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Development of Framework for Analyzing the Barriers in Total Productive Maintenance

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ABSTRACT

In recent times, many organizations implementing total productive maintenance (TPM) have been failing in their attempts due to different barriers and challenges in TPM implementation. The purpose of this study is to evaluate the barriers before manufacturing organizations for adapting to proactive total productive maintenance (TPM) initiatives. It is observed that in the case of TPM, top management should be committed to involve from the beginning to implement and follow up, as this decision is complex and involve huge investment in the long term. Before starting implementation, top management should be convinced of the necessary justification, which requires analysis of various barriers such as lack of top management commitment, lack of human resource management, high turnover at top management level, lack of co-ordination between different departments. This paper has tried to develop a framework for analyzing the barriers in TPM implementation

Keywords: *Total Productive Maintenance (TPM); Manufacturing Organizations; Top Management; Barriers; Maintenance; etc..*

1.0 Introduction

Total Productive Maintenance (TPM) is an extremely effective strategy for increasing industrial effectiveness. The development of TPM began in Japan in the 1970s where it proved to be very successful in enhancing the effectiveness and profitability of several Japanese companies.

TPM is now well accepted by Japanese industrialists and is attracting the interest of industrialists in several countries around the world. Nakajima (1988) defines TPM as ``productive maintenance involving total participation'' that includes the following elements:

TPM aims to maximize equipment effectiveness. TPM establishes a thorough system of preventive maintenance (PM) for the equipment's entire life span.

- TPM is implemented by various departments (engineering, operations, and maintenance).
- TPM involves every single employee, from top management to workers on the floor.
- TPM is based on the promotion of PM through motivation and management of autonomous

The last two elements are common Japanese concepts in line with total quality countries are

- small group activities. organized with maintenance and operations as two separate entities. Consequently, the implementation of TPM in non-Japanese companies shifts the attention from ``the total involvement of every employee'' to the effectiveness of equipment. Hartman (1992), who introduced TPM to several US companies, states that TPM permanently improves the overall effectiveness of equipment, with the active involvement of operators. From these definitions, there are basically two features that define and characterize TPM. The more important of these two features is equipment management. Production equipment is one of a manufacturing company's largest assets. Asset utilization is widely used as a measure of return on assets. In many cases, equipment utilization is very low. Consequently, a sound equipment management program aimed at improving asset utilization is a must for the competitiveness and profitability of any organization. This is why equipment management is the focus of TPM. The

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- second major feature of TPM is the empowerment of employees. The organizational line between maintenance, production, and engineering is often a source of inefficiency, higher costs, and lower productivity. With TPM, operators and mechanics must realize that they both have the same goal and consequently must co-operate and have a teamwork spirit. The goals of TPM include improve product quality reduce waste, improve the state of maintenance and empower employees.

These goals are achieved through a careful implementation of the concepts of employee empowerment and sound equipment management. The involvement of the operators in the success of TPM cannot be overemphasized. A pragmatic way of achieving this is by using a systematic approach to skill under which an operator who has been properly trained and certified can perform a mechanical task, and vice versa. This partnership between operations and maintenance has different benefits such as

- Operators and mechanics become multi-skilled, leading to job enrichment and improved flexibility of workers;
- The involvement of operators in routine maintenance builds a sense of responsibility, pride, and ownership;
- Delay times are reduced and productivity is increased; and
- Promotion of teamwork between operations and maintenance.

Equipment is the focus of TPM. This effort starts by identifying the major losses with regard to equipment. The six losses limit equipment effectiveness (Nakajima, 1988). These are equipment failure (breakdown), setup and adjustment downtime, idling and minor stoppages, reduced speed, process defects and reduced yield.

