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PERFORMANCE ENHANCEMENT THROUGH CONTINUOUS IMPROVEMENT

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ABSTRACT

Organizations have to simultaneously meet various stakeholders’ demands related to delivery times, supply chains (horizontal, vertical and cross integration), quality, production processes, equipment, safety, environmental concerns, workforce etc. They must be driven by both effective and efficient management approaches and strategies to do so. One approach to improving the performance is to develop and implement Total Productive Maintenance (TPM). However, a number of organizations are failing to successfully implement such strategies.

This paper describes successful TPM implementation in a continuous process firm in India and its effects, particularly on the firm’s performance. We describe the TPM concept, analyze the Indian manufacturing scenario briefly and thereafter chronicle the success of the firm. The paper tests the applicability of theoretical concepts in the Indian context, derives some managerial implications and provides suggestions to firms who are or shall be in the process of implementing such initiatives.
INTRODUCTION

In the present business scenario, firms must adopt world class competitiveness for their long-term survival and sustenance. The undeniable global competition necessitates the simultaneous fulfillment of various stakeholders’ demands related to delivery times, quality, production processes, equipment, safety, environmental concerns, workforce etc.

To be successful organizations must be driven by both effective and efficient management approaches and strategies. The maintenance function has rightfully been positioned as an integral part of the overall profitability of business with the introduction of new technologies and innovative practices. Modern maintenance techniques and practical approaches have the potential for significantly increasing competitive advantages for a firm. The challenge for today's maintenance managers and reliability professionals is to establish standards for maintenance and reliability practices, creating an appropriate information system to collect facts, building enthusiasm and initiating enabling action plans. *TPM* facilitates in meeting these challenges.

The movement towards *TPM* development has been quite evident in recent times, especially in the developed countries. This paper describes the successful *TPM* implementation in a continuous process firm (fictitiously named XYZ) in India and its impact on the performance of the firm. An effort has been made to test the applicability of theoretical concepts in the Indian context. We review the *TPM* concept, analyze the Indian manufacturing scenario briefly and thereafter chronicle the success of firm XYZ in *TPM* implementation. General conclusions are drawn, managerial implications summarized and recommendations suggested for firms undertaking *TPM* initiative. Finally, directions for future research have been suggested.
LITERATURE REVIEW

Since time immemorial, the maintenance of tools and equipments has been taken care of by the users when it was no longer possible to run them. This was termed as “Breakdown or Reactive Maintenance”. It was followed by the “Preventive Maintenance” in 1950s. It was time-based maintenance, featuring periodic servicing and overhaul to prevent damages of the equipments (Nakajima, 1988). Although it helped reduce down-time, it was an expensive alternative as many parts were replaced periodically, while they could've lasted longer.

In order to maintain the equipment in optimal condition, new and progressive maintenance techniques were needed beyond the routine preventive maintenance. In 1960s, a more practical approach called “Productive Maintenance” came into being. All people related to maintenance were assigned a higher responsibility to make a series of considerations about the reliability and design of the equipment and the plant itself. The change was so profound that the term “Maintenance” was changed to “Plant Engineering” and the tasks to be performed included a higher understanding of the reliability of each element of the machines and installations.

The following decades witnessed the globalization of the marketplace which forced the firms to excel in all activities. Along with this arose a strong need to adopt the World-Class standards in terms of equipment maintenance. This gave birth to the philosophy of Total Productive Maintenance (TPM). TPM involves the cooperation of the equipment and process support personnel, equipment operators and the equipment supplier. They work together to eliminate equipment breakdowns, reduce scheduled downtime, and maximize utilization, throughput and quality. It also provides the methods to measure and eliminate much of the non-productive time. TPM evolved from TQM, which evolved as a direct result of Dr. W. Edwards Deming's influence on Japanese industry. When the problems of plant maintenance were examined as a
part of the TQM program, some of the general concepts did not seem to fit or work well in the maintenance environment. Preventative maintenance (PM) which was practiced in most plants often resulted in machines being over-serviced in an attempt to improve production. There was little or no involvement of the machine operator in the maintenance. To control these factors, techniques of plant maintenance were introduced from the United States.

*TPM* is based on Productive Maintenance, which was introduced in the 1950s at General Electric Cooperation. Later on, the Japanese adapted it to their work-culture to make it more effective. JIPM (Japan Institute of Plant Maintenance) took the lead in popularizing this. Although maintenance is a key component, *TPM* is not really a maintenance concept but goes much further. In fact, nowadays *TPM* is more and more translated as Total Productive Manufacturing, Total Productive Management or Total Participation Maintenance. In this light, *TPM* is quickly becoming an internationally recognized management philosophy and strategy.

