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RESEARCH ARTICLE

Overall Equipment Effectiveness Improvement by Implementation of TPM- A study.

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Abstract

The improvement of Equipment effectiveness can be achieved by improving the maintenance strategies of critical equipments. This could be done through altering maintenance actions that are performed on the equipments. A case study approach was used. The paper focuses on improving the maintenance in a manufacturing set up using an innovative maintenance regime mix to improve overall equipment effectiveness. This paper investigates the imperfections of the existing maintenance policy of an industry and corrective actions were suggested and implemented accordingly to increase the percentage effectiveness of some critical equipment. The impact of the strategy change is that there is a growth up to 10% in the overall equipment effectiveness within a short period.

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Introduction

Today, in modern industry, equipment and machinery are very important part of the total productive effort than was the case years ago. Moreover, with the development of special purpose and sophisticated machines, equipments and machinery cost a lot and therefore their idle or downtime becomes much more expensive. Frequent machine breakdowns, low plant availability and increased overtime are a great threat to a manufacturing plant as they increase operating costs of an industry .For this reason, it is vitally important that the plant and machinery should be properly maintained. The studies show that over 50% of all maintenance work is avoidable [2]. The reason for this is that the basics of maintenance prevention, inspections and the right operating practices concurrently with planning, scheduling and execution are not done well. The common focus is changed from fixing breakdowns to preventing them. Preventive Maintenance is essential care and fixed time maintenance together. Both essential care and fixed time maintenance prevent failure, while Conditions Monitoring only detects failures early [1]. Since operators are the closest to the machines, they are included in maintenance and monitoring activities in order to prevent and provide warning of malfunctions.

Objectives of Maintenance Planning

Maintenance planning is the task of organizing resources to carry out a job satisfactorily at reasonable cost within a specified period of time. The most important objectives of the maintenance system is the maximization of availability of equipments and facilities so as to help in achieving the ultimate goals of the organization[3].To achieve minimum break down and to keep the plant in good working condition at the lowest possible cost. To ensure the availability of the machines and services in an optimum working condition. To keep the machines and other facilities in a condition to be used to achieve the maximum profit without any interruption or hindrance. To keep the time schedule of delivery to the customers or to the sections for further processing. To meet the availability

requirements for critical equipments. To keep the maintenance costs as low as possible for non critical equipment are the broad objectives.

Ishikawa Diagram (Cause and Effect Diagram)

In 1943 Prof Ishikawa of the University of Tokyo developed this tool and hence it is known as Ishikawa Diagram. The cause and effect diagram is a systematic diagram composed of lines and symbols designed to help the user to understand and list out all possible causes and effect [2].

For every effect there are likely to be various causes. The diagram is developed after brain storming by identifying a problem to be solved and the likely causes. The effect being investigated is shown at the end of a horizontal arrow to achieve the desired effect; the major causes are identified and placed on either side of the horizontal arrow. Then each major cause is further sub divided into numerous minor causes by brain storming technique. Fig1 shows a C&E diagram for the quality improvement of a particular component. The effect is the quality improvement of the component and identify major causes of men, machine, materials, work methods, Specifications and the environment.

