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Stabilization of Bottleneck Machine through JISHU HOZEN Methodology

As a Tool of TPM at SKF India Ltd.

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***Abstract*: Today's successful manufacturing organizations require a significant competitive advantage, hence they suffer from many problems to fulfill the customers' requirements. So they need to implement and develop their Total Productive Maintenance (TPM).**

Total Productive Maintenance is a key to the organization by which it can helpful in standing up in the competitive market, so the scope of this project is not only on departmental level but also on the international level is essential. So our project helps to achieve partial artificial intelligence by implementing JISHU HOZEN methodology also known as Autonomous Maintenance.

This project involves stabilizing the bottleneck machine by achieving zero BAD on that machine with the help of implementation of JISHU HOZEN methodology under Total Productive Maintenance (TPM). So the company is moving towards Autonomous maintenance to improve overall efficiency of the plant. Finally project focuses on a long-term change in organization culture.

This project begun with getting familiar with production on channel and knowing the operator and the task performed by them on individual machine, also the supervisor on channel help us with getting familiar and explain the process involved. This takes about a week.

From the research, it was shown that top management support for TPM activities is needed and that training is an essential factor for TPM's success in improving manufacturing performance.

***Keywords:* Total Productive Maintenance, Manufacturing Performance, Total Quality Management, Continuous Improvement.**

1. INTRODUCTION

In this competitive world total elimination of waste is necessary for the survival of the organization. The wastes generated due to the failure shutdown and breakdowns of facilities that have been built, with huge investment and also waste such as defective products should be absolutely eliminated. In a manufacturing scenario, the desirable productivity, cost, inventory, quality and delivery all depend on the efficient functioning of the company's facilities and machines present in company. Therefore industrial manufacturing of products are facing accelerating changes of technologies and new activities.

The above statements show that industries which have manufacturing systems, with high dependability, have implemented world class manufacturing strategies/ techniques such as Total productive maintenance (TPM).

Total Productive Maintenance (TPM) is a strategic change management approach that has considerable impact on internal efficiency of manufacturing organization. TPM is an organization strategy to increase the effectiveness of production environment, especially through methods for increasing the effectiveness of equipment.

2. LITERATURE REVIWE

To ensure smooth running of production facility maintenance is an important aspect. Total productive maintenance is stepwise strategy that combines best features of productive and preventive maintenance with total employee engagement.

Roman Bednar tells us that in production businesses were always to produce goods with low costs and high profit. Economic crisis showed that it is necessary to focus on reducing costs. He also focuses on Kaizen, 5S, and especially on the bottle necks of the company which are mainly going to affect the production rate. And also tells the importance to well design the production lines at the beginning in corporations dealing with mass production by removing bottlenecks.

While Iftekhar Aziz, Sazedul Karim, Md. Mosharraf Hossain are focuses on implementation of TPM and decrease breakdowns, MTBF (Mean Time Between Failures), MTTR (Mean Time To Repairs). By this they used that to increase OEE.

Disha M Nayak, Vijaya Kumar M N, G.Sreenivasulu Naidu, Veena Shankar give idea for improving productivity in the current global competitive environment has created a need for rigorously defined performance measurement system in a manufacturing process. OEE, a vital KPI of TPM is used to evaluate performance and productivity of the machine. OEE is one of the performance evaluation methods that are most common and popular in the production industries. This paper tries to evaluate the OEE index on insulation unit in a cable organization and identifies the main loss elements of the processes.

Arash Ghodrati, Norzima Zulkifli mainly focuses on implementation of 5s and its impact on performance of organization.

So after study these all research papers we get to know that in TPM implementation we have to focus on all the pillars which are included in TPM. Finally we have to stabilize the machine by decreasing breakdowns on that so we have decided to take support of Jishu Hozen pillar from TPM. Because in that pillar all TPM is seems to be concentrated in one pillar, since it includes all pillars directly or indirectly within it. Another advantage of this pillar is 'Tentative Standards' which are not present in any of other pillars and which are going to help more and more in future.

