IMPLEMENTATION OF KAIZEN AND JISHU HOZEN TO ENHANCE OVERALL EQUIPMENT PERFORMANCE IN A MANUFACTURING INDUSTRY

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ABSTRACT

In recent years, a remarkable improvement has taken place in the maintenance management of physical assets and productive systems to reduce the wastage of energy and resources. Total productive maintenance (TPM) methodology is a proven approach to increase overall equipment effectiveness (OEE) of equipment. It consists of eight activities; focused improvement and autonomous maintenance are two important activities to enhance equipment performance. These activities aim to educate the participants in the concepts and philosophy of equipment maintenance and give them an opportunity to develop their knowledge and skills. The case study taken from a leaves spring manufacturing company, an attempt is made to identify the areas of improvement in equipment; kaizen and Jishu hozen are implemented to enhance its overall performance to increase the productivity. Why-why method of root cause analysis is used to eliminate the causes. The OEE of the equipment is increased from 43% to 68% and labour cost decreases up to 43% .The improved OEE in a manufacturing industry resulted increase in availability, better utilization of resources, high quality products and also raised employee morale and confidence.

Keywords: *Overall equipment effectiveness, Availability, Equipment performance, Focused improvement, Autonomous maintenance.*

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1. INTRODUCTION

Any industry needs to keep proper vigilance for producing product without defect, reducing product rejection and wastage, reducing equipment breakdown and down time, increasing worker and equipment efficiency, maximize equipment and manpower utilization, eliminate accident of any types. Total productive maintenance (TPM) is a methodology that aims to increase the availability of existing equipment hence reducing the need for further capital investment Total productive maintenance (TPM) is a methodology that aims to increase the availability of existing equipment hence reducing the need for further capital investment. Hartman defines TPM as "Total Productive Maintenance permanently improves the overall effectiveness of equipment with the active involvement of operators" [2]. The aim of TPM to reduce the six major equipment losses, to zero, has been recognized as necessary for corporate survival. TPM is a unique Japanese system of plant management, developed from preventive maintenance concept. This approach emphasizes the role of team work, small group activities, and the participation of all employees to accomplish equipment improvement objectives [3]. It challenges a sense of joint responsibility between operators and maintenance workers, not only to keep the machines running smoothly, but also to extend and optimize their overall performance [4]. It is also defined as, bringing both functions (production and maintenance) together by a combination of good working practices, team working, and continuous improvement [5]. TPM is intended to bring both functions (production and maintenance) together by a combination of good working practices, team working and continuous improvement [6]. This paper presents a case study of implementing TPM concepts to a shot-peening machine. Overall equipment effectiveness (OEE) is used to measure the overall performance of the equipment and suitable data is considered for the analysis. The areas of equipment improvement are identified and why-why method of root cause analysis (RCA) is used for elimination of equipment problems. Kaizen and Jishu hozen are used to enhance the overall equipment performance and one-point lessons are used to raise the knowledge and confidence level of the participants.

2. OEE AND SIX MAJOR LOSSES

The concept of overall equipment effectiveness was originated from Japan in 1971.The Japan Institute of Plant Maintenance promoted the total productive maintenance (TPM) which includes overall equipment efficiency. The OEE calculation is quite general and can be applied to any manufacturing organization [7].OEE is a measurement used to determine how efficiently a machine is running. Though the definition implies that OEE is the measure of a

particular machine, but it can also be used to measure efficiency of product lines, sections of a plant or even the entire plant. Philip Godfrey [8] notes that 25 the effective operation of individual pieces of production equipment, assembly lines or whole factory is dependent on the three factors of OEE [9]. OEE is the most effective measure for driving plant improvement. It continuously focuses the plant on the concept of zero-waste [10]. Unless careful monitoring occurs, the reduced capacity goes unnoticed or is accepted as normal. OEE can be considered to combine the operation, maintenance and management of manufacturing equipment and resources. The losses are divided into six major categories, which affect the overall performance of the equipment namely [10]:

1. Equipment failures/breakdown losses are the time losses and quantity losses caused by defective products.
2. Set-up and adjustment losses are defined as time losses resulting from downtime and defective products that occur when production of one item ends and the equipment is adjusted to meet the requirements of another item.
3. Idling and minor stop losses occur when the production is interrupted by a temporary malfunction or when a machine is idling.
4. Reduced speed losses refer to the difference between equipment design speed and actual operating speed.
5. Reduced yield losses occur during the early stages of production from machine start up to stabilization.
6. Quality defects and reworks are losses in quality caused by malfunctioning of production equipment.