**TPM Concept**

Nakajima (1986) describes *TPM* concept in the following five points:

1. It aims to maximize equipment effectiveness (improve overall effectiveness),

2. It establishes a complete productive maintenance program encompassing maintenance prevention, preventive maintenance, and improvement related maintenance for the entire life cycle of the equipment,

3. It is implemented on a team basis by various departments and it requires the participation of equipment designers, equipment operators, and maintenance department workers,

4. It involves every single employee from top management down to the workers on the shop-floor,
(5) It promotes and implements productive maintenance based on autonomous small-group activities (participative management).

Further, Nakijama (1988) says that the object of production improvement activities is to increase productivity by minimizing input (labor, machine and material) and maximizing output by increasing productivity ($P$), improving quality ($Q$), reducing costs ($C$), meeting delivery dates ($D$), improving safety, improving health & work environment ($S$) and improving morale ($M$).

Thus, $TPM$ aims at:-

- Establishing a corporate culture that maximizes production system effectiveness,
- Organizing a practical shop-floor system to prevent losses before they occur throughout the entire production system life cycle, with a view to achieving Zero accidents, Zero defects and Zero breakdowns,
- Involving all the functions of an organization - production, marketing, logistics etc.
- Involving every employee, from top management down to front-line operators,
- Achieving Zero losses through the activities of "overlapping small groups."

Bamber et al. (1999) define $TPM$ as a company-wide approach to plant, equipment or asset care that involves the active participation of more than just the maintenance department working on maintaining and improving the overall equipment effectiveness. Waeyenbergh and Pintelon (2002) discuss participative management in detail while describing their framework for maintenance concept development. One of the hardest aspects of implementing $TPM$ is overcoming employee resistance and bringing about the necessary change in organizational culture. A variety of ways to promote organizational cultural change including training and changes in reward systems as well as mathematical modeling have been proposed in literature to bring about the necessary changes (Lawrence, 1999).
The literature indicates two main approaches to defining *TPM* which are considered as the Western definition and the Japanese definition. In American-style PM, normally the maintenance department is responsible for carrying out PM. This is attributed to the concept of division of labor prevalent in American labor unions. Whereas the Japanese-style PM features everyone’s participation, particularly autonomous maintenance by operators. It is the American-style productive maintenance, modified and enhanced by them (Japanese) to fit their industrial environment. We refer to *TPM* in this particular context in here.

*TPM* originated in engineering industries but has proved equally effective in process industries too. Process industry plants must operate continuously for long periods to be cost-effective. Accidents and breakdowns involving even one piece of equipment can shut down an entire plant and endanger life and the environment. The resulting financial losses can be devastating. These industries particularly need a collaborative equipment management system like *TPM* that can absolutely guarantee safe, stable operation. In the past few decades, many process industries in Japan and the U.S. have found it profitable to build *TPM* programs based on their existing preventive maintenance and quality improvement programs.

Thus, *TPM* is a continuous improvement concept that has proven to be effective, first in Japan and then back in America (where the concept was first created). It is a means of creating a safe & participative work environment, in which all employees target the elimination of all kinds of waste generated due to equipment failure, frequent breakdowns, defective products, rejections & rework. This leads to higher employee morale and greater organizational profitability. *TPM* also builds a close relationship between maintenance and productivity, showing how good care and up-keep of equipment results in higher productivity.

