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Title: Overall Equipment Effectiveness (OEE) Improvement by TPM Implementation in
Petrochemical Manufacturing Plants at Jubail Industrial City in Saudi Arabia

1. Introduction

Nowadays, to survive in the competitive industries, organizations require implement a best in class practices .TPM was identified as a best worldwide class for improving manufacturing process. Since achieving quality in all facets of manufacturing operations, implementation of Total Productive Maintenance (TPM) is required [1] .TPM provides a comprehensive, life cycle approach, to equipment management that minimizes equipment failures, production defects, and accidents. It involves everyone in the organization, from top level management to production mechanics, and production support groups to outside suppliers [2] and while TPM was built on pillars that include " 5S concept , Autonomous maintenance, Planned maintenance, Quality maintenance, Training, Office TPM, Safety, Health & Environment [3] ,

It valuable to see the Implementing Autonomous Maintenance pillar of TPM from point view of operator skills that restricts the Improving Overall Equipment Efficiency (OEE) in one Petrochemical plant, Petrochemical Producer at Jubail industrial City at KSA "Petrochemical Producer JIC-KSA"

2. Previous Studies:

i. What is Total Productive Maintenance (TPM) ?

It can be considered as the medical science of machines. Total Productive Maintenance (TPM) is A maintenance program which involves a newly defined concept for maintaining plants and Equipment. The goal of the TPM program is to markedly increase production while, TPM brings maintenance into focus as a necessary and vitally important part of the business. It is No longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of. The Goal is to hold emergency and unscheduled maintenance to a minimum. [3]

Bamber (1998) [8] presents the definitions of TPM that contains five main points:

1. To use the equipment more efficiently.
2. It establishes a total preventive maintenance system.
3. It requires a full participation from all department operator (equipment operator, designer, and departments workers)
4. It involves everyone in the company shop floor to the top management.
5. It promotes and implements preventive maintenance based on autonomous.

ii. TPM – History:

The Japanese, based on the planned approach to preventive maintenance (PM), evolved the concept of total productive maintenance (TPM). Nakajima (1986)

outlines how, in 1953, 20 Japanese companies formed a PM research group and,

after a mission to the USA in 1962 to study equipment maintenance, the Japan

Institute of Plant Engineers (JIPE) was formed in 1969, which was the

predecessor to the Japan Institute of Plant Maintenance (JIPM). In 1969, JIPE

started working closely with the automotive component manufacturer (Nippondenso) on the issue of PM, and when the company decided to change

roles of operators to allow them to carry out routine maintenance this was the

beginning of TPM [5]

iii. Overall Equipment Effectiveness (OEE) Vs TPM

Total productive maintenance has provided a quantitative metric tool, which is known as overall equipment effectiveness (OEE) to make them fit and agile for this competition. The OEE is a maintenance performance measurement tool that measures different types of production losses and indicates the areas of process improvement [6]

OEE is a result can be expressed as the ration of the actual output of the equipment divided by the maximum output of the equipment under the best performance condition. The Overall Equipment Effectiveness was originated from the Total Productive Maintenance practices, developed by S. Nakajima at the Japan Institute of Plant Maintenance, the aims of TPM is to achieve the ideal performance and achieve the Zero loss which means no production scrap or defect, no breakdown, no accident, no waste in the process running or changeover. The quantification of these accumulations of waste in time and its comparison to the total available time can give the production and the maintenance management a general view of the actual performance of the plant. And it can help them to focus the improvement on the bigger loss. [8]

iv. TPM Implementation:

Understand the TPM implementation in simple way can be found in the Four rules which illustrated the actual processes of TPM in the research "TPM and lean maintenance-A critical review [9]:

1. Dictates that anything done to maintain and improve equipment must be documented in procedures that every employee follows.
2. Proper maintenance tools, parts, and supplies be made available, as they are needed, and that maintenance requests are sent and acknowledged promptly. Lastly, when proper repairs or improvements are made, those who requested them should sign off on them.
3. Every maintenance person knows on what equipment he is qualified to work and where he or she can get help when a problem exceeds their expertise.
4. Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization" indicates that data should be collected, analyzed, and made available to make the improvements more efficient and effective. Additionally, informed people closest to the problem should work out possible solutions and conduct experiments to determine the workability of their solutions. Applying the logic of this rule also requires that formally experienced and trained problem solvers lead improvement effort and that changes are made in the equipment and supporting work processes and people are trained in the new methods.