The first two losses are known as down time loss and are used to calculate availability of a machine. The third and fourth are speed losses that determine the performance efficiency and the final two losses are considered to be losses due to defects in the products. OEE is measured in terms of these six losses, refer figure 1, which are function of availability, performance rate and quality rate of the machine, production line or factory [11].

3. PROPOSED METHOD TO ENHANCE EQUIPMENT PERFORMANCE

Companies practicing TPM invariably achieve startling results, particularly in reducing equipment breakdowns, minimizing idling and minor stops, reducing quality defects and claims, increasing productivity, reducing costs, shrinks inventory, decreasing accidents and promoting employee involvement [12]. Suzuki cites Productivity, Quality, Costs, Delivery,

Safety and Morale (PQCDSM), improvement for early TPM implementation [12]. The overall performance of equipment's can be enhanced by identifying and eliminating the root causes. OEE is used as a tool to measure the effectiveness of equipment's to know the current condition. It helps to identify the areas of improvement required in terms of availability, performance efficiency and quality rate of products classifying them into six major losses, as identified by Nakajima in the OEE model [10]. These six major losses are overcome by the Focused Equipment Improvement (FEI) and Autonomous Maintenance (AM) activities of TPM, (Refer fig. 2). These activities will be more effective if carried, in small groups or teams, which are more active, dynamic, self-motivated and also increasing one's-self-confidence of participants.