JIPM suggests an 11-pillar approach to successfully implement *TPM* as described in Fig. 1.
<table>
<thead>
<tr>
<th>Pillar</th>
<th>Salient Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5S</strong></td>
<td>Implementation of good housekeeping practices as a foundation-stone for involvement and participation of employees.</td>
</tr>
<tr>
<td><strong>Kobetsu Kaizen</strong></td>
<td>Improvement projects for chronic problems, for de-bottlenecking and for capacity enhancements to eliminate the &quot;big losses&quot;.</td>
</tr>
<tr>
<td><strong>Jishu Hozen</strong></td>
<td>Autonomous maintenance (kaizen and group activities) performed by equipment operators after they are trained and &quot;equipment skilled.&quot;</td>
</tr>
<tr>
<td>Planned Maintenance</td>
<td>Establishment of a planned maintenance (predictive, preventive and productive maintenance) system to increase maintenance efficiency.</td>
</tr>
<tr>
<td><strong>Hinshitsu Hozen</strong></td>
<td>All quality maintenance activities including confirmation to ISO 9000.</td>
</tr>
<tr>
<td>Initial Flow Control</td>
<td>Establishment of a system of maintenance prevention (MP) design reviews and early equipment management.</td>
</tr>
<tr>
<td>Safety &amp; Environment</td>
<td>All activities to achieve and maintain zero accidents and confirmation to ISO 14000 series.</td>
</tr>
<tr>
<td>Education &amp; Training</td>
<td>Establishment of training courses to bridge the skill-gaps of employees based on periodic updation of skill inventory.</td>
</tr>
<tr>
<td>Office TPM</td>
<td><em>TPM</em> activities (5S, Kaizen, Jishu-Hozen etc.) in administrative and support departments.</td>
</tr>
<tr>
<td>Logistics</td>
<td><em>TPM</em> activities (5S, Kaizen, Jishu-Hozen etc.) in logistics.</td>
</tr>
<tr>
<td>Sales &amp; Marketing</td>
<td><em>TPM</em> activities (5S, Kaizen, Jishu-Hozen etc.) in Sales &amp; Marketing with emphasis on delivery and customer satisfaction.</td>
</tr>
</tbody>
</table>

**Fig. 1**

11-pillar approach to successfully implement TPM
INDIAN SCENARIO

The Indian Industry has been facing severe global competition since the last decade. The customers are demanding more in terms of cost, quality & variety and have thus become a determinant of the market price of products and services. The current economic environment automatically brings tremendous pressure on optimizing the production cost for survival. Simultaneously, as the Indian firms are entering the world markets it becomes imperative for them to be prepared to face competition. This is to be done by improving their internal efficiencies by building capabilities that gives them an edge over their competitors. They need strategies and programs that help them meet the challenge with increased plant efficiency & productivity. TPM, if implemented successfully, addresses many of the concerns of Indian firms. It leverages on their assets and efficiency and effectiveness in their operations. Many companies have gone for ISO 9000 Series Certifications to become world class. However, a closer look reveals that many of these firms worked to get this certification only for the purpose of impressing the stakeholders and the market at large. Many of these firms have neither improved their internal systems nor are they exporting their products. They simply exploited the loopholes of these Certifications (which have since been removed by 2000 series certifications). However the scene is not totally pessimistic. In a selected number of Indian firms certain welcome features are discernible. Corporate attention is getting focused on meeting customer quality requirements. Management is leading the way in disseminating manufacturing excellence values throughout the organization. Employees are being asked as well as empowered to continually improve all key business processes. Collaborative partnerships with suppliers for improved product and service quality are being worked out. Thus, these managements are nurturing a flexible and responsive corporate culture.
Total Productive Maintenance (TPM) as a management system, got actively promoted in India when the apex institute of Japan namely Japan Institute of Plant Maintenance (JIPM) and the apex industry association Confederation of Indian Industry (CII) came together in late nineties. At about this time, the TPM club was founded to promote TPM at the national level to transform the industries in India. The present membership of TPM Club stands at about 250 companies. It provides a host of services which include training and education for people at all levels in an organization and experts from both, Japan and India.

The first company to achieve the TPM excellence award from JIPM was Vikram Cements Ltd. in 1995, followed by Sundram Fastners Ltd in 1998. As of today, about 15 companies have received TPM excellence award from JIPM. Vikram Cements has gone on further to the next level and has achieved Excellence in Consistent TPM Commitment award in 2001.

The TPM practicing companies, particularly award winners are a witness to a visible change in their work culture. Benchmarking themselves on parameters such as productivity, cost, quality, delivery reliability, inventory turns etc., is a good indicator of their performance vis-à-vis the global standards. This is a good eye-opener for other top managements aiming for a change and for building market dominance.

**TPM IMPLEMENTATION AT XYZ**

We chronicle TPM implementation at XYZ (fictitious name), a continuous process industry of a diversified business group of India. The firm is one of the most professionally managed companies of the Group with the most efficient continuous process plant in its category in India using state-of-the art technology. The firm was established with an initial investment Rs 7000 millions in 1988 and has been performing consistently well. Its main product is the first choice of the customers and it has been continuously bettering its performance in all aspects of business.
Basic Management Philosophy

Good management is essentially free-thinking, sound inquiry, good understanding of the issues and timely decisions. Moving from a state of management control to one of shared decision-making requires a commitment by management to the participation process and significant changes in the management’s role and modus operandi. Widespread employee support by way of involvement and commitment is *sine qua non* for involving employees in information sharing, consultation and job-related decision-making.

