company may have.

3 Based on business need, set priorities on losses and projects looking at resource constraints.

4 Selecting Kaizen themes based on losses, setting targets and assigning teams to take responsibility for each identified project.

5 Identify bottleneck areas, fix targets and set priorities.

6 Launching of project teams with pilot projects.

7 Helping all support functions to arrive at the Loss vs. cost matrix and the P, Q, C, D, S, M measures.

8 Identifying aim and scope of KK, training requirement and guiding the facilitators to focus losses on company performance.

9 Knowledge sharing through horizontal deployment activities.

10 Develop the Master plan for KK and track progress of Kaizens and OEE.

11 Motivate people to do Kaizens.

12 Giving inputs to the education and training matrix development.

13 Working in close co-ordination with other sub-committees for achieving the PQCDSM targets. This committee will meet at least once a week or month for the above mentioned points.

**Losses considered by KK**

KK pillar deals only with those losses that cannot be handled by any other pillar. All 16 losses have to be considered by the KK committee and make up the loss structure for the company. (Losses due to defect/rework losses...
through Quality Maintenance, failure losses through Planned Maintenance)

Next, the KK sub-committee will identify the priorities and assign project teams to work on specific losses on different machines and areas.

Remaining losses will have to be addressed by KK sub-committee. Usually, they address the following losses:

Each company has to make up their list and collect data. The highest losses will be the priority for the KK pillar. In some companies, this list may be different. This is only an example.

Loss no. 1: Breakdown
Loss no. 2: Set-up
Loss no. 3: Tool change
Loss no. 4: Start-up loss
Loss no. 5: Minor stoppages
Loss no. 6: Reduced speed or speed loss
Loss no. 7: Preventive/Shut down
Loss no. 8: Lay out loss
Loss no. 9: Management Loss
Loss no. 10: Operating motion loss
Loss no. 11: Energy loss.
Loss no. 12: Rejection & Rework
Loss no. 13: Measurement and adjustment loss
Loss no. 14: Logistic Loss
Loss no. 15: Tools, jigs and consumables loss
Loss no. 16: Yield loss

Major three losses can be prioritized in each area to start the work.
Role of operators

Be a member in small groups/circles and participate in circle meetings.

Improve and sustain 1’s’ and 2’s’ to eliminate search time losses.

Identify losses by identifying abnormalities.

E.g. 1. SET-UP time reduction- operators take part in the study of videos taken during set-up activity. They discuss, give ideas and contribute for Kaizen developments in fixing, eliminating and reducing elements in setting.

E.g. 2. Reduction of tool change time- Operators detect and inform the early wearing of tools, and contribute to extending their tool-life.

Provide inputs for quantifying management losses.

Maintain results by following standards built up by PM and JH pillars, which includes generating One Point Lessons.

Assist the KK team to make trials and implement Kaizens when proposed by all pillars.

Training –

Under TPM training is required.

Training covers –
- Training on 16 losses.
- Calculating costs.
- Why-why analysis.
- PM analysis.
- Machine structure/Principle of working.
- SMED [single minute exchange of dye] and setup reduction training.
- Tool technology.
- 3 Ms (Muri, Muda, Mura)
- FMEA, [failure mode effect analysis] Failure Trend Analysis, and other analytical techniques
- One Point Lesson [OPL]
- Industrial engineering and JIT [just in time] concepts
- Poka Yoke/fail-setting
- QC tools and storyboard
  - Training operators to collect data.

**Setting the Targets**

KK sets the targets.

It collects data for previous one year before kick-off. KK committee looks at P.Q.C.D.S. and M at the company level and selects areas under each category. (E.g.)

**P** - Productivity/production increase by
  - Improvement in OEE of machines
  - Improvement in attaining effective man-hours
  - Improvement in labor productivity

**Q** - To bring defects to zero by analyzing
  - Customer complaints & warranty returns,
  - In house rejections,
  - In-house rework,
  - Incoming material rejections.

**C** - Cost reduction through increase OEE-
  - Cycle time reduction in bottleneck machines,
  - Reduction of inventory on cutting tools,
  - Reduction in consumption of cutting oils,
  - Enhance tool life.

**D** - To maintain delivery performance through
  - OEE increase
  - Improve bottleneck machine/process

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S - To achieve zero accident level-
By providing training on machine operations
Identifying unsafe actions and locations and taking corrective actions to avoid accidents.

M - To improve morale of operators through
Involvement and participation in circle activities
By encouraging to generate Kaizens and rewarding for suggestions/improvement carried out.

Usually at least a 5% cost (variable) reduction target should be set as a company objective.
Set target for OEE and then set target for P, Q, C, and D.

1 In some case P targets are set using Task time calculation or 1.5 times current production to achieve in 3 years time.

2 Q targets are set in PPM range and warranty, based on last three-year trend (Q)

3 D target is set for own delivery to customers and also for supplier’s performance.

4 Target for safety is zero accidents. Eliminate unsafe actions and locations, and make hand injury zero in the first year.
In one case study of TPM, zero accident target was achieved by the company then it is now targeting zero breakdown and zero defects.

Target for M is in line with suggestion scheme and any other schemes the organization has liked QCC etc.

The company level targets are deployed down to product-wise and from there on to specific lines and machines.
KK does important job of prioritizing the losses.

Prioritizing of losses is based on –

1. Losses that affect OEE.
2. No. of occurrence of losses.
3. Type of losses (sporadic or chronic).

Quality and failure losses are not covered here. Losses for each machine are calculated and priority is set for bigger losses by value. A flowchart shows how losses can be categorized and then prioritized.

Machine-wise all 16 losses are calculated.

OEE related (8) losses are collected from Production and Inspection records.

Cost related losses-spare, coolant, lubricants are collected by maintenance department and tool losses from the tool crib or tool management center. Data for Vendor related losses is collected from Quality Maintenance team, and management loss is reported by officeTPM. Operating motion loss and line organization loss are reported by industrial engineering. Logistic loss is by Office TPM team. Then losses are compiled by the KK team into the loss structure matrix.

Master Plan –

After collecting losses and prioritizing them, an action plan is drawn up area and machine wise, based on current status as bench-mark and fixing targets:
1. For OEE improvement is planned in -
   - Model machines.
   - Rank A machines.
   - Other machines.
2. Productivity Improvement is expected in –
   - Cycle time reduction.
   - Man-hour utilization.

Project teams/circles are selected and targets on results and time frame are agreed upon.
The KK master plan is aligned to the Overall master plan.

Making the project teams -
Project teams are made for all losses.

Cross-functional teams with relevant knowledge are also made.

Team’s structure should be in a way so that cascading/horizontal deployment can be as fast as possible.

Affected parties are put in KK teams/Project teams.