In brief, the meaning of the four rules is : maintenance work is governed by planned maintenance routines and that frequent joint production/maintenance planning and status meetings are scheduled to keep efforts focused [9]

v. TPM Pillar "Autonomous maintenance" and Importance of Operator Maintenance Skills :

Mobley, R. K. (2008). Autonomous maintenance requires the proactive involvement of equipment operators to eliminate accelerated equipment deterioration to perform some of the routine maintenance tasks. [2].

Almeanazel, O. T. R. (2010) was conclude that the operator in the shop floor should involve in each maintenance operation because he is the one close to the machine and he know what are the abnormality of the machine [8].

McAdam and Duffner found that the Barriers for TPM Implementation was mainly due to worker's fear that the only drive is to improve production efficiency, reduce workforce and increase shop floor job load. Many production operators do not want to accept additional responsibilities and they are happy with the current situation. In additional research was concluded with that "As TPM is a concept that focuses on the human involvement, human participation and transfer of the

maintenance job function to the production operators, the production department must drive and lead TPM program since they are having the greatest degree of influence to make TPM a success. [10]

Acharya (2018) Operator is given a sort of semi ownership, and he is taught so that production does not stop even when machine faces minor failures. [6]

Brah, S. A., & Chong, W. K. (2004), Morale and performance of employees is another performance aspect of TPM. When operators and maintenance crew work together as a team, the result is fewer breakdowns and higher productivity. Conceivably, morale of both group of employees turn out to be higher as operators get a sense of ownership of the equipment and the maintenance crew avoids calls for simple maintenance jobs. [7]

3. Research Problem:

Since Petrochemical Producer JIC-KSA ,actually implemented TPM approach as four rules that been mentioned in pervious section "TPM implementation" ,TPM four rules have been embedded in "Petrochemical Producer JIC-KSA" organization structure as department wise and we can find them as Table-A:

Rule #	Rule Description	Department handle the Rule
1	Anything done to maintain and improve equipment must be documented	Execution & Technical Department
2	Request Maintenance need , preparation & Maintenance improvement acknowledgment	Planning & Operation Department
3	Leveling work skills authority	Execution & Technical Department
4	Continual improvement	Excellence and Specialist Sections

Table -001

We observed that Rule#2 of Maintenance improvement acknowledgment in Petrochemical Producer JIC-KSA impact Improving OEE Overall equipment Efficiency as mentioned in Maintenance Engineering Handbook [2] that Equipment efficiency is commonly used to metric when evaluating a manufacturing system. The Efficiency is typically maximized by running the equipment at its highest speed, for as long as possible, to increase the product throughput. The efficiency is reduced by time spent with the equipment Idling (waiting for parts to load), time lost due to minor stops (to make small adjustments to The equipment), and lower throughput from running the equipment at a reduced speed. These efficiency Losses can be the result of low operator skill, worn equipment, or poorly designed manufacturing System

while a TPM program typically enlarges the responsibility of production employees from merely operating machines to such areas as detecting machine failures, performing basic maintenance, and keeping work areas clean and organized [4].

Our observation is that TPM pillar "Autonomous maintenance" not implemented effectively due to the Operator Skills been impacted by only provide maintenance & technical training to maintenance & technical staff

4. Importance & Objectives of Research

- i. What is the correlation between Operation department objective and Autonomous maintenance aim?
- ii. What the Possibility for implementing the acquired new skills and Operator wellness for implementation?

5. Research Hypothesis

- o Operation department objectives that been cascaded from firm objectives which been distribute based on departments functions not support operator learning assignments to enhance operator knowledge about equipment failure root cause and enhance fundamental maintenance skills as required of TPM pillar "*Autonomous Maintenance*".
- o Why Research Hypothesis been taken

The lack of effective organizational communication on TPM implementation to all levels of the workforce contributes to the failure of the TPM program. The objectives and aims of TPM implementation must clearly inform to all levels of staff. Shop floor staff would only give their full support and commitment if they understand the main purpose of TPM implementation [6]. Besides this, TPM goals and objectives need to be fully integrated into the strategic and business plans of the organization and need to be communicated to all levels of staff, failing to communicate this will make TPM program fail [10]

6. Research Methodology

Questionnaire to measure Individual development Plan for operator in one Petrochemical plant (Petrochemical producer) in Jubail Industrial City at KSA.

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8. Appendix