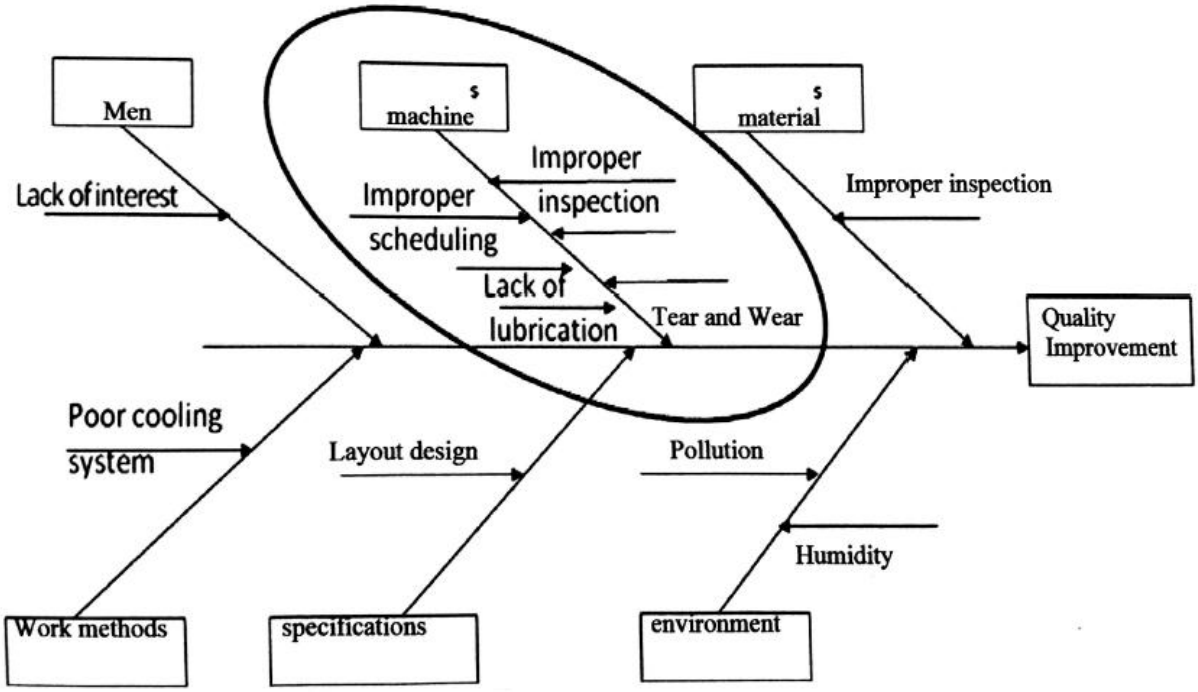

Fig: 1 Ishikawa diagram

Each major cause is further sub divided into numerous minor causes. Here the machine area has lot of minor causes which is indicated in the figure. So we came to know that the machine area is the main part that seriously affects the Quality Improvement. To acquire the quality improvement we have to eliminate all those minor causes by rescheduling the entire system with help of the concept of the Preventive Maintenance and Productive maintenance.

Back ground

The company under study is based in India [Kerala Electrical & Allied Engineering Co.Ltd. (KEL)]. The company manufactures and markets products like general purpose brushless alternators, brushless alternators for lighting and air-conditioning of rail coaches, medium power and distribution transformers as well as structural steel fabrications. The product categories for defence applications include high frequency alternators, frequency convertors, special alternators and power packs for missile projects. Critical equipments like Vertical turret Lathe, Milling Machine, Grinding Machine, and Radial drilling Machine, balancing machine, Induction Furnace and Vacuum impregnation Plant are supposed to function without interruptions. The situation on the ground is however different as there are numerous breakdowns which affect process continuity. These breakdowns tend to be frequent and longer thus affecting production targets.

Overall Equipment Effectiveness (OEE) Calculations.

By examining the respective history cards of the critical equipments it was clear that seven critical machines have problems. So extensive study has been carried out about those machines in total working hours and maintenance hours. We have analyzed their scheduled maintenance, breakdown hours etc. Then selected three machines on account of their importance and character. After that we have analyzed those machines with help of Cause and Effect Diagram. In that it was noticed some problems in machine's maintenance area, and concentrated in that area. The problem has been established after studies. The Preventive maintenance department of the industry is not running as per the established plan. Lack of preventive maintenance is the root cause of breakdown of machines [8,9]. Due to this breakdown, production time gets increased which results in delay in delivery of products. This needs to reschedule of the maintenance structure of that organization.

Equipment effectiveness can be measured as the product of the three parameters.
Equipment effectiveness, $EE = \mathrm{A} \times \mathrm{E} \times \mathrm{R}$

Where
A=Availability in percentage
E= Efficiency of the equipment as per records in the organization.
R= rate of equipments in percentage.

Availability (A) = T/P

Where,
T = Actual operating time in minutes, $T = (P - D)$
Where,
P and D are production time and down time in minutes respectively.
Rate of equipment R= $\left[\frac{(N-Q)}{N}\right]$

Where, N = No of piece produced per week and Q = Average no of rejection per week

The following are the existing performance level of selected critical equipment.