1. Once the losses are identified, they can be prioritized depending on occurrence and time loss.
2. The losses can be classified and allocation to be done to unit-wise/machine or process-wise.
3. Particular process or machine is selected for study to reduce the losses.
4. Unit/department head where the particular machine/process is taken for study should be the leader and members are drawn from production, tool room, tool design, production engineering, and quality etc. depending upon the requirement.
5. Once the model project team is formed, they should collect all relevant data on losses they aim to bring down/eliminate.
6. The action plan is drawn with activities, time target, person’s responsibilities to carry out the task; supporting help/facilities needed to carry out the task etc.
7. To monitor the programme, meetings conducted at determined frequency on shop floor/site. The necessary help can be drawn from other units/departments and even from external source. Monitoring is to be done by leaders and members of each pillar among with manager of concerned production unit/supervisor, depending on importance, time target, technology and cost involved.

8. The team should prepare the plan and obtain the concurrence from management/top officials. Once the target and results are achieved this can be extended to other departments/units.

9. On successful completion of the project, various teams can be formed throughout the company for elimination of different losses.

**Design changes in KK**

KK sub-committee should involve in introduction of new product or change in existing product. The following are to be considered as an example:

1. Design of fixture/tools to minimize set-up time from one part to another.
2. Cutting blade change time should be minimum.
3. Motion loss should be minimized.
4. Balancing of cycle time to avoid line organization losses.
5. Design changes should be easily adopted with the shortest lead-time.
6. Product design to be taken care of.
7. Commonisation with similar product.
8. Updating design records.
9. Feedback to development management
10. Feedback to OEM
11. Feedback to Machine manufacturer
12. Feedback to equipment design/capital planning and procurement team.
Through Poka Yoke, training and visual/audio instructions on machines
Through tentative standards of step 3 of JH

For standards to be used, it is essential to establish them involving the operators, and then operators must be trained.

Cost Benefit analysis -

KK being important pillar – does cost benefits analysis. Steps are. –
1. Analyze data available on each loss.
2. Categorize losses on
   a) Loss of production
   b) Loss of man-hours
   c) Loss of material
   d) Loss of energy
3. Cost benefit is calculated by evaluating payback periods.
   E.g. Loss on changeover time –
   M/c: MW 12, Cell – 1 (Aluminum), Unit:- Actuation Cell, hour rate:
   Rs.4000/-
   Current changeover time = 4 hrs/changeover
   Reduced changeover time = 1 hr/changeover
   No. of changeovers in a month = 10
   Total hours saved = 30 hours/month.
   Gross saving is at the rate of Rs. 4000/- adding up to = Rs.1.2 Lakhs.
   Amount spent per variety for achieving reduced changeover =
   Rs.2500/-
   Total amount spent = Rs.25, 000/-
   Payback period = \[
   \frac{\text{Total expenses}}{\text{Total cost saving}} = \frac{25000}{120000} = 0.2\text{months.}
   \]
   =Approx. 9 months
1. Monetary awards:
   For e.g. Spot award given for every Kaizen submitted, implementable will enable Rs.100/- award to the suggester, and after implementation, an award of 10% of annual saving (max. of Rs.20,000/-).

2. Non-monetary wards:
   Grading against P, Q, C, D, S, M, is done for proportionately rewarding Kaizens.

   Monthly Kaizen meets to boost the morale of good Kaizens. Awards are announced in common forums addressed by Department/Unit heads.

   Presented Kaizens are displayed in common places with photographs of the Kaizen team who have done the best Kaizen for the month Rolling trophy for the best Kaizens can be given.

3. Top 3 Kaizens of each quarter will be published in the house journal.
   No monetary rewards but certificates from CEO, individual recognition through photographs on notice boards are more desirable.

There may be the Kaizen committee, usually comprising around 7 or 8 members and chaired by plant head that facilitates knowledge sharing through horizontal deployment activities and gives inputs for educating & raining. It works in close connection with other sub-committees for achieving the productivity, quality cost, safety and morale targets.
TPM worker circles in various parts of the factory play a large role in KK. Themes on start-up time, changeover times reduction and so on are allocated to circle for analysis & improvement.

TPM circles may use effective tools such as One Point Lesson. To understand how equipment works & to learn the principles of processing & operation, CAP-DO Cycle,

5 W-1H Stratification of Problem, Why Why analysis, PM analysis for logical analysis for chronic problems. One Point lesson is a very useful tool. It is used for giving information to others, which is received while making improvement through TPM.
3 The Planned Maintenance

PM tries to improve efficiency of the maintenance department. It comprises-

**Planned maintenance**

- Preventive Maintenance
- Periodic Maintenance
- Predictive Maintenance
- Overhaul Maintenance
- Breakdown Maintenance
- Corrective Maintenance
- Maintenance Prevention

PM enables factory to stabilize failures, extend life of equipment, periodically restore deterioration and even predict equipment life. PM supports JH activities and creates awareness among operators on identifying abnormalities. It helps prepare tentative standard for cleaning inspection and lubrication through on the job training of workers.
4 Quality Maintenance (Hinshitsu Hozen)

Quality maintenance or Hinshitsu Hozen typically looks at targets for ensuring the quality products. Though it requires equipment maintenance, it tries to realize zero defects.

5 Early management of equipment or development management is an important pillar from the logical point of view that stitch in time saves time. It helps in initial flow control at times such as when a new product is being manufactured in a factory & when new equipment is being installed. The time taken to set up and get a newly purchased equipment start-up is also drastically reduced with early management. HLL has worked wonders under this pillar in many of its factories.

6 Under Education & training employees are classified into 5 grades (0-4) depending on their experience and skills. For e.g. zero would be an individual who has just moved into a job while one would be an employee who is just aware of what to do, but needs extensive exposure and training. At level 2, worker considers himself reasonably trained. At level 3, he could be considered proficient in theory and practice and at level 4, he would be able to teach & impart knowledge to his co-workers. There may be a skill and will map (like that in HLL) for all to see and it automatically defines everybody’s training needs without any aid from the personnel or HR Wing of the company. The company may call for JIPM consultant to get proper direction.

As the will to learn is important in education & training, employees are categories into 4 classes, also ran, dead wood, starts and passengers.

Also-rans for e.g. are trained in basic skills with on job training. The starts tend to become worker teachers and are given responsibilities of leading kaizen. They are also sent for external courses. The dead wood are given counseling and passengers usually are the people with grievances are encouraged to give feed back on their work and are motivated to move into other categories.
7 The safety and healthy environment (SHE) This pillar covers conventional safety management issues. This breaks (as in HLL) into the 5 basic of workshop management-- productivity management, equipment management, safety management, early management and people management. Under SHE, the aim is to achieve a level of zero accidents and zero defects and reduce the level of human efforts needed to achieve a level of production.