From its inception, *XYZ* has been a fore-runner in adopting current management practices for improvements in Productivity, Quality, Cost, Delivery, Safety and Morale. In order to achieve the objectives of its basic philosophy the company has reposed a great amount of trust in its human capital. Management looks for enthusiasm, acceptance and commitment from subordinates. The basic management philosophy aims at:

- Establishing a corporate culture that will maximize production system effectiveness,
- Organizing a practical shop-floor system to prevent losses before they occur throughout the entire production system life cycle, with a view to achieving Zero accidents, Zero defects and Zero breakdowns,
- Involving all the functions of an organization including production, development, sales and management,
- Involving every employee, from top management down to front-line operators, and
- Achieving Zero losses through the activities of "overlapping small groups."

Manpower Profile

The manpower profile is shown in Fig. 2. The plant has about 1000 employees and the average age of the employees is about 40 years. The operating and supervisory staff constitutes the
majority of the manpower. Most of the employees are literate with majority of them being technically qualified.

**Fig. 2**

**Manpower Profile of XYZ**

In December 1993, the management decided to implement the Japanese 5S concept. The strategic decision was to start an initiative for involvement and participation of employees beginning from the simplest and easiest one so that they could be geared up eventually for greater participation and involvement. This was followed by the much more comprehensive quality and productivity initiatives such as ISO 9002, ISO 14001, TPM and Benchmarking. Prior to this, Quality Circles and Quality Improvement Teams had been tried on voluntary basis and had met limited success.

To initiate the 5S initiative, the whole plant complex was divided into 71 “small overlapping groups” (Nakajima, 1988) which were cross-functional in composition and generally involved participation of employees who usually worked together in their daily chores in and around certain pre-determined work-zones. This was likely to initiate break-up of functional barriers, promote mutual trust, innovation, self-initiative, pro-action, autonomy, collaboration and experimentation and ultimately to total employee involvement. The teams were to meet one hour
daily and carry out 5S activities. The adopted “small overlapping groups” set-up was quite different from the existent organizational hierarchical set-up. The management expected this set-up to work both “top-down” and “bottom-up” to achieve the best possible results.

The main objectives of this initiative as seen by top management were to introduce a system that encourages responsible behavior and total employee participation. It sought moving from managing by results to managing by causes. The management aimed to utilize its human capital in changing business environment to create consensus on goals and objectives, for commitment building, for bringing in a sense of belongingness and ownership and creating a disciplined workforce. The idea was to change the whole mind-set of employees towards work and workplace and developing a process orientation in them to focus on value addition to customers. This would lead to emphasis on purpose, process and people, creating a learning organization and ultimately raising the bottom-line for maintaining industry leadership. An expected natural outcome was the emergence of OCTAPACE culture characterized by Openness, Confrontation, Trust, Authenticity, Pro-action, Autonomy, Collaboration and Experimentation (Pareek, 1994).

Unless the management defines new terms and persuades/ convinces employees to accept them, it is unrealistic for it to expect employee involvement and commitment. It needs to be understood that employees and organizations have reciprocal obligations and mutual commitments, both stated and implied that define their relationships. The commitment may be in formal, psychological or social terms. The employees wish to know what they are supposed to do for the organization and the support they will get in performing their jobs. Their performance appraisal and reward systems need to be linked to the new initiative. They should derive personal satisfaction and social recognition from the new initiative. Most of all, they should believe that the top management is sincere and practices what it preaches.
The management, on its part needs to understand the likely benefits of the initiative, the likely reaction of the employees in general and the workers’ union in particular. It should also see whether the values and beliefs of the employees are congruent to those of the firm. It should put in place an effective mechanism for accountability and responsibility. If seniority and proximity to power centers affects an employee’s career growth and level of compensation, then people will have no motivation and incentive to work towards the success of any new management initiative. A strategic plan is needed with accompanying contingency plans before formally starting the initiative. New and informal rules should be put in place for getting employee involvement and commitment. Terms for change should be tough and unambiguous. Clear targets should be set and progress monitored with continuous feedback. The management should encourage the workers to take a longer-run view and provide short-term job security to them. Finally, it should be patient and tenacious while undertaking such initiatives.

The top management at XYZ was fully convinced of the likely benefits from the change initiative provided it was carried out effectively. Taking this into account, it prepared a long-term strategic plan along with accompanying contingency plans before formally starting the initiative. It had a dialogue with the employee union (which in general had been quite reasonable). The union looked at the initiatives as mere buzzwords meant to exploit the employees with additional workload. However good faith prevailed and it agreed “not to oppose” the initiatives.