2.0 Literature Review

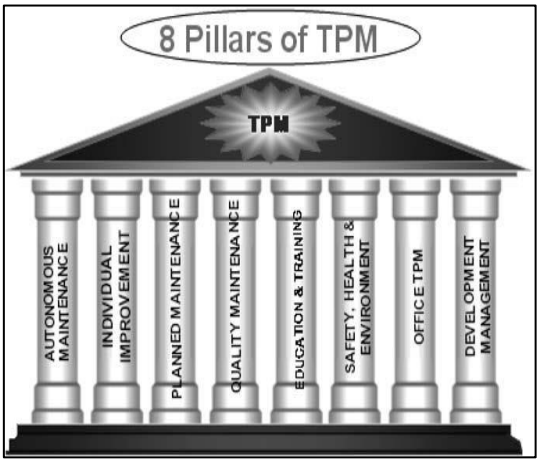
Bamber et al. (1999) identified that one approach to improve the performance of maintenance activities is to implement and develop a total productive maintenance (TPM) strategy, however, it is well documented that a number of organizations are failing to successfully implement such strategies. This research provides the development of a generic model indicating factors affecting the successful implementation of TPM, in addition to this; it also led to the development of recommendations to improve the TPM development and implementation program of organization. John J. Lawrence (1999) identified that total productive maintenance, or TPM, represents a major shift in the way an organization approaches the maintenance function and implementation, the implementation requires a change in the approach and mind set of the employees in the organization. This paper proposed an additional means to help bring about the cultural change necessary to make TPM work on mathematical modeling. Using examples of four mathematical models in the maintenance field, he described how such models might are useful to promote this cultural change by making the potential benefits of TPM more tangible and objective to employees and by improving employees' understanding and their involvement in TPM, which could be beneficial the organization and its customers. Fang Lee Cooke (2000) worked on the study of the production and maintenance function of four processing/manufacturing companies. He highlighted the difficulties that these companies had been faced with in their attempt to implement TPM initiatives between the production and maintenance departments in order to improve organizational efficiency. The paper concluded that implementing TPM is by no means an easy task, which is heavily burdened by political, financial, departmental and inter-occupational barriers. Mohamed Ben-Daya (2000) considered the nature of total productive maintenance (TPM) and reliability-centered maintenance (RCM) and the relationship between the two. They noted equipment management and empowerment of employees as key features of TPM. They also noted the development of an effective preventive maintenance program as essential to effective equipment management and suggest that RCM is central to the development of such a program. They pointed out that, if implemented within the framework of TPM, RCM can help to achieve better results from the TPM implementation. F. Ireland and B.G. Dale (2001) focused on a study of total productive maintenance (TPM) in three companies. The companies implemented TPM because of the business difficulties they faced. In all three companies senior management had supported TPM and set up suitable organizational structures to facilitate its implementation. The companies had

followed Nakajima's seven steps of autonomous maintenance, although different TPM pillars had been adopted, with the common approach focusing on improvements, education and training, safety, and quality maintenance. Jonas Hansson and Fredrik Backlund (2002) included a comparative study of literature on TQM, TPM and RCM implementation, focusing on organizational change. They studied several common categories of activities when implementing TQM and the maintenance methodologies. These categories can be considered crucial to obtain management and employee commitment. This should also bring a change with attitude of both and should consider the importance of maintenance Case studies on TQM, TPM and RCM implementation were used to validate the categories identified, and to yield recommendations on the handling of activities within these. Dinesh Seth and Deepak Tripathi (2004) studied the strategic implications of TQM and TPM in an Indian manufacturing set-up and to detail literature reviews to highlight gap areas. To examine the relationship between factors influencing the implementation of TQM and TPM and business performance for the following three approaches in an Indian context: TQM alone; TPM alone; both TQM and TPM together. This was done to extract significant factors for the above three approaches. Masjuki Hj et.al (2004) discussed the state of implementation of TPM in small and medium industries (SMIs) and the effects of lack of productive maintenance. The main hypothesis is to determine if SMIs have understood the importance of a productive maintenance system as a constituent of manufacturing management apart from the sole focus on production. A survey methodology has been applied for this test. The outcomes of some case studies are kept in mind. All these show that the implementation of TPM or preventive maintenance in SMIs is still low as they have the mind set to produce only rather than to obtain continuous service of the machines with high efficiency. Therefore, more effort should be given to developing a better understanding, motivation and participation for implementation of productive maintenance systems. Finally, an implementation methodology was proposed. Sharma et. al (2006) examined the need to develop, practice and implement such maintenance practices, which not only reduce sudden sporadic failures in semi-automated cells but also reduce both operation and maintenance (O&M) costs. Ahuja and Khamba (2007) identified maintenance-related losses for ascertaining and addressing the performance losses, and affecting improvements in the manufacturing performance in an organization through strategic total productive maintenance (TPM) initiatives. TPM has provided an excellent means to improve the overall efficiency of the manufacturing system. Thus, in a highly competitive scenario, TPM might prove to be one among the best of the proactive strategic initiatives that can lead the organizations to scale new levels of achievements and could really make the difference between success and failure of the organizations. Panagiotis Tsarouhas (2007) adopted the total productive maintenance (TPM) in the food industry and especially in bakery products. He developed a methodology for increasing production rate, improving the quality of the products and providing a healthier and safer work environment which is only possible through a proper maintenance of plant in total. Ahuja and Khamba (2008) investigated the contributions of successful TPM initiatives to competitive manufacturing. They also critically examined implications of strategic TPM implementation initiatives in Indian manufacturing organizations. The holistic deployment of an effective TPM implementation program can help organizations to realize manufacturing competencies for sustainability efforts for meeting global competition. Strategic TPM initiatives have helped the struggling organizations across the globe to effectively compete in increasingly turbulent and technologically complex markets. Ahuja and Khamba (2008) evaluated the challenges before Indian manufacturing organizations for adapting to proactive total productive maintenance (TPM) initiatives. The aim of this research was to critically examine the factors influencing the implementation of TPM practices in the Indian manufacturing industry, and to devise an overall maintenance strategy for overcoming obstacles to successful TPM implementation. In order to ensure the successful implementation of TPM initiatives and practices in the challenging Indian manufacturing environments, the organizations must be willing to foster an environment that is willing to support change in the workplace, and create support for TPM concepts. The top management's contributions for successful TPM implementation had

