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TPM: A Strategic Tool to Improve the Organizational Efficiency

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ABSTRACT: The manufacturing sector in Indian context, continuously strives from competition in market. This competition cause the firms to deduce the product cost whereas increase in product quality with providing new features to make it compatible as per customer need. Depending on the specific challenges and opportunities, careful in vigilance of facilities with in the manufacturing system in the company requires more attention. Therefore, the planning and considerations for the manufacturing system are required to ensure that 'real' benefits are being achieved, and further, the waste isn't being introduced to the systems. The advance technologies to improve organizational efficiency such as TPM, Lean, JIT, SCM, Agile, Green manufacturing etc. are rottenly linked to the development of 'higher order thinking'. In Indian manufacturing context, TPM is considered as a step towards the sustainable manufacturing system that encouraged a lot of research and investigation into the field of Maintenance Management. This paper tries to give various perspective of TPM: how it is defined, where is "fits in", what are the basic guidelines for implementing TPM, and performance measurement practises. This paper also provides in depth knowledge about the restrictions in production system of a manufacturing company and concluded 2 to 6 % increment in OEE of every workstation.

Keywords: Total productive Maintenance (T.P.M.), Overall Equipment Effectiveness (O.E.E.), Availability, Maintainability, and Quality rate, 5'S, Autonomous Maintenance.

I. INTRODUCTION

Development of advanced technologies in the area of information flow has results in increasing competition between manufacturing industries. This increases the pressure on manufacturers for performing competitively in the market and provides new, innovative, and cost effective products. Due to this reason, most of the manufacturing industries have shifted their focus from improving quality of product and productivity, to optimization of their physical assets. From the past few decades, maintenance of plant resources has became enormous potential which is to be improved and finds significant attention for mathematical modeling due to failures on random basis.

"Maintenance operations are characterized as the operations performed at departmental level focusing on keeping the facilities and equipment in operational conditions or serviceable condition."

The concept of maintenance is so simple that the process must be maintained sufficiently to retain its inherent capability. Without adequate maintenance in manufacturing industries, equipments breakdown on random basis and requires frequent adjustments more often. The importance of maintenance in the manufacturing firms has given rise to the concept of TPM, for identify the causes for breakdowns, analyzing the breakdown reasons and solution for the problems. To execute TPM process in industry, TPM execution team is formed which consist the production line workers, maintenance personnel, process engineers, and other as needed. Problems are kept narrow in scope to encourage a steady stream of small improvements *i.e.* reduction in no. of tools lost during operation and simplifies the process adjustments. Maintenance of any part some time defined as remanufacture which means applying set of operations on existing equipment to restore it to 'as-new' condition or in

currently industry specifications. Repair operations differ from maintenance functions in that the equipment/systems being worked is no longer functioning properly. Repair functions require a much higher level of skill. In an organization, maintenance of the equipments has a strong influence on the assets (Wireman T.1998). The various objects of manufacturing industries are not achieved without the support of the quality and maintenance strategy. The maintenance strategy adds to customer value in terms of profit, quality, time and service. Therefore, the maintenance function has become important for a manufacturing company's ability to maintain its competitiveness. Without well maintained equipment; it will not be advantage in the market that requires low cost products at a high quality to be delivered quickly.

The disturbance in the production process may occur due to different factors such as the failures of the important components of equipments, the quality of the purchase materials and spare parts, design, manufacturing process control, management systems and human error. TPM is characterized by 5 key elements.

1. TPM strives for maximum equipment effectiveness.
2. TPM establishes a total system of Preventive Maintenance for the entire life of the
3. equipment.
4. TPM includes participation by all sectors of the organization that plan, use, and
5. maintain equipment.
6. TPM participation is from top management to the frontline staff.