From the analysis, following defects and drawbacks are obtained.

Draw backs of Preventive maintenance checklist. This checklist has not been updated. Because it is not suitable for all the critical machines as they have different parts. As a result the machine performance may decrease and the overall efficiency of the equipment will also decrease.

The period of inspection is half yearly. To avoid breakdowns of Critical machines, it should be inspected frequently. The machines are inspected in a time interval of six months. The Preventive maintenance checklist is divided into two sections. The upper side is mechanical and the lower side is electrical but the parts to be inspected are not common. The work instruction for this checklist is also not much effective. There has a work instruction manual, which is related to Preventive maintenance checklist. These two are same for every machine.

Improper maintenance scheduling: It does not have a perfect maintenance schedule of operation. As the organization was established in early years, they are following the old strategies which are discussed about some of common points. So the Maintenance schedule should be planned and rescheduled for each and every machine.

Maintenance structure was not perfect. Maintenance organization department in the organization was not up to the mark. Maintenance organization department should be strong enough to organize, plan and schedule the maintenance activities. But the existing organization department is not like that.

The above said draw backs lead to decrease in equipment effectiveness, poor quality of products, increases the production time, increases number of rejections of products. Due to these reason the overall efficiency will also decrease.

Recommendation and suggestions.

In order to overcome the draw backs lead to the decrease in equipment effectiveness, poor quality of products, increases the production time, increases number of rejections of products the following recommendations were made.

Maintenance is not treated seriously at board level or even at local management levels of course, many company organization show maintenance at the same level as production, marketing, finance etc., Since TPM includes improvement, autonomous maintenance and quality maintenance an action team is formed with people who directly have impact on the problem being addressed. Operators, maintenance personnel, shift supervisors, schedulers and top management might be the members of force. This action team should take care of all those needs

To rectify the draw backs of the organization it is suggested to reschedule 'The Preventive maintenance checklist' for each and every machine according to their nature. Revised their old checklist for all critical machines, which makes the preventive maintenance easier and to revise the organizational structure also inorder to implement the concepts of TPM.

The revised maintenance organizational structure is shown below. The head of the structure is DGM, and the maintenance superintendent coordinates the entire system. The maintenance engineer assists the coordinator, which is shown below.

Result and Discussion

Equipment	Efficiency	Rate	Availability	Effectiveness %
Vertical turret lathe	0.77	0.88	0.95	64.3
Balancing machine	0.74	0.92	0.95	64.6
Drilling machine	0.74	0.92	0.95	64.6

Table 1: Overall equipment effectiveness- by existing maintenance methods

By introducing the concepts of Total Productive maintenance for a short period considerable changes in product rejection and reduced down time of critical equipment has been observed.