been found to be highly critical and successful managers must know how to use TPM initiatives in the different situations to develop employee involvement in every step of the manufacturing process and facilities maintenance to optimize production flow, increase product quality, and reduce operating costs. Moreover, it could be concluded from the research that the successful organizations need to strategically integrate proactive maintenance initiatives into their manufacturing strategies and successfully boost organization's productivity, improve maintenance performance, reduce costs, improve plant profitability, minimize unnecessary downtime, ensure better utilization of resources, thereby enhancing the competitiveness of the organization. Ahuja and Khamba (2009) investigated the contributions of successful total productive maintenance (TPM) initiatives to competitive manufacturing. They critically examined the implications of strategic TPM implementation initiatives in an Indian manufacturing organization. A manufacturing facility had been studied and analyzed to study TPM implementation issues, the roadmap followed and the key benefits achieved as a result of TPM implementation. The research highlighted the contributions of various TPM implementation initiatives in Indian industry to accruing strategic benefits to meet the challenges posed by global competition. The study revealed that the TPM initiatives were far more influential in affecting manufacturing performance improvements as compared to traditional maintenance practices. This validates the extremely high potential of TPM initiatives in realizing overall organizational competencies. The study shown that systematic TPM interventions in the organization had significantly contributed to improving the manufacturing system's productivity, quality and safety and the morale of the workforce, and had also ensured the cost effectiveness of the manufacturing functions within the organization. They suggested that effective TPM initiatives can significantly contribute towards the realization of strategic manufacturing performance improvements for competing in the highly dynamic global marketplace. Kodali et al. (2009) emphasized that in the case of TPM or world-class maintenance systems WMS, top management should be involved from the beginning to implement and follow up, as these decisions are complex and involve huge investment in the long term. Before starting implementation, top management should be convinced of the necessary justification, which requires analysis of various qualitative and quantitative factors apart from analyzing various tangible and intangible benefits. In such a situation, the conventional, financial justification techniques alone cannot be used. Simoes et. al (2011) examined the relevant literature related to maintenance performance measurement in the manufacturing sector. In the process, innovative approaches and models utilized to measure and manage maintenance performance in manufacturing operational settings are classified and examined. They examined issues relevant to the different facets of maintenance activities, resources, measures, and measurement in manufacturing organizations.

2.1 Eight pillars of TPM

Fig 1: Eight Pillars Of Tpm Implementation Plan (source - JIPM, 1994)



Pillar 1 - Jishu Hozen (Autonomous Maintenance)

This pillar is geared towards developing operators to be able to take care of small maintenance tasks including cleaning, lubricating, visual inspection, tightening of loosened bolts etc. The aim of this pillar is to maintain the machine in new condition.

Pillar 2 - Kaizen (Individual Improvement)

Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization.

Pillar 3 - Planned Maintenance

It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction.

Pillar 4 - Quality Maintenance

It is aimed towards customer delight through highest quality by defect free manufacturing.

Pillar 5 - Training

It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently.

Pillar 6 - Safety, Health and Environment

In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis. The target of this pillar is zero accident, zero health damage and zero fires.