It sets out to achieve these goals by Gap Analysis of previous historical records of Product Defects, Equipment Failures and Accidents etc. Then through a clear understanding of this Gap Analysis (Fishbone Cause-Effect Analysis, Why-Why Cause- Effect Analysis, and P-M Analysis) plan a physical investigation to discover new latent fuguai (slight deterioration) during the first step in TPM Autonomous Maintenance called "Initial Cleaning". Many companies struggle to implement TPM due insufficient knowledge and skills especially in understanding the linkages between the 8 Pillar-Activities in TPM. A typical TPM implementation requires company-wide participation and full results can only be seen after 3 years and sometimes 5 years.

The main reason for this long duration is due to the basic involvement and training required for Autonomous Maintenance participation where operators participate in the restoring the equipment to its original capability and condition and then improving the equipment. TPM has 8 pillars of activity, each being set to achieve a "zero" target.

II. LITERATURE REVIEW

Due to more competition in the market, the requirement of modern manufacturing for successful organizations must be supported by both effective and efficient maintenance [3]. The effective maintenance work becomes necessity for equipments which has become more challenging in the current dynamic business environment. They examined that the operation on a machine efficiently and effectively without disruption due to equipment breakdown, stoppages and failure is required in manufacturing sector. The total participation from all employees including top management stimulates the contribution of operators to achieve zero breakdowns, zero stoppages and a safer working environment [8].

The Japanese has developed TPM to support their lean manufacturing system based on Preventive Maintenance, Corrective Maintenance and Maintenance Prevention concepts and methodologies that was originated and developed in the U.S.A. The process of O.E.E. finding is to increase equipment effectiveness so each piece of equipment can be operated to its full potential and maintained at that level [10]. Before TPM, the industry performance was examined by using Preventive Maintenance. The service life of the plant equipment can be prolonged by reconditioning the equipment before adverse condition lead to failure. There was lack in P.M. system, i.e. the operators were not empowered in maintaining minor activities rather they only operates the equipment [13]. Also, the utilization gap for installed capacity was found rather low due to various reasons. The personnel have received data collection experience it is possible to go over to a full OEE model. This gives both an exact assessment of the magnitude of the disturbance and a deeper understanding of the reason for losses. It was theoretically hypothesized that if t he production process is new to the company the OEE will be lower than the company is already familiar with older production process [9].

The methodology for estimating the quantitative monetary managerial effects as a result of TPM activities was developed. Calculating the OEE also gave the company where they were and where the weakness point was and how to improve. This will also help to calculate the total saving monetary amount composed of contribution profit and saving costs that are obtained by improving the overall equipment efficiency (OEE) of processing type equipment [7].

In Indian context, TPM methodology is mostly adopted by the manufacturing organizations. The main contributions of strategic TPM programmes will improve the manufacturing competencies of the organizations [1,2]. In recent researches**,** TPM recognized as fundamental component of world-class manufacturing which has been used in significant operation strategy to regain the production losses due to equipment inefficiency. TPM is the methodology that aims to increase both availability of the existing equipment hence reducing the need for the further capital investment. TPM advocates the concept of generate awareness among the budding technocrats and budding enterprises about TPM philosophy adoption in Indian Context [11]. Another purpose of the application of TPM is reducing the defects. The major factors that cause defects are the human negligence, less quality of raw materials, machines that need maintenances and work procedures [4].

The big six losses in any industry due to the quality, availability and speed were identified and eliminated through waste removal i.e. the time waste while changeover or the downtime losses etc. Another benefit of TPM implementation was to give them the chance to know what the best techniques that they can apply which improved their performance. The main difficulty in TPM implementation is the time taken because it is not a short-term fix program. It is a continuous journey based on changing the work-area, then the equipment so as to achieve a clean, neat, safe workplace through a "PULL" as opposed to a "PUSH" culture [6].

III. DEFINING PROBLEM

For sheet metal industry, there are lot of problems associated the production system. A study is carried out on the production system of XYZ industry.

In recent years, the company cannot compete in the competitive market unless it uses it resource and capabilities to the maximum level. The company must have to work to get rid of the problems to get the competitive advantages with respect to cost, service, quality and on time delivery. These issues do not allow the company to achieve its set goals.

- To investigate the current situation of the production of the case company.
- To pick up the weakening in the production system those do not allow the company to achieve its full capacity and meet the set goals.
- To suggest the ways to improve the situation.