8 Office TPM aims to improve productivity & infuse efficiency in administrative functions by identifying and eliminating losses. It analyses processes and procedures with respect to increased office automation and provide support to shop door activities. The concept of efficiency losses is broken down into decision-making losses, communication losses, data document processing losses and so on.

Office efficiency is bench marked (as in HLL) by looking as issues like the time taken in any manual works, the inventory turnover ratio, and the number of places where work is duplicated, use of storage places for documentation & inventories and money spent on communication. These are analyzed & steps are taken to improve work efficiency. Office TPM helps/enables factories to cut raw material cost by processing payments to supplies faster. As in HLL, office TPM helps cut down on supplier's bill by processing payments faster obtaining discount.

Let us see in details this pillar.

Office TPM addresses seven major losses:
1. Processing loss.
2. Cost loss including in areas such as procurement, accounts, marketing, sales leading to high Inventories.
3. Communication loss.
4. Idle loss.
5. Set-up loss.
6. Accuracy loss.
Benefits:

1. Involvement of all people in support functions for focusing on better plant performance
2. Reduction in administrative costs
3. Reduced inventory carrying cost
4. Better utilized work area
5. Reduce repetitive work
6. Motivate people in support areas
7. Multi skilling in support areas.

Some evident results are:
- Reduced inventory levels in all parts of the supply chain.
- Reduction in number of files
- Reduction of overhead costs (to include cost of non-production/non-capital equipment)
- Increased productivity of people in support functions
- Reduced breakdown of office equipment
- Reduced customer complaints due to logistics
- Reduced expenses due to emergency dispatches/purchases
- Reduced manpower
- Clean and pleasant work environment.

PQCDSM in Office TPM

Each company will have to define for themselves, looking at all losses, which affect plant performance:

These are some examples:

P  - Production output lost due to want of material
   Manpower productivity
   Production output loss due to want of tools.
Q - Mistakes in preparation of cheques, bills, invoices, payroll
   Customer returns/warranty attributable to BOPSs
   Rejection/rework in BOPs/job work
   Office area rework.

C - Buying cost/unit produced.
   Cost of logistics – inbound/outbound
   Cost of carrying inventory
   Cost of communication
   Demurrage costs

D - Logistics losses (Delay in loading/unloading)
   Delay in delivery due to any of the support functions
   Delay in payments to suppliers
   Delay in information

S - Safety in material handling/stores/logistics
   Safety of soft and hard data

M - Number Kaizens in office area.

**Subcommittee in Office TPM**

After kick-off, activate four pillars (JH, KK, QM, PM), THEN START Office TPM (After about one year). A senior person from one of the support functions e.g. Head of Finance, MIS Purchase etc. should lead. Members are representing all support functions and also someone from Production & Quality should be the member.

Starting of Office TPM
Steps followed are:
1. Providing awareness about office TPM to all support departments.
2. Helping them to identify P, Q, C, D, S, M in each function in relation to plant performance.
3. Identify the scope for improvement in each function
4. Collect relevant data
5. Help them to solve problems in their Circles
6. Make up an activity board where progress is monitored on both sides – results and action along with Kaizens.
7. Fan out to cover all employees and circles in all functions.

Identifying losses in Office TPM.

In each functional area identity the losses separately and add them up to build up a master plan for Office TPM. For example:

1. Office equipment breakdown.
2. Communication channel breakdown, telephone and fax lines.
3. Time spent on retrieval of information
4. Non availability of correct on line stock status.
5. Customer complaints due to logistics
6. Expenses on emergency dispatches/purchases
7. Cost reduction on non-production/non capital items.

The role of the TPM Coordinator in Office TPM

- To initiate the Pillar and then review its progress. This will include activities like:

1. Plan and guide activities of Office TPM to the sub-committee’s members from time to time
2. Do audits for office Jishu Hozen activities in office TPM
3. Do audits for Kobetsu Kaizen of activities in office TPM
Kobetsu Kaizen in Office TPM

Kobetsu Kaizen topics are selected aiming at:

1. Inventory reduction
2. Lead time reduction of critical processes
3. Motion & space losses
4. Retrieval time reduction
5. Reducing or eliminating office workflow stagnation
6. Equalizing the work load
7. Analyzing for 'on material areas and improving them
8. Improving the office efficiency
   * By eliminating the time loss on retrieval of information
   * By achieving zero breakdown of office equipment like telephone and fax lines

Audit in office TPM

Check items like:
- 1 's', 2 's'
- Time for retrievability of information
- Number of files
- Disposal of unwanted records
- Dirt and dust free office equipment
- Lights switched off when not in use

This is other than the set targets and actions taken up by each function.

Audit of office to be carried out as Jishu Hozen audit in 3 steps:

   Autonomous audit (self)
   Audit by Section chief
   Top management audit.

Benchmarking:

Benchmarking to be done for various objectives (as on date) like:
- Time taken in any manual work.
- Inventory turnover ratio as on date.
- No. of places where duplicate working taking place.
- Storage space used for documentation.
- Storage space used for keeping inventory.
- No. of suggestions/employees/month as on date.
- Money spent on communication.

Collect data of each loss and fix the present level as benchmark (This can be last month or average of last three months – as long as it is a steady trend).

Data can be average only, if the variation between maximum and minimum is not too much and variation is centered around the average value. In case data indicates downward trends over the last three months, then take the lowest and latest data point as a benchmark.

**TPM Circle** - All the employees from the support function are TPM circle members.

They can take part in JH and KK activities. In some cases, companies have trained all office staff on JH activities (step 1 & 2). Machines are identified where people from office are also involved in the daily cleaning.

TPM circle members should be involved in plant TPM activities, right from the beginning at various states:

**Stage I**
- Planning.
  - Setting targets of office TPM.
  - Formulating basic improvement concepts.

**State II**
- Activities
  - General cleaning of documents, desks and shelves etc.
  - Develop procedure for orderliness and tidiness.
  - Identify abnormalities.
  - Doing focused improvements.
  - Standardisation.

**Visual in Office TPM**
1. Location of each manufacturing unit, departments through clear boards.
3. Visuals for filing system. E.g. putting identification tags when files are removed.

4. Organization of working table.

5. Identification of standard instruments for easy to find.

6. Identification of all materials to enable retrieval within one minute.

7. Organization in stores – labeling, KANBAN, Maximum and Minimum levels.

8. Visualizing results and improvement action on display boards

   The objective of visualization is to make any abnormality immediately visible.