Pillar 7 - Office TPM

Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation.

Pillar 8 – Development Management

Development management helps in drastically reducing the time taken to receive, install, and set – up newly purchased equipments.

3.0 Barriers in TPM Implementation

As mentioned earlier, TPM implementation though easy on paper, is difficult to achieve and this is mainly due to reluctance by the organization to understand and implement the concepts of TPM and failure to realize the benefits obtained by implementation of TPM. The different barriers are discussed in following such as:

3.1 Lack of top management commitment

TPM programs can be effective if and only if the top management is totally committed and involved. The top management drives TPM. It is the responsibility of the top management to distill the benefits of TPM down the organizational levels. Lack of top-management commitment may stem from various reasons like lack of experience and training, resistance to change, and hesitation in initiating improvement programs. Without top management support, the TPM program will suffer a premature death.

3.2 Lack of human resource management

Human resource problem is an important barrier to successful TPM implementation. Human resource assets are to be treated with care and management should go the extra distance to make them feel at home. Remuneration and employee benefits and facilities should be at par with global levels. Employees should feel wanted in the organization and be motivated to overcome all barriers in TPM implementation.

3.3 High turnover of employees

Employees in most of the organization encounter difficulties in adopting themselves to modern work environments with new rules and organization hierarchies. Structural problems like organization culture and performance appraisal problems like lack of reward system and training program were the most often cited explanation for failing to return to work as scheduled and for absenteeism (Mosadegh Rad, 2005). Other explanations such as cultural differences, employees family issues (Teagarden et al., 1992), and switching the jobs for a minimal increase in salary (Lawrence and Lewis, 1993), have been offered to explain the high turnover at management level. Ineffective employee compensation and promotion (Wentling and Palma-Rivas, 1998) are also significant factors that influence turnover and absenteeism in the organization. Appraisal schemes such as family finances, basic healthcare facilities, quality and punctuality bonuses, and on-site healthcare clinic for employees and their families could dramatically reduce turnover and absenteeism (Teagarden et al., 1992).

3.4 Lack of co-ordination between different departments

Poor co-ordination between departments is one of the critical barriers that an organization inhibits.

Employee relations and co-ordination between departments influence the performance of the organizational system and consequently determine the nature and extent of TPM implementation. Additionally, lack of coordination between departments is seen to be detrimental to successful TPM implementation. There is very wide difference of opinion between the quality and production departments in many organization-related matters. Weak internal communication within the departments can also cause lack of co-ordination between departments and thus, leads to major barrier to TPM implementation.

3.5 Poor planning and strategy developed

The absence of a sound strategic planning by the top-management has often contributed to ineffective TPM implementation. Though, the pre-planning stage of developing the right attitude and level of awareness is considered crucial in implementing the TPM. It is observed that a large number of organizations are either unable or not willing to implement TPM. Therefore, careful and detailed planning is needed prior to the implementation of any quality program and organizations should identify beforehand the stages that their processes undergo.

3.6 Lack of communication

Poor communication is one of the major barriers found to hinder TPM implementation in an organization. Lack of communication across the organization often results to unsatisfied customers, unfulfilled customer requirements, and environment of distrust. Al-Zamany et al. (2002) argued that in most of the cases the management resists in sharing important information with the employees for several reasons. This would create the environment of distrust and conflict among management and employees.

3.7 Lack of education and proper training

To impart knowledge on TPM, extensive training schedule needs to be developed by the organization. An organization should identify the specific knowledge, skills and management abilities that it wants its employees to have and then design suitable training to achieve to develop the skills (Suzuki T., 1994). Organizations should be willing to spend on training, educating and developing its employees on TPM implementation and its benefits. When compared to the benefits achieved through TPM implementation, the costs incurred on training are very minimal.

3.8 Employees' resistance to change in system

Employees' resistance to adopt the change is a common barrier that every organization experiences while implementing TPM. A common comment in Indian organizations is "This is not my job". When the work culture promotes distinction and boundaries, employees view themselves as belonging to the departments in which they work and not to the organization that employ them. A narrow sense of vision hinders growth of an organization. It is the task of the management to align employees to the organization's vision and goals.

3.9 Inadequate use of manpower and team work

Teams are integral to TPM implementation strategy. Employee empowerment and teamwork are critical factors in TPM.