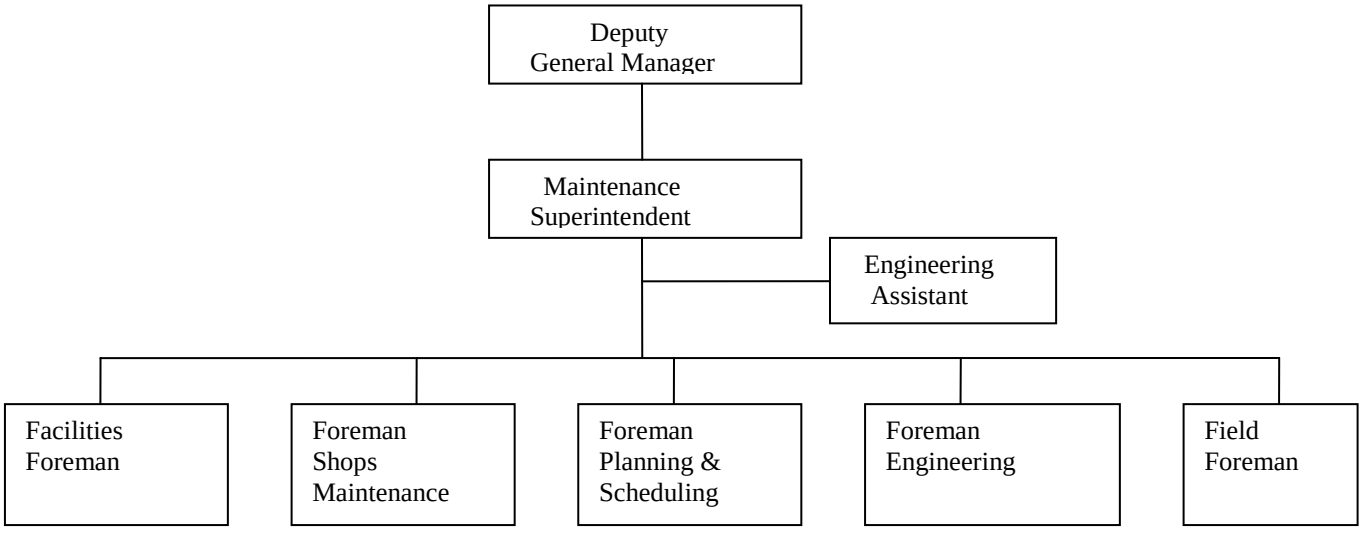

Fig2: Revised maintenance organization structure.

Organizational chart has been revised which is more helpful for doing Productive maintenance.