The context for change had been created by drawing attention of all the employees and the union. The program started with much fanfare and a Japanese consultant was also invited. The visibility of senior management support generated widespread enthusiasm. The General Manager (Maintenance) was made the Chief Co-ordinator of the activities. Thus, the process started from the top with lot of commitment, faith and awareness campaigns.
Initial Problems

There was wide euphoria and some of the workers also showed keen interest. However, this was short-lived and problems arose chiefly because of “resistance to change” and “a few vested interests” (Strebel, 1996). There was reluctance on the part of workers’ union as they looked at the initiatives as a means to exploit the employees with additional workload. They had agreed “not to oppose” the initiatives but covertly the union leaders tried to discourage the workers from participating actively. All the employees feared a threat to job security as they felt that the management could thrust anything on them “besides their job responsibilities”.

At implementation level, suitable change agents were not there and no one had clear accountability and responsibility for the success and monitoring of the program. Middle managers and supervisors were not clear about their roles. The Chief Co-ordinator also had many other “pressing assignments”.

Besides, time for renewal of “Wage Agreement” was in the offing. Workers started looking for “extra incentives/ benefits” from participation in the initiative. Some people scorned at the management’s decision to call a Japanese Consultant for implementation of such a simple concept as 5S. Aged employees and those who had served earlier in other Group companies were more reluctant to accept it but they did not say so publicly. A lot of grapevine emerged. More importantly, awareness was still not up to the desired level to sustain the initiative.

Overcoming the Problems

The top management was fully committed to the success of the 5S initiative as it looked at it as “a foundation stone” for all such future initiatives. The Managing Director and General Manager (Maintenance) had fully bought the idea and so they proceeded on. A department to facilitate the initiative with General Manager (Maintenance) as the Chief Co-ordinator was set-up with two
full-time members (drawn from the existing employees who possessed the qualities and zeal to qualify to act as change agents). These persons had been perceived as competent at the shop-floor level, so it was supposed that their suggestions would be taken in seriously by the employees at shop-floor and higher levels. They were supposed to facilitate all such initiatives and act as a conduit between the top management and the Japanese Consultant on one hand and other managers and the employees on the other hand. They were to set targets and systems to monitor progress with continuous feedback. They were also expected to suggest ways to link performance appraisal and reward systems to the new initiative. The Chief Co-ordinator took personal interest in the success of the program. The full-time change agents devised audit criteria and procedures to monitor the progress once the target had been set. They also carried on vigorous awareness campaigns for all the employees for about three months. Leaflets and literature was distributed. As the workers informally withdrew from the initiative, it was carried out by staff and managers and “Managers’ Model Areas” were developed. These Model Areas became immediate success as the results were clearly visible – the workplaces became much more convenient to work in, number of items/documents reduced drastically and these could be retrieved within 30 seconds. Inventory worth Rs 10 millions was returned to company stores as a result of this exercise.

Quarterly rewards for “best area” in audit ratings was introduced (the audit system is shown in Fig. 3). Visitors were taken to these areas. The appreciation by the visitors led to further boosting of motivation and slowly, but surely, a healthy competition between the 71 areas started. The workers also appreciated the improvements in private. The management remained astute in Wage Agreement and stated in clear terms that the participation in such activities was not beyond the scope of the job although the same was not put in writing. As a result, the workers
also joined in the initiative gradually (it took about 2 months before most of them started participating actively).

![Diagram of the audit system for quarterly awards at XYZ]

**Fig. 3**

**The audit system for quarterly awards at XYZ**

Overall, the change process helped in improving the image of the organization. It helped in achieving the objectives of XYZ for its implementation eliminating 3D’s (Dirty, Difficult and Dangerous) from manufacturing areas and arresting the tendency of people shifting from manufacturing areas to office areas. It also created a consensus on goals and objectives of the unit and commitment building. Then newly introduced system encouraged responsible behavior and total participation, bringing in a sense of belongingness and ownership. There was a change in the whole mindset and the way people approached their work and workplace. The responsibilities and accountabilities were worked out in detail. A disciplined work force was created. A sense of participation and group identity and a sense of wonder and accomplishment also emerged. It was ensured that everyone takes part and does something. There was
standardizing (systemizing) of behavior for getting good results along with the process orientation of employees and focus on value addition to customers. More emphasis was laid on Purpose, Process and People. There was a move from managing by results to managing by causes. It helped in raising the bottom line and emergence of OCTAPACE culture.