**Scope of office TPM**

1. Office TPM supports the plant, initially in doing Jishu Hozen of the machines (after getting training of Jishu Hozen), as in Jishu Hozen at the initial stages machines are more and manpower is less, so the help of commercial departments can be taken, for this office TPM can eliminate the lodes on line for:
   - No material
   - Logistics

2. Office TPM can be extended to suppliers and distributors.

   This is essential, but only after company has done as much as possible internally.

   With suppliers it will lead to on time delivery, improved ‘incoming’ quality and cost reduction.

   With distributors it will lead to accurate demand generation, improved secondary distribution and reduction in damages during storage and handling.

   In any case, we will have to teach them based on our experience and practice and highlight gaps in the system, which affect both sides.

   In case of some of the larger companies, they have started to support clusters of suppliers.
3. It can be applied in system department
   Start with PC’s Do1 ‘s’ activity to identify required files and make up rules to clean up e-mail folders, fix folder size, frequency of back-up etc. Then at next step go to the mainframe. Decide frequency at which complete clean up will be done.

**Customer satisfaction** (internal and external) is measured as:

- **Internal** – reduction of internal losses is a measure of internal customer satisfaction.
- **External** – On time delivery, customer complaints, customer returns, warranty, response times etc.

For e.g. Company’s Office TPM is –

<table>
<thead>
<tr>
<th>Table 5.3</th>
<th><strong>Office TPM</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P</strong></td>
<td>No material – BOP</td>
</tr>
<tr>
<td></td>
<td>- Data collection</td>
</tr>
<tr>
<td></td>
<td>- Pareto analysis</td>
</tr>
<tr>
<td></td>
<td>- Monitoring</td>
</tr>
<tr>
<td>Office equipment breakdown</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- List out all items to be covered</td>
</tr>
<tr>
<td></td>
<td>- Root cause analysis and countermeasures</td>
</tr>
<tr>
<td>Communication channel breakdown telephone &amp; fax lines</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- List out all items to be covered</td>
</tr>
<tr>
<td></td>
<td>- Implement systems for recording failures, reasons for failures and Corrective action, time taken.</td>
</tr>
<tr>
<td>Non-availability of correct on line stock status – production material</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Introduce system of entry of issues in stock registers before physical</td>
</tr>
<tr>
<td></td>
<td>- Fix responsibilities for root cause analysis on a continuing basis</td>
</tr>
<tr>
<td></td>
<td>- One logic in S/W for all stock statement</td>
</tr>
</tbody>
</table>
In TPM, 'M' stands for Maintenance & Management. Activity Index is decided after taking note of Management Index.
For e.g. Management Index is -
1. Increased Production – * Increased productivity (Production / Manpower x Man-hour)
2. Decreased cost
4. Zero accident

Different pillars of TPM decide their Activity Index & Activity Result Index based on management index.

Table 5.4 KOBETSU KAIZEN INDEX

<table>
<thead>
<tr>
<th>Activity Index</th>
<th>Activity Result Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. No. of Kaizens by - Project Team Circle Members and Engineering staff</td>
<td>1. Overall equipment efficiency</td>
</tr>
<tr>
<td>2. No. of Kaizens for 16 losses</td>
<td>2. Overall line efficiency</td>
</tr>
<tr>
<td>3. No. of Kaizens for each loss</td>
<td>3. Overall Plant efficiency</td>
</tr>
<tr>
<td>4. No. of Horizontal deployments</td>
<td>4. WIP</td>
</tr>
<tr>
<td>5. No. of cases in which various methods are used.</td>
<td>5. Total Down Time</td>
</tr>
<tr>
<td></td>
<td>6. Total saved money</td>
</tr>
</tbody>
</table>
### Table 5.5 JISHU HOZEN (Autonomous Maintenance) INDEX

<table>
<thead>
<tr>
<th>Activity Result Index</th>
<th>Activity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Time reduction of cleaning, inspection, retightening, lubrication</td>
<td>1. No. of tags attached and removed.</td>
</tr>
<tr>
<td>2. Breakdown reduction due to poor JH</td>
<td>2. No. of one-point lesson sheet.</td>
</tr>
<tr>
<td>3. Defect reduction due to poor JH</td>
<td>3. No. of Good to find cases.</td>
</tr>
<tr>
<td>4. Downtime reduction</td>
<td>4. No. of JH Kaizens</td>
</tr>
<tr>
<td>5. Reduction elimination of quantity, parts and materials, which drop during processing.</td>
<td>5. No. of repairs by operators.</td>
</tr>
<tr>
<td>6. Total saved money by preventing leakage of oil, material.</td>
<td>6. Score of 5 'S' activity.</td>
</tr>
<tr>
<td>7. No. of repaired malfunctions by operators</td>
<td></td>
</tr>
<tr>
<td>8. Reduction Time by using One Point lesson Sheets</td>
<td></td>
</tr>
<tr>
<td>9. Trends of JH steps</td>
<td></td>
</tr>
<tr>
<td>10. No. of visual controls.</td>
<td></td>
</tr>
<tr>
<td>11. Upgraded skills</td>
<td></td>
</tr>
<tr>
<td>12. No. of suggestions.</td>
<td></td>
</tr>
</tbody>
</table>
Table 5.6  Planned Maintenance Index

<table>
<thead>
<tr>
<th>Activity Result Index</th>
<th>Activity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduction of downtime due to breakdown.</td>
<td>1. Preventive Maintenance implementation rate.</td>
</tr>
<tr>
<td>2. Improvement of MTBF, MTTR</td>
<td>2. No. of corrective maintenance activities.</td>
</tr>
<tr>
<td>3. Reduction of spare parts</td>
<td>3. No. of MP sheets.</td>
</tr>
<tr>
<td>4. Reduction of oil consumption, Electricity.</td>
<td>4. No. of machines under CBM</td>
</tr>
<tr>
<td>5. Reduction of down-time</td>
<td>5. No. of breakdowns recurrence.</td>
</tr>
<tr>
<td>7. No. of inspections, repairs, transferred in house from Subcontractor.</td>
<td>7. Multi skill maintenance workers.</td>
</tr>
<tr>
<td>8. No. of Red tags removed.</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.7  Quality Maintenance Index

<table>
<thead>
<tr>
<th>Activity Result Index</th>
<th>Activity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduction of quality defects rework</td>
<td>1. no. of Kaizens.</td>
</tr>
<tr>
<td>3. Reduction of inspection time, Manpower.</td>
<td>3. Duration of zero cases - One month - Three months - Six months - More than six months.</td>
</tr>
<tr>
<td>4. Reduction of customer complaint.</td>
<td>4. No. of revised standards.</td>
</tr>
</tbody>
</table>
### Table 5.8 Education & Training Index