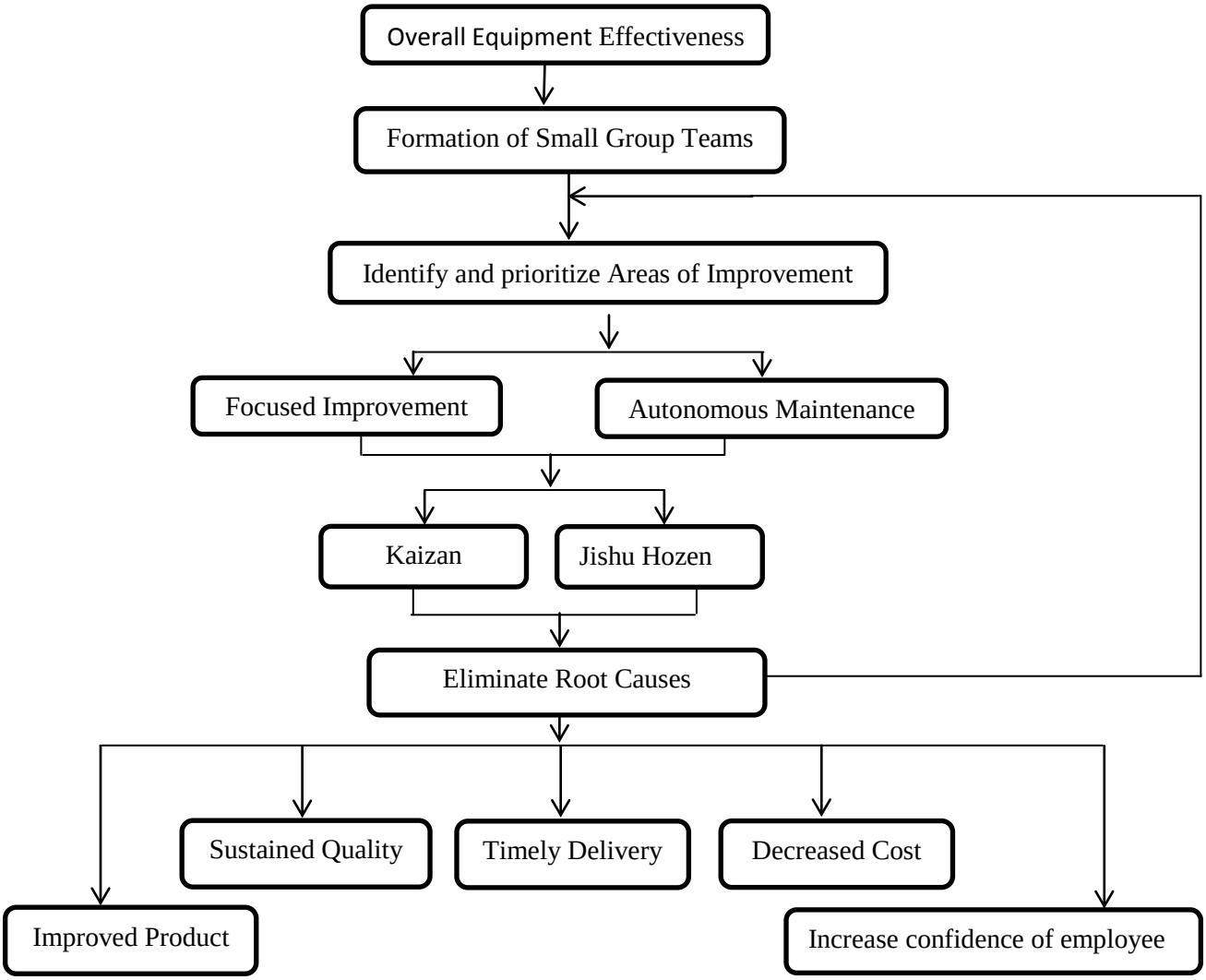

Fig.1. *Overall Equipment Effectiveness Calculation and Losses [6]*

3.1. AUTONOMOUS MAINTENANCE (JISHU HOZEN)

This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating.

Policy:

1. Uninterrupted operation of equipment's.
2. Flexible operators to operate and maintain other equipment's.
3. Eliminating the defects at source through active employee participation.
4. Stepwise implementation of JH activities.