The ―Team concept on which TPM is based on should involve all departments including engineering, operations and maintenance (B. S. Blanchard et al., 1995). If the teams are not constituted properly, problems in the equipments cannot be detected and rectification and modification actions cannot be initiated.

A team consisting of only management staff or only non-management staff or personnel from one department does not add any value. The teams should consist of personnel from the cross-section of the organization spanning all the levels and departments.

3.10 Lack of continuous improvement in organization culture

This is directly related to work culture in an organization where-in frequent breakdowns are tolerated and not analyzed, processes are inefficient, product quality is not checked and customer feedback not monitored.

Operators have to become involved in routine maintenance and improvement activities that halt accelerated deterioration, control contamination and help prevent equipment problems (Suzuki T., 1994). Absence of continuous improvement culture in the organization leads to total failure of TPM.

3.11 Unawareness towards quality and productivity

Employee's attitude towards quality is another important hindrance in effective implementation of TPM program. Difficulty in changing the mindset of employee with regard to quality and urgency among them are reasons which generally obstructs the movement of quality program. Employees have to be made to feel that quality adds improvement in productivity, services, and reduce costs and they are directly or indirectly responsible for customer satisfaction (Mosadegh Rad, 2004).

3.12 No benchmarking and performance analysis

Organization cannot achieve global standards without benchmarking the critical business processes. Absence of benchmarking in the organization leads to lack of competitiveness. Benchmarking is a continuous systematic process of measuring the products, services, and practices against those of competitive organization leaders (Saravanan and Rao, 2006). Al-Zamany et al. (2002) examined that regular meetings to review and improve the strategic plans will help in achieving the well defined goals and targets, and results to removal of no-benchmarking barrier in the organization. A recent study showed that despite the benefits of benchmarking, it is seldom applied within the organization due to lack of feasible tools organizations develop internally which are often unstructured, to compare their business practice with the practice of others (Bjo¨rklund, 2010).

3. Development of Framework for TPM Barriers

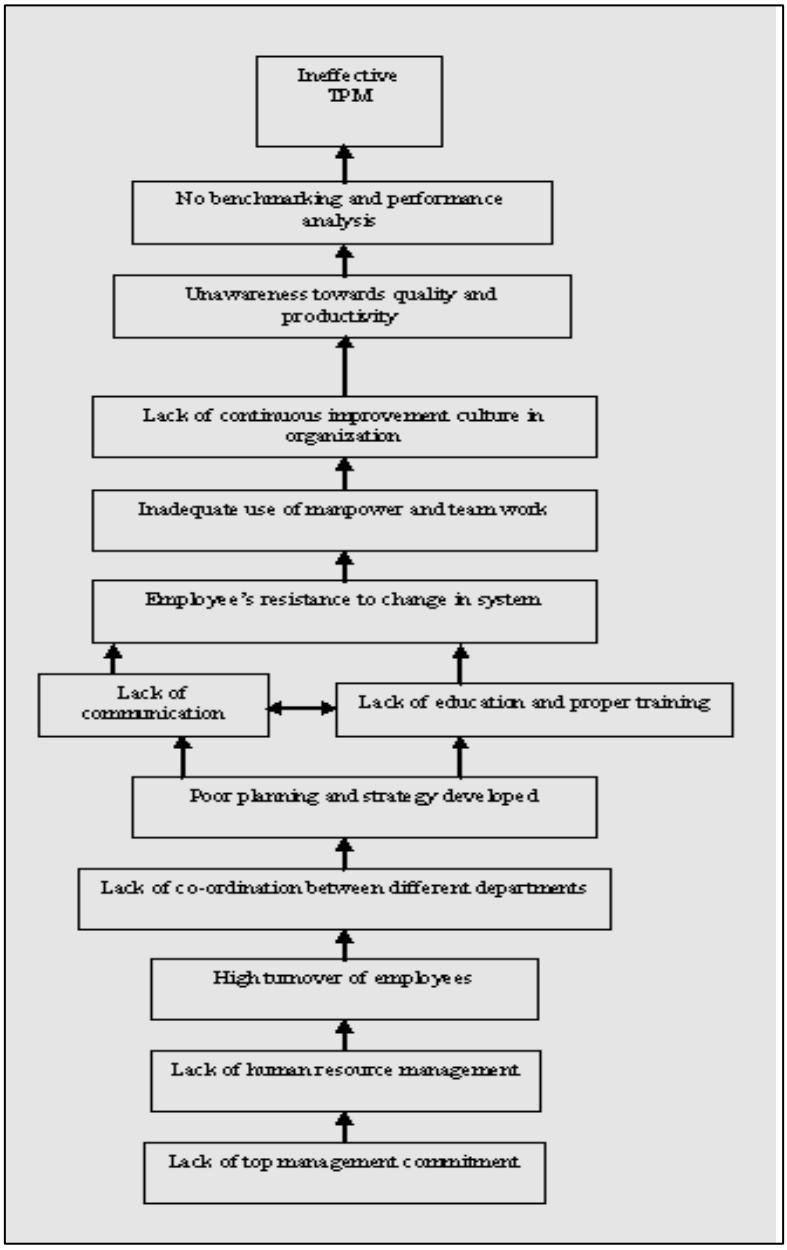
Implementation of TPM program will be ineffective due to the different reasons. These are shown in the framework in figure 2. As per the given framework, lack of top management commitment will lead to lack of human resource management in manufacturing organization. As human resource management is not functioning properly, the high turnover of employees will take place at each level. High turnover of employees will increase the lack of co-ordination among the employees of different departments. It will generate poor planning and strategy which can be subgroup as lack of communication, lack of education and proper training. This will result resistance to any change in manufacturing system by the employees. Resistance to change will develop inadequate utilization of manpower and team work. It again leads to lack of continuous improvement in organization culture. Organization culture will hamper the awareness towards to quality and productivity. As a result no benchmarking and performance analysis will be in manufacturing organization which will lead to ineffective TPM.