<table>
<thead>
<tr>
<th>Activity Result Index</th>
<th>Activity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduction of down time, breakdown due to lack of knowledge &amp; skill.</td>
<td>1. Total time of education, training for operator and maintenance worker.</td>
</tr>
<tr>
<td>2. Reduction of down time breakdown after getting knowledge and skill.</td>
<td>2. Total item of E&amp;T</td>
</tr>
<tr>
<td>3. Reduction of quality, defect, rework after getting knowledge and skill.</td>
<td>3. No. Of one point lesson sheets.</td>
</tr>
<tr>
<td>4. Reduction of sub-contractor job after getting skill.</td>
<td>4. No. of delegates for seminars.</td>
</tr>
<tr>
<td>5. Evaluation of knowledge &amp; skills.</td>
<td>5. Evaluation of knowledge &amp; skills.</td>
</tr>
<tr>
<td>6. No. of Kaizens proposed.</td>
<td>6. No. of Kaizens proposed.</td>
</tr>
</tbody>
</table>

### Table 5.9 Safety & Environment Index

<table>
<thead>
<tr>
<th>Activity Result Index</th>
<th>Activity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Reduction of accidents.</td>
<td>1. No. of Keizens for unsafe place, action.</td>
</tr>
<tr>
<td>2. Reduction of noise.</td>
<td>2. No. of safety proposals.</td>
</tr>
<tr>
<td>4. Reduction of downtime by no accidents.</td>
<td>4. No. of Pokayoke Kaizens.</td>
</tr>
<tr>
<td>5. Saving by reduced energy consumption.</td>
<td>5. Score of five ‘S’ activity.</td>
</tr>
<tr>
<td>6. Reduction of industrial waste quantity.</td>
<td></td>
</tr>
</tbody>
</table>
Table 5.10 Office TPM Index

<table>
<thead>
<tr>
<th>Activity Result Index</th>
<th>Activity Index</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Marketing</strong></td>
<td></td>
</tr>
<tr>
<td>- No. of new customers, new Orders.</td>
<td></td>
</tr>
<tr>
<td>- Reduction of customer order</td>
<td></td>
</tr>
<tr>
<td>cancellations.</td>
<td></td>
</tr>
<tr>
<td>Reduction of inventory due to</td>
<td></td>
</tr>
<tr>
<td>wrong judgement.</td>
<td></td>
</tr>
<tr>
<td><strong>R &amp; D</strong></td>
<td></td>
</tr>
<tr>
<td>1. No. of new products</td>
<td></td>
</tr>
<tr>
<td>2. Reduction of lead-time</td>
<td></td>
</tr>
<tr>
<td>3. Reduction in number of design</td>
<td></td>
</tr>
<tr>
<td>4. Minimizing vertical start up time.</td>
<td></td>
</tr>
<tr>
<td>5. Reduction in numbers.</td>
<td></td>
</tr>
<tr>
<td><strong>TPM measurements</strong></td>
<td></td>
</tr>
<tr>
<td>1. Downtime</td>
<td>5. Maintenance cost</td>
</tr>
<tr>
<td>- Planned &amp; - Unplanned</td>
<td>6. Clean up time</td>
</tr>
<tr>
<td>2. Changeover time cost</td>
<td>7. Accidents</td>
</tr>
<tr>
<td>4. Equipment Check time</td>
<td>9. Defect rate</td>
</tr>
</tbody>
</table>

1  Downtime-
   Planned – This category is made up of schedule production stoppages.
   Unplanned – This category is made up of 8 major losses, which obstruct equipment efficiency.
2 Changeover time is the time period from last good piece produced to the first good piece produced on the new part.
3 Equipment check time is the amount of time required to perform daily checks on the equipment.
4 Clean-up time - the amount of time required to perform daily clean up of the equipment & surrounding area.
5 Equipment failures—total no. of equipment failures on a cell during the shift.
6 Minor stoppages—no. of minor equipment stoppages during the shift.
7 Maintenance costs refers no associated costs for maintaining the equipment on a line. These costs include all replacement costs and the labour required to replace the parts. It also includes cleaning supplies required to maintain the equipment.
8 Accidents—No. of accidents on a cell and the lost time and not lost time.
9 Defect Rate—refers to the defects generated by the process.

The above steps in TPM followed rigorously surely show the improvement in the work process. It helps the companies to identity the productivity losses by involving all members of the company in loss elimination programme. This fact is proved from the following case studies.

**CASE STUDY 1**

Lord Ram's short stay in the holy city of Nashik has enhanced its sanctity. This religious holy city Nashik is the home of Gaskets of all types of the company in the case study. The products i.e. gaskets manufactured in this company are used in all types of motors/ engines throughout the country and also in abroad.

Let us take a closer look at how TPM has rolled out in this Nashik plant of the company. A company has a production capacity of about 14 lacs per annum.
Every TPM rollout follows a step-by-step process. The first step consists of a declaration of the TPM initiative by the local management. In Nashik Plant, a declaration of TPM initiative was made in October 2003 in a ceremony, where everyone was present. It is important from the perspective that TPM though top driven in its approach requires a tremendous amount of involvement from the workforce on the shop floor to derive optimum results. The company has decided to focus on four pillars: Autonomous Maintenance, Planned Maintenance, Focused improvement & Training & Education. Company has already acquired 14000 K certification for Environment and 18000 K for safety.

The second step forms the introduction stage. Here basic knowledge on TPM is communicated to all the employees through a TPM material & 3 days workshop. A deputy manager enthused TPM in a plant, gave training to the workforce in batches at regular intervals. Till November 2004, TPM training has been given to

1. All managers,
2. All shift supervisors,
3. 41 operators,
4. TPM Hindi modules have been prepared and from January 2005 training started or other operators,
5. TPM/Six Sigma booklets have been distributed throughout the company.

To emphasize the importance of TPM, competitions were held for generating TPM slogans, TPM poem/posters to start the involvement process of employees. In a workshop on TPM, the idea of TPM, its tools, were explained in one session of the day followed by practical shop floor training. This helps in understanding the techniques of TPM well.

The third step includes TPM organization or a structure. In Nashik Plant, structure consists of all shifts of production operations, unit maintenance,
tool personnel and plant managers. The groups or circles have been formed in such a way that all employees are covered under TPM activities.

A model manufacturing line with pillar model machines was then started and carried out by the managers and supervisor/teams practically to demonstrate how TPM process should be initiated.

The fourth step included the setting up of the basic policy and targets, which employees could work towards. As per TPM policy, each unit draws up PQCDSM targets in line with business objectives.

The TPM POLICY AT Nashik Plant of the company is-
Zero Accident,
Zero breakdowns,
Zero defects – reduction of losses through teamwork & continuous employee development.

This target has been printed in bold and it has been put in every plant of the company.