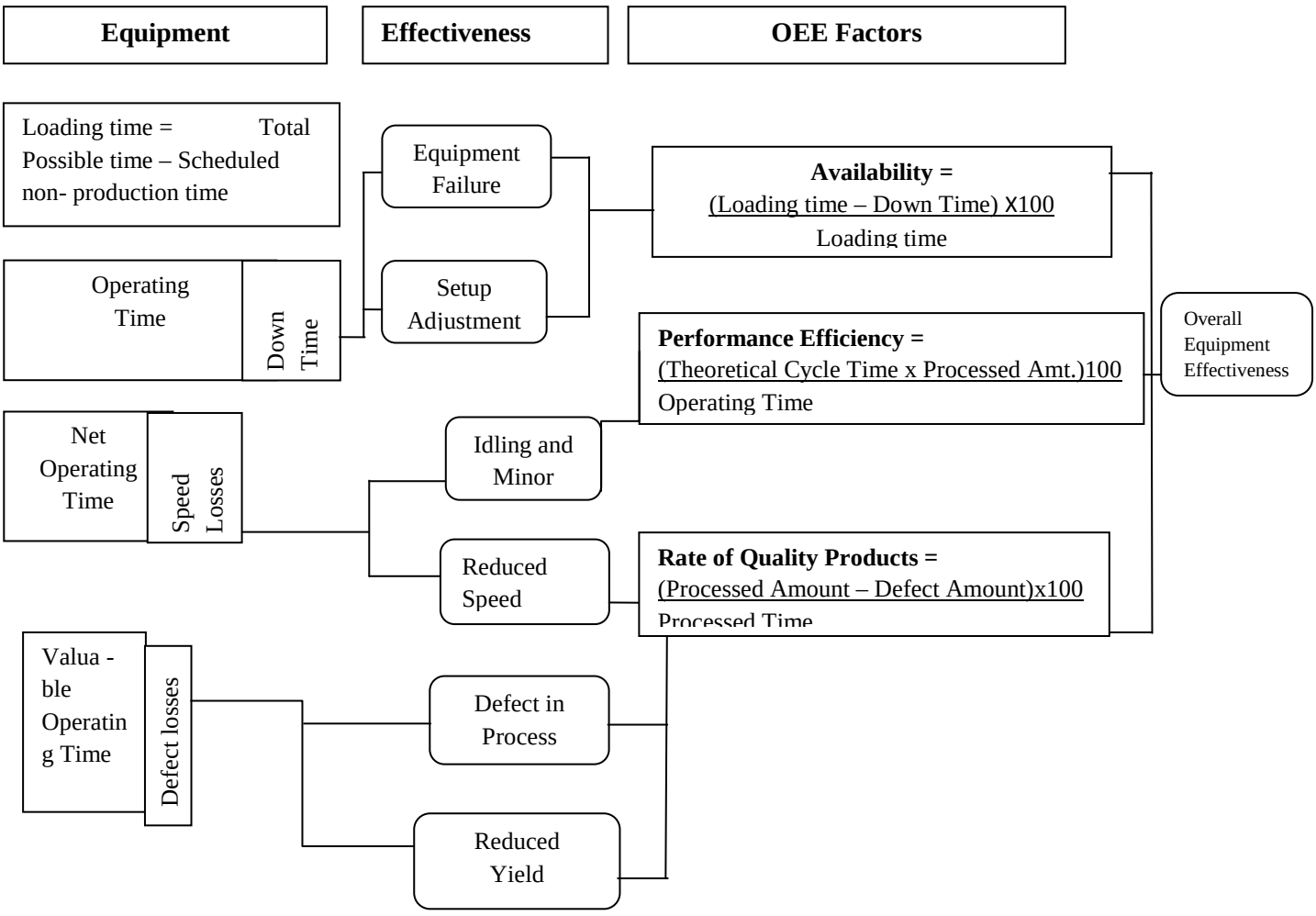

Fig.2 Impact of OEE on Competitiveness [13]

3.2 FOCUSED IMPROVEMENT (K0BESTU KAIZEN)

"Kai" means change, and "Zen" means good (for the better). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are more effective in an organizational environment than a few improvements of large value. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well.

Kaizen Policy:

1. Practice concepts of zero losses in every sphere of activity.
2. Relentless pursuit to achieve cost reduction targets in all resources.
3. Relentless pursuit to improve over all plant equipment effectiveness.
4. Extensive use of PM analysis as a tool for eliminating losses.
5. Focus of easy handling of operators.

4. CASE STUDY

The present case study was taken up in a manufacturing company. The company was facing problems due to break downs, equipment defects and poor working conditions. The management of company took a decision to overcome these problems by implementing TPM concepts. The management also took a decision if there is an improvement in the overall equipment efficiency, and then this method will be extended to other machines. In the initial stages of TPM implementation, more importance was given to equipment improvement (focused improvement pillar of TPM) by using autonomous maintenance, kaizen and Jishu Hozen. A team was developed headed by Senior Manager, with a leader (Supervisor) and members consisting of operators [17]. The reasons for choosing the shot-peening machine are,

- Poor performance among the other shot -peening machine.
- Oldest machine
- Dusty and dark atmosphere
- Poor house-keeping
- Poor safety

4.1 Objectives

The objectives of this case study were,

• Improve equipment reliability and maintainability.

• To cultivate the equipment-related expertise among operators.

• Maximize OEE, through total employee involvement.

• Create enthusiastic work environment.