**Further Progress**

The success of 5S led to initialization of the process of employee involvement and participation at XYZ. The concept was extended to township, hospital, school etc. so that it could reach the everyday milieu of each and every employee. All this led to total awareness, involvement and commitment and led to launch of higher level management initiatives – XYZ won ISO 9002 in 1994, ISO 14001 in 1998, the **TPM** First Category Award in 2000 (second chemical plant in India and the fourth Indian Company to receive the award). Later, it also won the **TPM** Consistency Award in 2003.

The **TPM** initiative was launched in 1996. Initially 9-pillars were launched in the First Phase of **TPM** (till 2000) and thereafter the remaining two (in logistics and sales & marketing domains) were launched for the second phase implementation which is currently under progress. The process was a long and tedious one. The employees’ participation in **TPM** activities increased gradually and is practically total now. Figure 4 and 5 show **TPM** activities carried out by circle members and an individual operator respectively. Successful **TPM** implementation was carried out by finding a way to break down the walls between various management functions. Figure 6 illustrates this for the production and maintenance functions.
Breaking the wall between Operations and Maintenance Functions

The top management led by example. A lot of emphasis was put on information sharing (through paper, intra-net and activity boards). Photograph of one such activity board is shown in Fig. 7.
These activity boards are maintained continuously updated by the circle members. Similarly, visual indicators were used extensively. Figure 8 shows some such indicators. A number of kaizen were carried out. Employees were encouraged to offer suggestions through a *Suggestion Scheme* initiative. Training was given a new focus and impetus. Think-tanks and cross-functional teams came into being and contributed immensely in progressing towards the target of zero accidents, zero breakdowns, zero defects and zero losses. In brief, *TPM* activities engulfed the whole corporation and the organization culture is continuously changing for the better.

![TPM Activity Board](image1)

![Few Visual Indicators](image2)

**Fig. 7**  
A *TPM* Activity Board  
**Fig. 8**  
Few Visual Indicators

Overall there has been tremendous progress in terms of both employee involvement and commitment resulting in a number of tangible and intangible benefits. *XYZ* has been the top performer in its category of continuous process plants in India. Its performance is unparalleled in the continuous process industries in India as is evident from the results and benefits derived.

**Results and Benefits**

There have been significant tangible improvements in the past years in terms of Productivity, Quality, Cost, Delivery, Safety and Morale. Some important of these achieved in Phase I are depicted in Fig. 9.
Fig. 9

Some Tangible Benefits of TPM during Phase I

- **Product Sale Value**
  - 1996-97: Rs 3885 Million
  - 1997-98: Rs 4788 Million
  - 1998-99: Rs 5414 Million
  - 1999-00: Rs 5808 Million

- **Value Added Productivity**
  - 1996-97: Rs 1018 Thousand
  - 1997-98: Rs 1147 Thousand
  - 1998-99: Rs 1445 Thousand
  - 1999-00: Rs 1362 Thousand

- **Labour Productivity**
  - 1996-97: Rs 3014
  - 1997-98: Rs 3708
  - 1998-99: Rs 4457
  - 1999-00: Rs 4866

- **Rate of In-Process Defects**
  - 1996-97: 0.181%
  - 1997-98: 0.125%
  - 1998-99: 0.073%
  - 1999-00: 0.068%

- **Total Accidents**
  - 1996-97: 30
  - 1997-98: 10
  - 1998-99: 3
  - 1999-00: 2

- **Kaizen Suggestions**
  - 1996-97: 0.95
  - 1997-98: 1.39
  - 1998-99: 1.92
  - 1999-00: 4.5
Besides the tangible benefits, many intangible benefits also accrued. The employees have become self-disciplined with increased self-confidence and motivation. Their mindset towards change has become positive. Their participative response has resulted in an environment of mutual trust and goodwill. The equipments operate at their optimum efficiency and the waste elimination has been reduced to a great extent. Work procedures have simplified and there is a customer-friendly atmosphere in offices. Employees have developed a better perception of social and environmental responsibilities. Thus TPM has brought about a progressive outlook leading to overall development.

CONCLUSIONS

General

The main objective of this paper was to develop a critical understanding of factors affecting successful implementation of Total Productive Maintenance in an Indian continuous process industry and thereby understand performance enhancement through continuous improvements. This was carried out by chronicling the TPM implementation in a particular continuous process firm and by reviewing other literature on TPM implementation experiences. We find that TPM is excellent at creating and reinforcing a team work approach with the key objectives of sharing best practice, problem solving, organization and methods. It is also a method of removing waste, by involving everyone in improving the way things are done. Every operator is a data-collector, diagnostician, industrial engineer, quality technician and a trainer. The workers are “circle members” and not just employees.