The fifth step takes TPM targets setting to the next level and initiates the drafting of the master plan.

In Nashik Company, it is expected that through TPM following goals can be achieved.

I  **Productivity**
   1. Value added improvement 1.5 to 2 times.
   2. 40% reduction in breakdowns.
   3. Overall equipment efficiency (OEE) up to 2 times.

II  **Quality**
   1. Reduction in WIP defects.
   2. Reduction in parts per millions (PPM)

III  **Cost**
   1. Production cost reduced by 30%
   2. Quality cost reduced by 30%
IV Delivery
1. Reduced finished goods inventory by 50%
2. 100% on time delivery
3. Reduced premium freight by 60%

V Safety & Morale
1. Zero accidents
2. 5-10 suggestions per employee

VI Education
Skill upgrading of employees.

In the Company, there is daily Autonomous Maintenance [AM] exercise and employees have to fill check sheets of cleaning, lubrication and inspection. Then a TPM requires the machinery to be cleaned and accessible. Dirt is thoroughly cleaned. Blue & Red tags are attached to problems. Blue tag says that the operator is responsible to repair while red tag says it is the responsibility of maintenance group. One Kaizen and major breakdown elimination was completed. The OEE is to be increased by minimum 30% with corresponding reduction in cost. OEE was 43% whereas Co’s target is 85%. 
OEE = Availability x Performance efficiency x Rate of quality product which is expected to be 85%. For that, company decided to accomplish:

1. Availability 90%
2. Performance 95%
3. Rate of quality 99%
4. OEE = 85%

Most companies find their OEE at 40% - 50% before TPM

I At the beginning the list of CRITICAL machines was prepared.
1 Keystone Gr.4 Batteries
2 Profile Gr. 2 Machines
3 CNC Finish Turn 4 Machines
4 CTB 1
II TPM IMPLEMENTATION SCHEDULE

PILOT MACHINES--------QUARTER 1 TO 13

CRITICAL MACHINES-----QTR 4 TO 14

IMPORTANT MACHINES----QTR 9 TO 14

ALL MACHINES-------QTR 13 AND 14---JIPM AWARD [EXPECTED]

III FIVE STAGES TO SUCCESSFUL EQUIPMENT MANAGEMENT
decided as
1 Re store Equipment to New Condition
2 Identify complete Maintenance Plans
3 Implement Maintenance Plans
4 Prevent Recurring Machine Failures
5 Improve Machine Productivity

IV For MODEL Machines following machines were decided and
started from November 2003.
1 Rails and steel section
2 HMT ECNO CNC Finish Turn

V As Critical Machines the following machines were decided
started from April 2004
1 Key stone gr. 4 batteries
2 Profile gr. 3 machines
3 Auto FNT 4 machines
4 CTB
For model machines the stages followed with details were

### Table 5.1.1  Model machines stages

<table>
<thead>
<tr>
<th>STAGE</th>
<th>STEP</th>
<th>STEP DETAILS</th>
<th>PERIOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Restore Equipment to New Condition</td>
<td>Minor defect identification, F tag, one point Lesson, Activity Board Inspection Standards</td>
<td>Up to QTR 3 i.e. July 2004</td>
</tr>
<tr>
<td>2</td>
<td>Identify complete maintenance plan</td>
<td>PM Plans, procedures, PM schedule</td>
<td>From March 2004 to May 2004</td>
</tr>
<tr>
<td>3</td>
<td>Implement Maintenance Plan</td>
<td>Precision maintenance, Visual workplace, Spare part management, Tool management</td>
<td>From June 2004 to Feb 2006</td>
</tr>
<tr>
<td>4</td>
<td>Prevent recurring machine failures</td>
<td>PM evaluation, Failure analysis, PM analysis</td>
<td>From June 2005 to Feb 2006</td>
</tr>
<tr>
<td>5</td>
<td>Improve machine productivity</td>
<td>Lubrication analysis, QM analysis, Machine part analysis, Condition of use and life analysis, Analysis of waste, Maintenance cost analysis</td>
<td>From Oct 2005 to Feb 2006</td>
</tr>
</tbody>
</table>

At every step an audit is by the auditor. If the score is above 80% then that step is declared ‘pass’.
### MODEL/PILOT MACHINE AUDIT RESULT

Table 5.1.2

<table>
<thead>
<tr>
<th>MONTH</th>
<th>MACHINE</th>
<th>SCORE</th>
<th>STEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOV 03</td>
<td>RAILS</td>
<td>56</td>
<td>FIRST</td>
</tr>
<tr>
<td></td>
<td>ECNO CNC FNT</td>
<td>52</td>
<td>FIRST</td>
</tr>
<tr>
<td>MAY 04</td>
<td>RAILS</td>
<td>66</td>
<td>FIRST</td>
</tr>
<tr>
<td></td>
<td>ECNO CNC FNT</td>
<td>68</td>
<td>FIRST</td>
</tr>
<tr>
<td>JULY 04</td>
<td>RAILS</td>
<td>82</td>
<td>FIRST</td>
</tr>
<tr>
<td></td>
<td>ECNO CNC FNT</td>
<td>84</td>
<td>FIRST</td>
</tr>
<tr>
<td>SEPT 04</td>
<td>RAILS</td>
<td>83</td>
<td>SECOND</td>
</tr>
<tr>
<td></td>
<td>ECNO CNC FNT</td>
<td>81</td>
<td>SECOND</td>
</tr>
<tr>
<td>OCT 04</td>
<td>RAILS</td>
<td>84</td>
<td>THIRD</td>
</tr>
<tr>
<td></td>
<td>ECNO CNC FNT</td>
<td>86</td>
<td>THIRD</td>
</tr>
<tr>
<td>DEC 04</td>
<td>RAILS</td>
<td>READY FOR TPM KICK OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ECNO CNC FNT</td>
<td>READY FOR TPM KICK OFF</td>
<td></td>
</tr>
</tbody>
</table>

**TPM KICK OFF PLAN**

Manager model machine == ready for kick off.