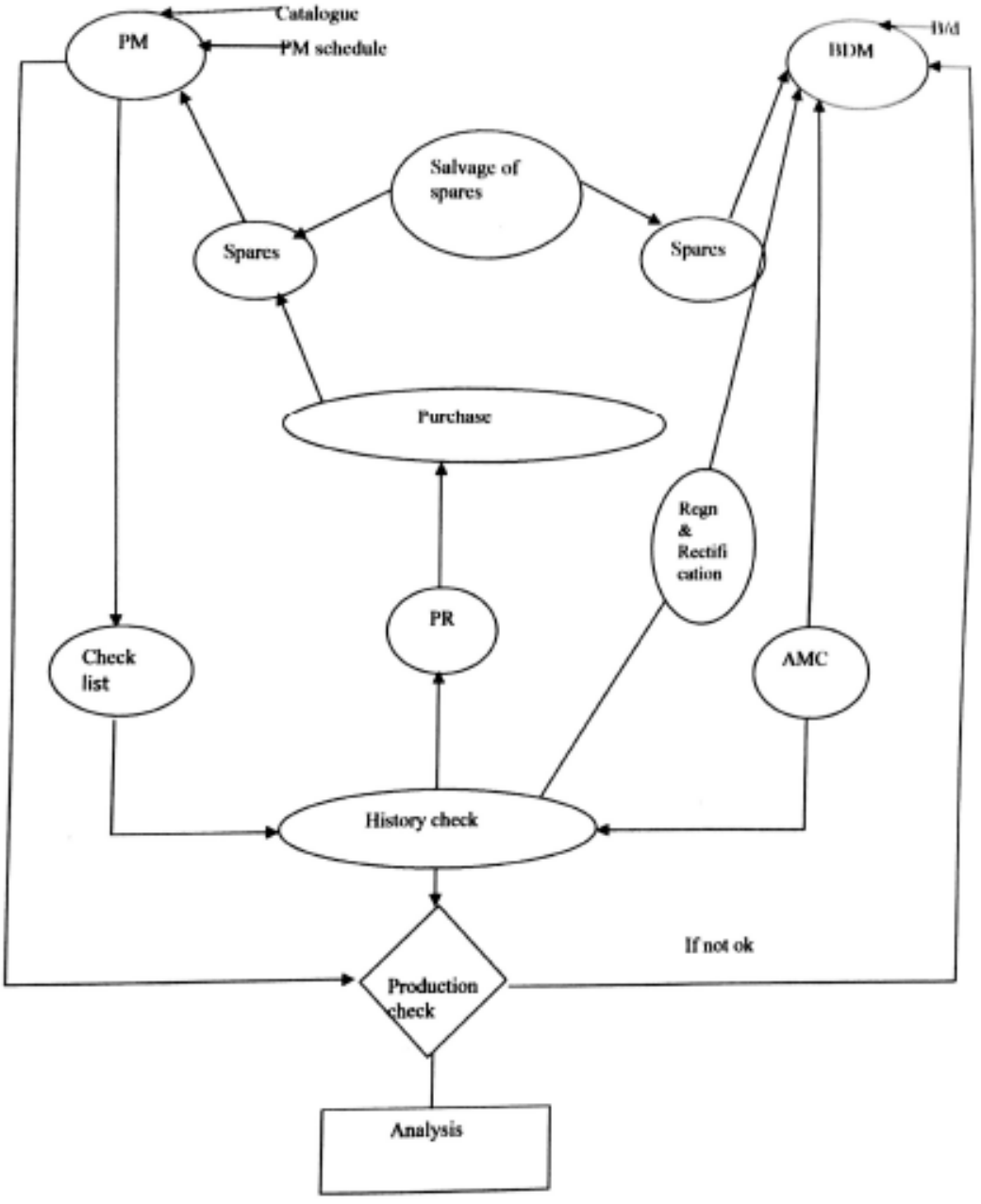

Fig3: Revised organizational chart

Overall Equipment Effectiveness Calculations (After strategy change)

After the implementation proposed strategy the improvement of the equipment effectiveness is increased at a period of six months which is given below

Equipment	Efficiency	Rate	Availability	Effectiveness %
Vertical turret lathe	0.79	0.96	0.98	74.3
Balancing machine	0.74	0.98	0.98	71
Drilling machine	0.74	0.97	0.98	70.3

Table2: Overall Equipment Effectiveness- after strategy change.

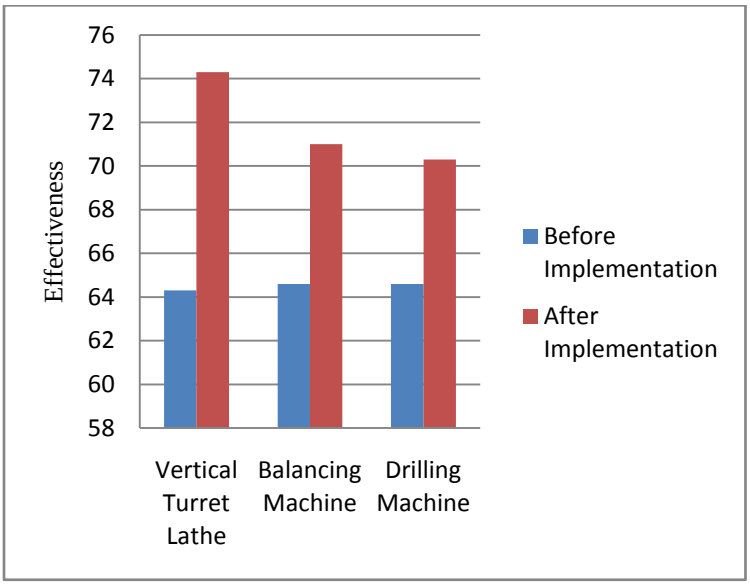

Fig2: Improvement in overall Equipment effectiveness (Before and after TPM implementation)

By comparing the equipment effectiveness before and after implementation of corrective measures it is observed that there was a maximum growth up to 10% in the equipment effectiveness of vertical turret lathe within a short period of time (6 months).

Conclusion

Studied the different processes and operations performed at KEL. And was noticed the lack of proper organization chart, Maintenance Check list, Work Instruction Manual, etc. and spot out weaker areas of their Maintenance system, with the help of Ishikawa Diagram. In order to rectify the issues there are remedial measures were suggested and introduced the concept of Total Preventive maintenance (TPM).It is proactive rather than a reactive approach. Breakdown may be occurred once, but the TPM system will not permit to occur the same one again. By this, considerable minimization will happen. After the implementation of TPM total productivity or capacity of each and every work centres in the organization will be enhanced proportionally with the effectiveness of the implemented TPM system. Ultimately adoption of the system ensures the desired output in the right time as per the plan of organization. On following this system the efficiency got increased 5% after three months and after six months it reaches up to 10%. If the organization strictly adheres with this modified system the efficiency will definitely attain up to the mark of 75- 80%.

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