5. APPROACH TO ENHANCE OVERALL EQUIPMENT PERFORMANCE

The following steps were used for the implementation of TPM activities,

• Initial cleaning

• Listing and classification of abnormalities

• Why-Why Analysis

• Kaizen

• Jishu hozen

• One point lessons

• Safety

5.1 Initial Cleaning

Initial cleaning is aimed at exposing and eliminating hidden defects [18]. Thorough one time cleaning emphasizes on the following activities resulting into clean and tidy machine.

• Eliminate dust, dirt, grime, oil, leakage etc., from main body and ancillary equipment.

• Open cover/lids and remove all dirt

• Tighten loosed nuts, bolts, screws and replace damaged ones.

• Get operators in touch with their machine and make them more familiar

• Cleaning is inspection, find abnormalities and fix defect tags – Red tag and White tags.

• Try and identify areas which are,

- Hard to clean

- Hard to lubricate

- Hard to inspect

- Hard to tighten

5.2 Listing and Classification of Abnormalities

It is a systematic method to organize, order, clean and standardize a work place and keep it that way. In this activity two different colour tags (red and white) were used to classify the abnormalities. A common methodology used during the initial Sort phase of 5S's is the Red-

Tag Inspection [17]. The tagging process allows operators to identify the items that are required for production use at the workstation and provides an action path for appropriate storage or disposal of items not required at the workstation. Items that are not required immediately for production at the workstation are red tagged for disposition. The red-tagged items are then sent to the red tag holding area for further evaluation.

5.3 Counter Measure for Forced Deterioration

Counter measure for the cause of forced deterioration helps to eliminate accelerated deterioration and also reduces cleaning time. Table 1, shows an example of why-why method used for root cause elimination.

• Eliminate source of contamination.

• Convert hard to clean, lubricate, inspect and tighten areas, into easy to clean, lubricate, inspect and tighten.

• Repair and remove pending red / white tags

• Grow buds of Kaizen through Why? and How?

Table1. Why-why method of root cause analysis

Why –Why Analysis		
Why	Answer	Action
Why shot leakage from the discharging end	The rubber part provided to avoid it	
Why: It was damage due to the high intensity shots strike on it.	Design defect	
Why – Design defect	Design modified	
Why – Design modified	To prevent of shot leakage	An extra steel plate is attached on the discharge end.

5.4 Kaizen

Kaizen, basically translates to 'continuous improvement' or 'change to become good', is a management concept originated by the Japanese in order to continuously effect incremental

changes for the better, involving everybody within the organization from workers to managers. Kaizen is aimed at producing more and more value with less and less wastes (higher efficiency), attaining better working environment, and developing stable processes by standardization. Table 3, shows the kaizens implemented to the shot-peening machine.

5.5 Jishu Hozen

In the Jamna Auto Industry as per observation they carry out this autonomous maintenance. It has the seven steps which are followed;

1. Cleaning.
2. Find the source of contaminate and hard to excess area.
3. Formulate provisional (standards) check sheet.
4. General inspection.
5. Autonomous inspection.
6. Standardisation.
7. Full self-management.

Table 4 show the implementation of jishu hozen on shot peening machine.

Table 2 Comparison of OEE factors.

Machine Performance	World- class performance
84% Availability	>90% Availability
82% Performance Efficiency	>95% Performance Efficiency
100% Rate of Quality	>99% Rate Of Quality
68% OEE	>85% OEE

5.6 One-Point Lesson

One point lesson is considered to be one of most powerful tools for transferring skills [1]. A one-point lesson is a 5 to 10-minute self-study lesson drawn up by team members and covering a single aspect of equipment or machine structure, functioning or method of inspection. Regarding education of operators, in many cases sufficient time cannot be secured for the purpose of education at one time or operators cannot acquire such learning unless it is repeated through daily practice. Therefore, study during daily work, such as during morning meetings or other time, is highly effective. One-point lesson is a learning method frequently used during autonomous maintenance. The one point lesson is also referred to as the single point lesson (SPL).

Table 3 Kaizens implemented for shot peening machine.