1. MFNT 4 HMT ECONO CNC
2. RAILS CUT OFF
3. WEEKWISE MONITORING OF BREAK DOWN/ACCIDENTS/DEFECT STARTED FROM NOVEMBER 2004 FOR MODEL MACHINES
4. ACHIEVED ZERO BREAK DOWN IN NOVEMBER 2004/DECEMBER 2004
Remedial Actions taken and results

Table 5.1.3

<table>
<thead>
<tr>
<th>MONTH</th>
<th>NATURE OF BREAK-DOWN.</th>
<th>TIME FOR REMEDY</th>
<th>REMEDY</th>
<th>PREVENTIVE ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>APRIL,04</td>
<td>TAIL STOCK NOT WORKING</td>
<td>1 HOUR</td>
<td>ELEC. PNUMETIC VALVE SPOOL NOT FREE, CLEANING, LUB. DONE.</td>
<td>PROVIDED F.R.L. UNIT.</td>
</tr>
<tr>
<td>MAY,04</td>
<td>NO B/D</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JUN,04</td>
<td>COOLENT LEAKAGE</td>
<td>.75 HOUR</td>
<td>COOLENT LEAKAGE HOSE CLIP TIGHTENED</td>
<td>REPLACED CLIP FITTING BY THREAD HOSE FITTING</td>
</tr>
<tr>
<td>JUL,04</td>
<td>OIL LEAKAGE FROM HYDRAULIC CYLINDER</td>
<td>1.15 HOUR</td>
<td>REPLACED ‘O’ RING</td>
<td></td>
</tr>
<tr>
<td>AUG,04</td>
<td>NO B/D</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SEP,04</td>
<td>NO B/D</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>OCTO,04</td>
<td>NO B/D</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>NOV,04</td>
<td>NO B/D</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DEC,04</td>
<td>NO B/D</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5-JAN</td>
<td>NO B/D</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

The kick off is the sixth & last step of the initiation, which sets the TPM process rolling in the entire factory. In the said Case Study, the Kickoff
Ceremony took place in January 2005. However certain preconditions need to be satisfied before the kick off to prove that TPM is indeed possible in the factory. Some conditions that need to be satisfied include completion of steps 1, 2, 3 of AM, Autonomous Maintenance.

With the introduction of AM, operators themselves started taking care of machines without being ordered.

With reduction in the breakdown and defects, operators got new confidence in their own abilities. Also, they found that the workplace that used to be covered with oil & chips was now clean and pleasant. Employees have been trained to look for defects in the production line and got involved in a process that aims for continuous improvement. Company employees now know that tools of focused improvement such as one point lesson, why-why-analysis.

VIII TPM ON CRITICAL MACHINES FROM QTR 4
Machines selected

KEY GRD—4 BATTERIES
AUTO FINISH TURN--4
PROFILE GR.—3
CTB—1
Like the model machines TPM is being done in 5 stages.
STAGE 1--- FROM AUG 04
STAGE 2---FROM DEC 04
STAGE 3---FROM SEP 05
STAGE 4 ---FROM FEB 06
STAGE 5 ---FROM JUNE 06
THUS 11 MACHINES ARE COVERED UPTO DECEMBER 04 OUT OF 14 MACHINES

IX CNC FINISH TURN 10&11----JAN 05
CNC FINISH TURN 5 ---------FEB 05
X  OEE FOR KEY MACHINES FOR THE YEAR 04-05

Table 5.1.4

<table>
<thead>
<tr>
<th>CRITICAL MACHINES</th>
<th>OEE 03-04</th>
<th>Apr 04</th>
<th>May 04</th>
<th>Jun 04</th>
<th>Q1 04</th>
<th>July 04</th>
<th>Aug 04</th>
<th>Sep 04</th>
<th>Q2 04</th>
<th>Oct 04</th>
<th>Nov 04</th>
<th>Dec 04</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key GRD. Avg</td>
<td>65</td>
<td>67</td>
<td>65</td>
<td>68</td>
<td>67</td>
<td>65</td>
<td>69</td>
<td>71</td>
<td>68</td>
<td>70</td>
<td>68</td>
<td>72</td>
</tr>
<tr>
<td>Auto FNT Avg</td>
<td>74</td>
<td>84</td>
<td>77</td>
<td>81</td>
<td>80</td>
<td>83</td>
<td>75</td>
<td>75</td>
<td>78</td>
<td>79</td>
<td>78</td>
<td>82</td>
</tr>
<tr>
<td>Prof GRD. Avg</td>
<td>68</td>
<td>80</td>
<td>76</td>
<td>77</td>
<td>78</td>
<td>81</td>
<td>77</td>
<td>81</td>
<td>80</td>
<td>76</td>
<td>76</td>
<td>84</td>
</tr>
<tr>
<td>CTB</td>
<td>66</td>
<td>67</td>
<td>69</td>
<td>66</td>
<td>67</td>
<td>70</td>
<td>67</td>
<td>74</td>
<td>70</td>
<td>72</td>
<td>74</td>
<td>76</td>
</tr>
<tr>
<td>Overall Average</td>
<td>68</td>
<td>74</td>
<td>72</td>
<td>73</td>
<td>73</td>
<td>75</td>
<td>72</td>
<td>75</td>
<td>74</td>
<td>74</td>
<td>74</td>
<td>79</td>
</tr>
</tbody>
</table>

CASE STUDY 2

TPM CASE STUDY

Department : Maintenance
No. of meetings : 56
Problems solved : 9
Goal of TPM Circle : Total productive maintenance
                     : Cellular Mfg. System
                     : Cell level cost management
                     : Group/personal development

Maintenance Department was facing the following problems –
1. Tedium riveting operation in M 80 C' case line.
2. Improper material handling in machine shop 3.
3. Inconvenient assembly table for M 80 C’ case.
5. Time consuming coolant hole drilling operation in LCA
6. Coolant motor space and flow problems related to coolant system.
7. 7001/quality of groove related problems on BA 4980
8. Frequent breakdown of BA 4271
10. Autoloader for GCL grinder

Under TPM, the model machine was selected –BA-4271, as frequent breakdowns of this machines was resulting into lot of rejection, rework energy losses, etc. On the basis of 16 losses this was decided.

Table 5.2.1 TPM method for selection of machine on the basis of 16 losses:

<table>
<thead>
<tr>
<th>Problem/Description</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
<th>P5</th>
<th>P6</th>
<th>P7</th>
<th>P8</th>
<th>P9</th>
<th>P10</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Breakdown</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2. Set up/adj. time</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>3. Tool Change time</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Start up loss</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Minor stoppages</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Speed loss</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Rejection &amp; Rework</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Preventive / shut down</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Management loss</td>
<td>✓</td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>10. Operating Motion loss</td>
<td>✓</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Layout loss</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>12. Logistic loss</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Measure &amp; Adj. loss</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Energy loss</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Die Tool &amp; Jig loss</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Yield loss</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Model Machine selection for TPM

Frequent Breakdown of BA 4271 i.e. frequent breakdown of main shaft loading. Conveyor on BA 4271
In the company KK pillar deals with losses. It makes a loss structure for the company.

In the case study KK pillar identified the priorities and assigned the project teams to work on specific losses on different machines and areas.

The maintenance Dept was allotted the project where through a TPM circle, the members identified 10 problems and based on 16 losses, prioritized them.

TPM leader who is the Works Manager explained the process to have complete idea of the problem to the TPM circle.