However, TPM implementation is not an easy task. The number of companies successfully implementing a TPM program is relatively small and failure may be attributed to three major obstacles namely lack of management support and understanding, lack of sufficient training and
failure to allow sufficient time for the evolution. Successful *TPM* implementation requires total commitment by the Top Management as it has to be TOP DRIVEN to succeed. Total involvement & participation of all the employees as well as attitudinal changes & paradigm shift towards job responsibilities need to be cultivated and nurtured continually. We agree with Nakajima (1988) that since *TPM* is “productive maintenance involving total participation”, it should be implemented on a companywide basis then only it can be effective. It requires finding ways to break down the walls between different functions within the organization.

A change initiative must be treated as an element of the whole organization and its benefits should be measurable from its contribution to the objectives of the firm. There are many factors other than employee involvement that affect the success or failure of a change initiative such as management ability, type of business, Government policies, technology etc. The following should be clearly understood and established before undertaking any such initiative:

1. The existing organization
2. The company’s philosophy and vision
3. Redefining them if necessary and involve the top management
4. Implementing the philosophy by creating both structures and incentives.
5. Management commitment
6. An implementation plan
7. Time allocation for implementation
8. Measures of performance
10. Involving each and every employee.
11. Developing communication and interpersonal skills at all levels.
12. Looking both inwards and outwards for new opportunities.
13. Adopting a pro-active approach.
14. Continuously auditing the system.
15. Permitting the development of holistic relationships.

The key factors that contribute towards successful TPM implementations include adopting a realistic approach by developing a practical plan employing project management principles. The management should accept the fact that TPM will take a long time to spread across the company and change existing maintenance culture but should be determined to keep going. It should put in place, train and develop a network of TPM co-ordinators with senior level back up who promote and support TPM activities every day and also support them with time and resources. Relevant measures of performance should be established and continually monitored. The management should also publicize benefits achieved in financial terms to enhance the impact and awareness and thereby, further participation and improvements. XYZ was able to overcome major obstacles, took pragmatic steps and therefore was able to reap rich rewards.

Indian Industry is on crossroads today. The future depends on how well it responds to the existing and new emerging challenges. More fundamental changes in the way manufacturing and services are organized are needed. Adopting TPM or any such initiative can prepare a firm better for future. Other Indian firms and firms in other developing nations can learn a lot from the TPM implementation experiences of XYZ.

What is needed today in India is focus on indigenous R&D, capability driven approach to manufacturing and adaptation of borrowed technology on part of manufacturers. In addition, unbundling of vast human capital resources by training and development should be adopted for developing professionalism, entrepreneurship, employee involvement and empowerment.
Besides, unshackling of government controls, better infra-structural facilities, and much better co-ordination between academia, industry and government are the desired policy changes.

**Managerial Implications**

A lot of spade-work needs to be done before taking up any ambitious program for change management. It requires detailed strategic planning. Financial implications play a significant role in strategic planning and decision-making. A number of streamlining procedures need to be established and a lot of commitment from top management is required. As the visibility of senior management support generates widespread enthusiasm, top management and managers must lead by example and take charge of the process and address each area of concern. The implementation should be planned in phases. For a beginning, some “managers’ models” may be developed. Management should foster change agents and encourage multidisciplinary teams. Change agents are required to facilitate co-ordinate and initiate the activities. They should possess the requisite qualities to effect the desired changes at the desired rate. Services of an expert, preferably outside the roles of the company, may be required to initiate and guide TPM activities. Later on, the same may be taken over by change agents who should be accountable for overall implementation of the initiative and this should constitute their full-time job requirements. This leads to clear focus, accountability, expert advice and overall co-ordination.

It is also important that sensitive human issues be considered before taking strategic decisions. It should be ensured that the company culture is conducive to change i.e., enough actions should already be taken to bring the employees’ mind-set to accept, welcome and even initiate changes. Since mutual trust and confidence are *sine qua non* for success of any management initiative, people should be taken into confidence. Communication should be improved at all levels as the provision of reliable information by the firm increases efficiency by facilitating worker co-
operation in tougher times. Participatory management erodes the traditional powers of middle managers and supervisors and many times makes them seem redundant. Since they have an important role to play, the role of middle managers and supervisors should be made clear. Employees should be encouraged to step outside established roles to accept assignments beyond the scope and structure of the existing organization. A conflict between employee involvement and distributive bargaining over the wage share is likely to arise. It should be solved amicably.