S No.	*Problem Definition*	*Solution to Problem*	*Key Improvement*	*Before Improvement*	*After Improvement*
1.	No Min. no. of shots level indi cator, rotor runs even if shots are less resulting to poor peening quality rework.	A visual shots level indicator & sensor provided.	Better quality and no rework.	Minimum shots level indicator.	Shots level in hopper- visual Rotter stop if shots level is low Good peening Quality No rework.
2.	No ladder railing was provided resulting chances of accidents.	Ladder railing is provided.	A chance of accident reduces.	No ladder side railing.	Safety
3.	Manual operation only trained person can operate.	New control panel with delay timer Relay with all controls developed.	Semi-automatic control.	Manual & complicated operation requiring trained operators.	A single button press starts the operations in sequential manner with delay timer, relay timer, buzzer & safety controls developed.
4.	No Emergency switch on machine, unsafe.	No Emergency switch on machine, unsafe.	Quick Stopping is impossible	Unsafe Operation.	Safety.
5.	Poor accessibility for daily leading to accelerated Deterioration.	Landing platform around machine with aluminium ladder is provided.	Easy CLIT activity all around the machine.	Poor accessibility for CILT and unsafe.	•Easy accessi-bility for CLIT activity. • Elimination of accelerated Deterioration.

• Tools to convey information related to equipment operation or maintenance knowledge and skills.

• Designed to enhance knowledge and skills in a short period of time.

• A tool to upgrade the proficiency of the entire team.

5.7 Safety and Environment

The TPM safety and environment is equally, important if not more than others. TPM program is meaningful without strict focus on safety and environmental concerns. Shirose [14] describes safety as “maintenance of peace of mind”. It creates systems to ensure zero accidents and environmental safety. An emergency switch is provided in front of the main

door as well as on control panel to switch off the machine in case of emergencies. Proper illumination arranged around the machine and also dust collector is provided to maintain the environment clean.

Table 4 Jishu Hozan implemented for shot peening machine.

S. No.	Problem Area	Immediate Corrective Action	Preventive Action
1.	Leakage from the Gap between turbine and side plate	To be sealed with the help of compressed felt.	Turbine base plate and housing guards are to be repaired and proper fixing of roof liner to be done.
2.	Leakage from the gap near the elevator shaft (both sides).	Gap will be removed by adjusting the plates.	To be checked during every preventive maintenance and correct it if necessary.
3.	Leakage from the side plates of roller of work conveyor.	To be sealed with the help of compressed felt.	To be checked during every preventive maintenance and correct it if necessary.
4.	Leakage from the main body of the shot peening machine.	All chambers liner's to be checked and replaced also chamber body to be repair.	Liner's condition frequently and to be replaced accordingly.
5.	Leakage from the control cage pipe.	New pipe to be provided.	To be checked during every preventive maintenance and correct it if necessary.

6. RESULT & DISCUSSION

Focused improvement and autonomous maintenance concepts of TPM were implemented to shot peening machine successfully. These concepts helped to increase the availability along with increase in quality and performance of the shot peening machine by controlling the losses that affected the production. The number of breakdown hours (Refer fig.3) was reduced considerably. This resulted in turn decrease of throughput time, better quality products and reduction in rejection costs. OEE of the machine is increased from 43 % to 68 % whereas the labour cost decrease up to 67% (Refer fig 4). The management has decided to extend these concepts of TPM implementation all over the plant.