Details of the component / process
Component – Main Shaft
Component Code – 22101053 / 16101121
Operation – Friction welding.
Function No. – 0050, 0055
Semi finished code – 4305002
Machine No. – BA 4271
Graph 5.2.1 Breakdown

Graph 5.2.2 Bar Chart for the Labour minutes

Check Sheet

<table>
<thead>
<tr>
<th>Period</th>
<th>B/D minutes</th>
<th>Prod. Loss</th>
<th>Labour min</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Months</td>
<td>1620 Min.</td>
<td>3240 Jobs</td>
<td>4080 Min.</td>
</tr>
</tbody>
</table>

Unrecorded B/D like tripping were 5 to 6 times/day
Goal Setting –

1. To minimize machine breakdown.
2. To simplify unloading process
3. To reduce energy consumption
4. To increase productivity
5. To reduce space required for unloading process.

1. Productivity - Value added improvement 1.5 to 2 times
   - 60 % reduction in breakdown
   - Production loss to be reduced by 80%
2. Quality - Reduction in PPM
3. Cost - Production cost reduced by 40%
4. Delivery - 100% time delivery
5. Safety & Morale - Zero accident
   - 2 – 4 suggestions per employee
6. Education - Training to employees
   - Training of TPM methodology
   - Analysis and assessment.

In the Maintenance Department, 1,2,3 steps of Autonomous Maintenance were completed.

There was daily Autonomous Maintenance exercise & employees had to fill check sheets of cleaning, lubrication, inspection. In AM exercise – problems found were –

   a. Wrong positioning of job on conveyer
   b. Unbalanced geometry of job.
   c. Impact of job on conveyor strips.
   d. Conveyer orientation problem.
   e. Wrong method of part transfer
KK pillar had provided training in -

1 Why-why-analysis
2 QC tools & Tool technology
3 Calculating costs
4 Training on 16 losses
5 Machine Structure / Principle of Working
6 TPM training

Why-why-analysis -

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conveyor not operating</td>
<td>Conveyor links</td>
</tr>
</tbody>
</table>

Why 1 : Conveyor B/D
Why 2 : Conveyor links deformed
Why 3 : Impact of job on links
Why 4 : More distance between fixture and conveyor
Why 5 : Inadequate design.

Solution : Design low cost automation unit for cost effectiveness and reliability.

Goal setting for the problem solving –[SMART]
Specific : Improve design by means of low cost automation.
Measurable : B/d towards zero/operator fatigue reduction.
Achievable : Better/reliable process.
Realistic : Involving of all members
Time bound : One month

It was decided that

1. New unit should be sturdy.
2. Use of available material should be done.
3. Involvement of all TPM circles and circles should be made.
4. Less space used and operation cost should made possible.
5. Interface with machine control system should be made easy.

**Action taken –**

1. Draw sketches – for proper planning.
2. Detailed drawing – for accurate mfg. on computer
3. To collect material for mfg. of new design
4. Marking & machining – as per drawing
5. Welding – structure construction
6. Assembly – for try out

**New method –**

Planned Maintenance –

- Always provide filtered and lubricated air to the unit by cleaning filter element (Quarterly)
- Strictly follow cyclic refilling of lubricator (Monthly)
- Ensure correct setting of flow control valves to avoid dashes at the end of the stroke.
- Lubricate roller wheels with grease manually (Quarterly)
- Replace cylinder seals 2 years.

**Organisational Benefits**

- Breakdown time eliminated
- Reduction in Labour hours
- Space saving
- Operator fatigue reduced
- Process improved
- Energy saved
- Cost effectiveness

After set up was changed,

Autonomous maintenance - continued
Planned maintenance - continued
Results:

Check Sheet

<table>
<thead>
<tr>
<th>Period</th>
<th>B/D minutes</th>
<th>Prod. Loss</th>
<th>Labour min</th>
</tr>
</thead>
</table>

Graph 5.2.3 B/D Times Check Sheet

Graph 5.2.4 Labour min. - Check Sheet
Graph 5.2.5

Reduction in B/D Time

Graph 5.2.6

Reduction in Labour min.

Graph 5.2.7

Space Reduction

Old Setup

New Setup

0.27
Energy Saves per Month.

Power capacity of Conveyor Motor = 0.746 kW.
Total power Tariff in KWH = 0.746 x 14.66

(* 14.66 is the total no. of hours in 880 minutes shift)

Power Tariffs = 10.93636
= 10.93636 x 4 (cost / unit)
= Rs. 43.74 x 30 days
= Rs. 1312.36

Graph 5.2.10

<table>
<thead>
<tr>
<th>Energy Saving per Month</th>
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<tbody>
<tr>
<td>Rs.</td>
</tr>
<tr>
<td>2000</td>
</tr>
<tr>
<td>1800</td>
</tr>
<tr>
<td>1600</td>
</tr>
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<td>200</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

Old Setup | New Setup
---|---
1312.36 | 240

In this case study the TPM is in the initial stage. But still then the results are surprising. The problem has been solved by TPM circle, which is a very important part of Total Productive maintenance.

Conclusion:
The advantages of letting employees take responsibility for making modification to the machinery and increasing efficiency results and constant improvement in the skill-sets of the employees, which would ultimately help the company to achieve its target of TPM.

From the case studies it can be confidently said that shop floor renaissance is possible through TPM. The JIPM offers awards for excellence in TPM but the real reward for companies lies in the tangible benefits it brings. For any organization what is the most important factor for its successful running is the involvement of its employees at every level as well as top to bottom commitment in the programme. In TPM, the programme begins at shop floor & is initiated by the top level.

Given zero accidents utmost importance, is found an important reason for employees' involvement in it. In the first case study, for a long time the accident rate is zero, which is a main cause for employees' involvement in
the TPM. They feel very much secured while working and can concentrate on work, which has resulted into increased efficiency. Also training given to the employees helps them in improving their skills. It results in improved quality of goods.

Constant production is possible only when there is no breakdown. It also results in job security, which is also an important reason of employees’ involvement in this quality improvement programme.

TPM is the only business initiative where returns have been 8 to 12 times of investment as HLL Director, Gurudeep Sing mentions. Due to proper maintenance of machines under TPM, zero breakdowns is possible. Optimum utilization of assets increases productivity and reduces cost of production.

Through TPM circles also much can be achieved as they solve the problems in time which otherwise might turn into a serious one hampering the process of total Production as well as pace of TPM in the company.

All these factors result in to change in the work culture of the organisation, which is the most important benefit for the organisation as it has along term impact on the work force which is going to implement TPM system of Quality Management over a long period. Though zero defects may not be possible in its initial phase, it is definitely an important tool for the company to move towards it.