Company manufactures the different sheet metal product by press machine technology. Present work is carried out at a production line at which different operations are carried out at different stations, which are blanking, bending, piercing and restrike workstation. These stations face various problems from which some are common. After examine the workstations and operation the following problems were found which led to the implementation of TPM Strategies at the floor Shop.

- Low overall equipment effectiveness
- High rejection rate
- High Down time
- High Set up time.

A. Research objectives

- Critically examine and investigate the problems of the existing maintenance system of the company.
- To study the maintenance system of the company and develop a system for the implementation of Total productive maintenance of the company.
- Identifying the common faults and remedies of those problems.
- Implement the new techniques from which can help to improve of maintenance system.
- To propose developed maintenance system and implementation model for the company.

Table 1. Faults and remedies.

S.No.	Faults	Reason	Remedy
1.	Misalignment of upper and lower die	Wrong position of lower die	Lower die must be at centre of line at bolster plate
2.	Burr	Due to friction force at the edge of punch And die	Finishing of edge of the punch and die after a certain period
3.	Dimensions out in blanking	Change of location of nest plate	Nest plate must be at their locating position
4.	Change of hole position	Change of position of the strip plate	Location of strip plate should be proper
5.	Crack	Don't proper clearance between die and punch surface	By buffering process surface cam maintain according to design
6.	Scratch	Dust, low clearance between die and punch surface	Surface finishing should be proper
7.	Wrinkle	Rough surface of die	Surface finishing should be proper
8.	Dimensions out in forming process	Lack of proper foundation of the product	Support for product should be proper can maintain by welding and finishing
9.	Movement of nest plate	Lack of proper bolting	Bolting should be proper
10	Scraps in die	Don't proper space for slug	Slug should be clean time to time
11.	Improper forming of product	Don't proper adjustment of cushion	Cushion movement should be proper
12.	Improper forming of product	Downward movement of punch	Shut height must be maintain

B. Data collection

Some of the data pertinent to the above loss are difficult to obtain, since the company doesn't apply the overall equipment efficiency concepts in evaluating the performance of the machines at the individual level. It has been attempted to gather some relevant data to estimate the OEE of the typical machinery. From the observations and few recorded data to calculate the availability of the machine, the researcher has treated the workstations as a whole as one machine and considered the available machines in that departments. Therefore accordingly the available machines on the days are collected and recorded in the following table.

Now finding the O.E.E. value for all the workstations individually and finding the current situation of the production process by utilizing the data. To find the overall equipment efficiency of the Metal Industry, identifying the six major losses of the machines was the first stride by organizing under three key factors. And then data pertinent to those losses was collected for randomly selected machineries.

IV. IMPLEMENTATION OF TPM METHODOLOGY

TPM seeks to encourage the setting of ambitious, but attainable, goals for raising the value of the OEE. The importance of maintenance has been increased than before, due to its role in maintaining and improving availability, performance efficiency, and quality products, on time deliveries, the environment, safety requirements and overall plant productivity at a high level. These are all the key factors of TPM methodology. Now, the TPM is implemented in the industry. For implementing the TPM in industry, it is very important to study the TPM Pillars and requisites, which are mentioned in Section 1.0 (Introduction). The proposed activities for improving the above problems are given as

1. Firstly divide the duties of operator and Maintenance Personnel
2. Auto maintenance schedule
3. Initial cleaning
4. Training
5. Implement the new technique (Focused improvement).

Table 2. Activities at different workstation.

Sr. No.	Description of activity	Improvements in Process	Name of Workstation
1.	Attach the spacer between the press spindle and upper plate of tool	Reduction of set up time	At all workstation
2.	Cut groove in the upper plate of die	Reduction of set uptime Reduction of down time	At all workstation
3.	Guide pin for locating the product in die	Decrease the rejection of product Help to support the product	At bending and restrike operation
4.	Gauge pin	Reduce the rejection of product Reduce the set up time	At blanking and punching operation
5.	Locating pin	Reduce the risk of product rejection It's a full proofing process	At bending and restirke operation

A. Analysis

Now, the data after TPM implementation is calculated. Table 3 shows the comparison of OEE of the plant after and before TPM. From this Fig.1, it is cleared that the TPM improves the O.E.E. value of every workstation from 2 to 6 %. From this figure, it is cleared that the TPM help to reduce the down time value of every workstation from 11 to 70 min/day and reduce the set up time of every workstation from 2 to 4 min/day.