Continuous improvements are possible by harnessing employee potential. However, the point of caution is that they should be applicable in the particular industry and cultural set-up. These should be properly adapted to the requirements of a particular country. In fact, studies reveal that the Japanese spend four times the cost of acquiring technologies in adapting them to their particular requirements (suitability to industry and work-culture). Thus, any change has to be adapted to a specific company. Any employee involvement effort must be treated as an element of the whole organizational and cultural change and its benefits come from its contribution to the objectives of the firm and finally it’s bottom-line. Thus, the consequences are reflected at all levels – social, psychological, financial and cultural. It should also be kept in mind that system can be killed by building too many controls. People involvement, commitment and empowerment are concomitant with any improvement associated with them.

**Recommendations to Other Firms**

The research findings may benefit the organizations that are embarking or have started a *TPM* program but are experiencing difficulties in implementation, or their efforts are not providing the success expected of the program. Consequently, we suggest the following eight-step approach:

*Step 1: Get Top Management Commitment:* This is a basic pre-requisite for any management initiative to succeed.
Step 2: Create a steering Committee: A steering committee if not already in place should be created with the authority and responsibility to develop the TPM program.

Step 3: Understand the current situation: The steering committee should carry out a situational analysis of the current level of TPM development; this can be done through established review techniques or using audit methodology. However, the recommendation from this case study is to examine the organization in respect to the fifteen categories mentioned earlier.

Step 4: Understand the restraining forces and the driving forces: An understanding of the restraining and driving forces is necessary before developing an improvement plan aimed at successful implementation of TPM. The recommendation is to adopt the force field analysis method by the steering committee.

Step 5: Develop an implementation plan including milestones and measures of performance: Production driven programs have been shown as being the most successful approach in implementing TPM. Therefore, it is advocated that production workers are involved in the development of the program to encourage production ownership in the early stages of TPM development, hence increasing the chances of successful implementation. At this stage the full requirements of the eleven pillars of TPM must also be considered, because successful TPM can only be achieved through consideration of each pillar due to their dependence and interrelated requirements. Additionally, at this stage measures of performance (in terms of PQCDSM indices) and milestone objectives should be included in a master plan to provide criteria for assessment, review and direction of the program in future.

Step 6: Get employee involvement and commitment through awareness campaigns: This is essential for really reaping the expected benefits from the initiative. At this stage the
determination of top management and the steering committee to make \textit{TPM} succeed must be well communicated to all employees.

\textit{Step 7: Implementation of the TPM Master Plan:} The master plan should be implemented with continuous monitoring and auditing as in the case. Project management techniques may be employed to give the implementation of the plan the best opportunity to succeed. However, there should be some flexibility as employees are not machines and hence it is all the more difficult to harness and channelize their skills and energies.

\textit{Step 8: Review the implementation of the plan and amend activities or milestones as necessary:} Motivation of management and workforce is a key success factor in the implementation of \textit{TPM}. Hence, a review of the achievements of the \textit{TPM} program must result in the communication and reward of the achievements aimed at reinforcement of successful behavior and practice. Reward and recognition should be used to encourage and motivate in the required direction. Furthermore, this reinforces management commitment to the \textit{TPM} program. Conversely, if failure to achieve the required results is seen at the review stage, analysis of why the expectations have not been met must be carried out and consequently amendments to the activities must be promptly made so inappropriate practice or direction is not continued. Continuous management commitment is necessary for continued improvement and development of \textit{TPM}.

\textbf{Directions for Future Research}

Many management initiatives such as statistical process control (SPC), total productive maintenance (\textit{TPM}), automated process control (APC), total quality management (\textit{TQM}), environment management (EM) etc. overlap in terms of the tools, techniques and methodologies they employ and the objectives they wish to attain. These disciplines are traditionally separated (both in literature and in business practice) but their goals have a great deal of overlap. Their
common goal is to achieve optimal product quality, little downtime, cost reduction, etc. by controlling variations in the equipment and process so as to maximize profitability while causing minimal environmental damage. However, single or separated parallel applications may be not fully effective. This implies the need for an integrated approach to define, describe and improve the production processes. A few authors have proposed to combine them to provide an unbeatable system for continuous improvement in the organization. An integrated concept like TQEM (Total Quality & Environment Management) need to be properly developed and its results tested at the industrial turf.
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