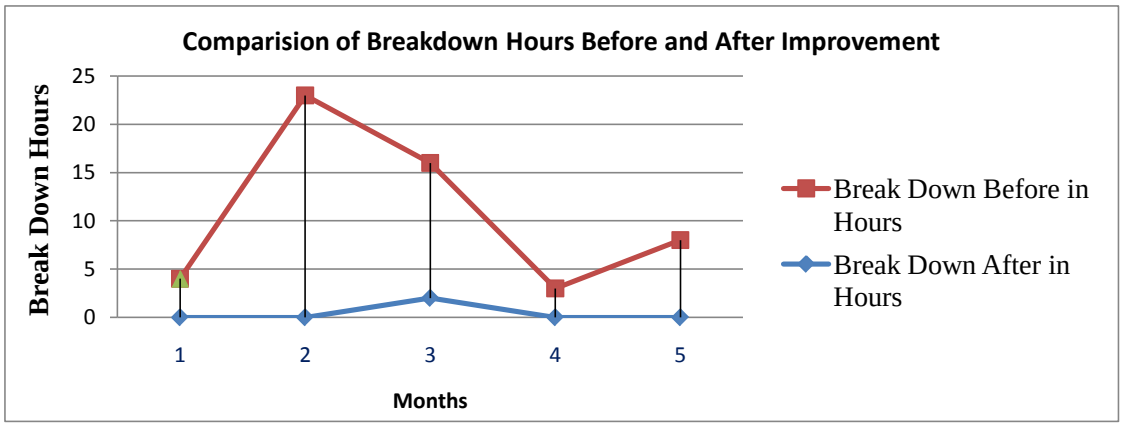

Fig. 3 Comparison of breakdown hours

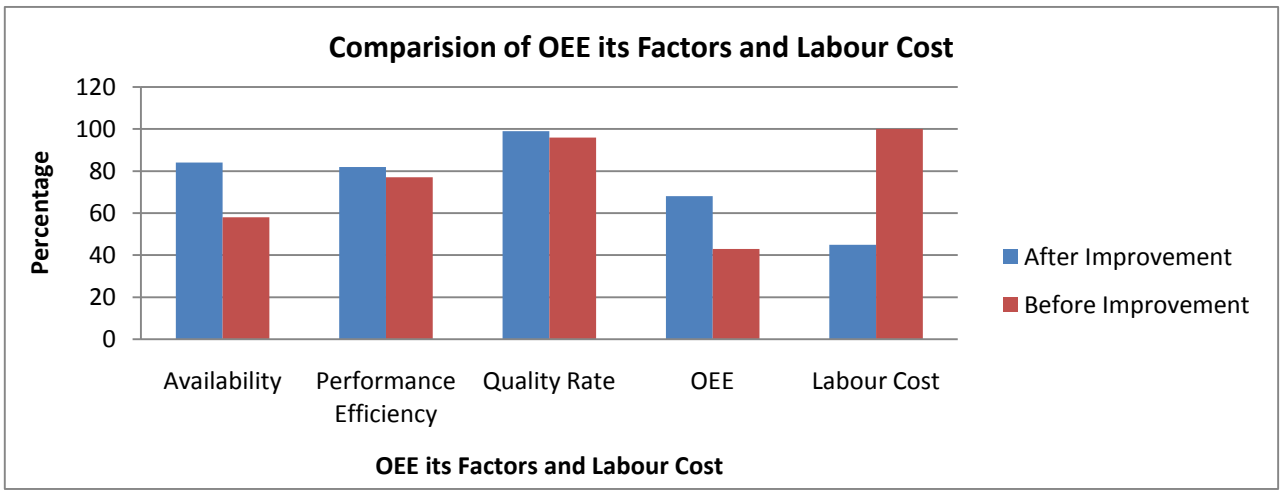

Fig. 4 Comparison of OEE its factors and cost

7. CONCLUSION

If the world-class performance of 85% OEE (Refer table2) is to be achieved then efficient maintenance is necessary, in order to establish autonomous maintenance teams, better communication and team work must be promoted. It is essential that the company devices an efficient data recording systems, so that up to date and accurate information will be available to the management. OEE gives complete details of the overall equipment efficiency. Analysis of this leads to identification of focused improvements required to enhance the overall equipment performance. This method does not interfere with routine maintenance, in turn helps to improve with systematic approach towards eliminating the accelerated deterioration. It also gives an opportunity to the operators to raise their skills and know-how to foster improvement suggestions. The OEE of the equipment was increased from 43% to 68% and labour cost reduces to 67%, resulting increase in availability, better utilization of resources,

reduction in defects and the cost of labour and increased morale and confidence of employees.

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