Table 3. Comparison between after and before data for various workstations.

Sr. No.	Description	Blanking Workstation		Bending Workstation		Piercing Workstation		Restrike Workstation	
		Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
1.	Setup time per day	26 min	22 min	22 min.	19 min	28 min.	26 min	20 min.	18 min.
2.	Break down time per day	110 min.	106 min	45 min.	42 min	42 min.	40 min	105 min	102 min
3.	Preventive maintenance per year	7 days	7 days	7 days	7 days	7 days	7 days	7 days	7 days
4.	No. of failure per month	3	2	2	2	2	1	4	2
5.	Time to cover failure	24 hrs.	22 hrs	14 hrs.	13 hrs	12 hrs.	10 hrs	11 hrs.	10 hrs.
6.	Short stoppages per years	1200	1150	60	58	80	76	120	112
7.	Time for one short stoppage	15 min.	14 min	15 min.	14.5 min	15 min.	12 min	15 min.	14 min.
8.	No. of product produced per week	1200	1285	450	495	360	390	1050	1115

Table 4. Availability, Quality Rate & Performance comparison for Individual workstation.

Sr. No.	Description	Blanking Workstation		Bending Workstation		Piercing Workstation		Restrike Workstation	
		Before	**After**	**Before**	**After**	**Before**	**After**	**Before**	**After**
1.	Availability (%age)	84.82	89.71	85.53	86.71	87.22	93.45	92.78	96.57
2.	Quality Rate (%age)	95.33	95.33	88	92.77	93.33	95.38	91.88	93.09
3.	Performance efficiency (%age)	20	22.64	16.92	17.46	56.58	59.16	17.02	78.60

Table 5. O.E.E comparison for Individual workstation.

Sr. No.	Name of Workstation	O.E.E(%)	
		Before TPM	After TPM
1.	Blanking	16.17	19.64
2.	Bending	12.73	14.04
3.	Piercing	46.06	52.73
4.	Restrike	14.50	16.72

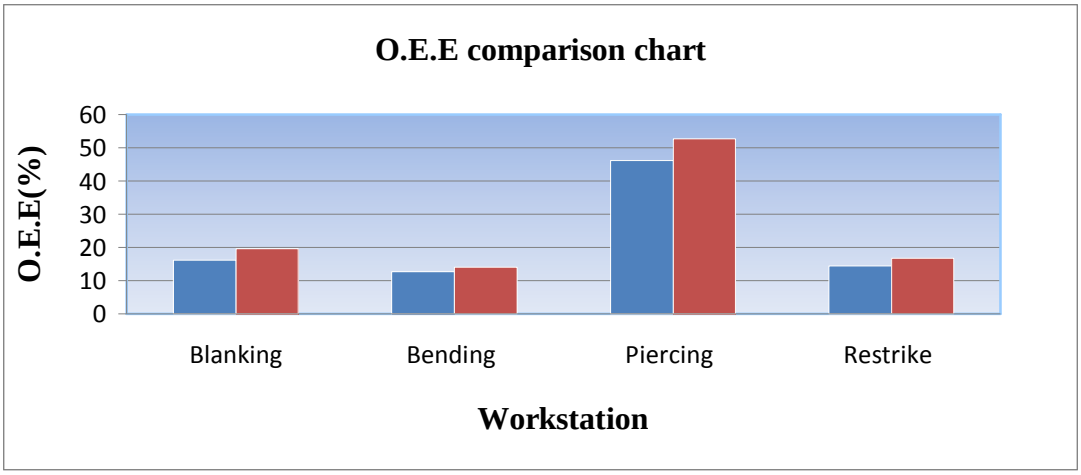

Fig. 1. O.E.E comparison.