4.0 Challenges for TPM Implementation in Manufacturing Organizations

As the organizations across the globe have faced stiff cut-throat competition in the last three decades, the manufacturing organizations too could not escape the brunt of globalization. Ahuja and Khamba (2007) have observed that Indian manufacturing industry has also witnessed irrepressible competition in the recent times, predominantly due to the entry of multinational companies in the wake of liberalization, since early 1990's. Owing to opening up of the Indian economy from merely a regulated economy, the manufacturing industry has been faced with uphill Strategies and success factors in task of competing with the best in the world. The intense competition has been witnessed in terms of low costs, improved quality and products with high performance, competition (Chandra and Sastry1998). Moreover shorter lead times, shorter innovation times and reduced inventories have lead to increasing demands on the organization's preparedness, adaptability and versatility. Traditionally, manufacturing organizations have suffered from inherent deficiencies like poor responsiveness to changing market scenarios, low productivity, poor quality, poor cost effectiveness of production systems, stubborn organizational character and structures, uncertain policy regimes, low skill and knowledge base of employees, low production automation, non-motivating work environments, high customer complaints, high utility rates, high wastages associated with production systems, high labor rigidity, high internal taxes, and infrastructural glitches. The manufacturing organizations are faced with the challenge of adopting cost effective manufacturing strategies for staying competitive. While implementing effective TPM programs, the Indian Manufacturing organizations have often been plagued with teething problems and challenges like difficulties to understand business economics,

reluctance to changing practices, vague worker's apprehensions, inability to realize the same level of benefits as reaped by developed countries by imitating the TPM implementation procedures and practices adopted abroad. Thus manufacturing organizations need to shed the sluggish character and move forward aggressively to develop adapt proactive processes and practices for overcoming the inherent deficiencies in manufacturing systems for harnessing distinct competencies in comparison to their global competitors

Fig. 2 Framework for Barriers in Tpm Implementation



5.0 Conclusions

It has been revealed from the research that traditional manufacturing organizations have somewhat struggled in the past, while attempting to implement strategic proactive TPM initiatives and practices, since it needs to bring about significant cultural transformations in the organization for changing the mind sets of the employees. In this paper have been analyzed various barriers affecting

the successful implementation of TPM. The difficulties faced by the organizations have been categorized into organizational, behavioral, technological, operational, and departmental barriers. It has also been revealed by the study that successful implementation of TPM initiatives can be realistically achieved by the whole hearted commitments of top management. The successful implementation of TPM requires top management support and involvement, a greater sense of ownership and responsibility from the operators, co-operation and involvement of both the operators and the maintenance workers. Therefore it is received that for successful implementation of TPM, top management should focus on improving co-ordination between departments, improving communication skills, education and training of employees. By working on, maintenance management organizations can improve their overall productivity and competitiveness in global market. This study can be further extended for case studies on TPM implementation.

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