Table 6. Down time comparison for Individual workstation.

Name of Workstation	Down time (min/day)	
	Before TPM	After TPM
Blanking	356.91	287.70
Bending	167.72	156.52
Piercing	161.76	126.76
Restrike	245.53	198.89

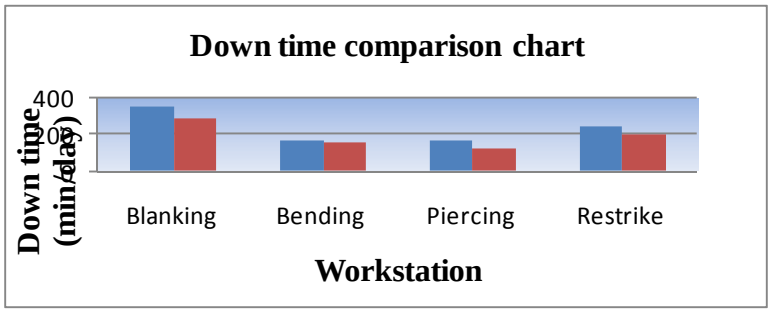

Fig. 2. Down time comparison.

Table 7. Setup time comparison for Individual workstation.

Name of Workstation	Set up time (min/day)	
	Before TPM	After TPM
Blanking	26	22
Bending	22	19
Piercing	28	26
Restrike	20	18

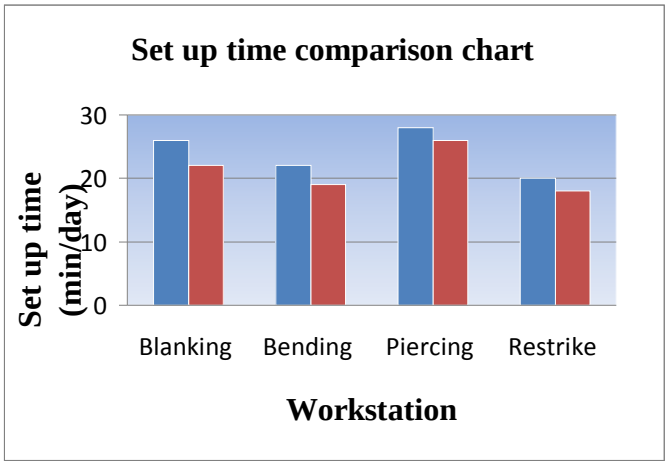

Fig. 3. Set up time comparison.

V. RESULTS AND DISCUSSION

From the above analyzing of data it is cleared that TPM methodology and poka-yoke are very helpful for improvement in the equipment's efficiency and condition. It increases the O.E.E. of each workstation from 2 to 6 %.

It also helps to reduce the set up time, breakdown time and down time of machine. By using of kaizen technique workstation can make fool proof from defects which reduce the no of rejections.

Company must try to maintain this system that quality and productivity can increase and do continuous improvement in the system. Some of the faults find in the process and their remedial action had taken for better output.

From the results and discussion, the following conclusions are drawn

- TPM may be the only thing that stands between success and total failure for some companies. It has been proven to be a program that works. Employees must be educated about TPM for its implementation in regular flow. By implementing the TPM O.E.E. of all workstation is improved from 2% to 6% which show that TPM is just not only a concept but also capable to improve efficiency of machine.
- By implementing the TPM strategy they can eliminate downtime losses from 10 min/day to 70 min/day. Set up time loss also can reduce from 2 min/day to 4 min/day.
- With this maintenance strategy the responsibility of maintain the equipment is all operator and engineering responsibility, there will be no more "his or my" fault the break down will be solved as fast as possible.
- By implementing the TPM they can also reduce the no of rejections from 6 pcs/week to 18 pcs/week. It means quality of all the operation is also improved by implementing this strategy.
- From the observation, it is clear that organization must be care about TPM for long term program for getting continuous improvement in productivity at lower cost. TPM is a beneficial tool from which help cost of equipment can cut for long term.

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