After deciding the methodology we have to decide by what we can show our results. For that we take help of OEE because it is the only measure of TPM results.

3. PROBLEM STATEMENT

DCBB channel no 4 and channel no 05 of SKF Pune has in past few years has faced many problems regarding losses in the form of leakages.as all the machinery is old there have been issue of safety man and machine relation is not up to the mark of maximum. The channel has faced many challenges in recent times.

SKF has global reach and there motto is to provide customer satisfaction with less utilization of energy. Our focuses to upgrade the channel to have zero safety issue and maximum man power utilization with reduction in fatigue

To archive this state all the issue need to remove this will help in better org.of the channel which in fact will be merits as new operator or engg to understand the process. With operational excellence this can be done as it is an element of org. leadership that stress the application of variety of principles systems, and tools towards the sustainable improvement of key performance merits.

TOTAL PRODUCTIVE MAINTENANCE:

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, at the same time, increasing employee morale and job satisfaction (3). 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 manufacturing day and, in some cases, as an integral part of the manufacturing process. The goal is to hold emergency and unscheduled maintenance to a minimum.

Objectives of TPM are

• Avoid wastage in a quickly changing economic environment.

• Producing goods without reducing product quality.

• Reduce cost and non-defective.

• Produce a low batch quantity at the earliest possible time.

• Finally ZERO "BAD". (Breakdown, Accidents, Damage)

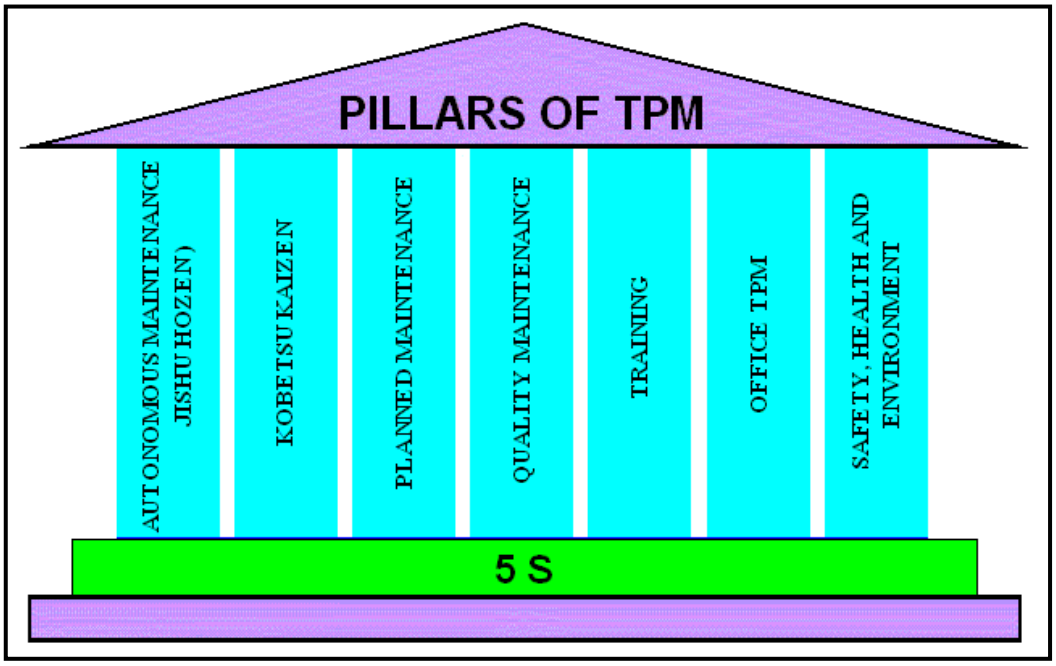

Fig. 3.1 Pillars of TPM

Pillar 1 - 5S:

TPM starts with 5S. This pillar is the base of TPM. Problems cannot be clearly seen when the work place is unorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement.

Table 3.1 5S

Japanese Term	English Translation	Equivalent 'S' Term
SEIRI	Organization	Sort
SEITON	Tidiness	Systematize
SEISO	Cleaning	Sweep
SEIKETSU	Standardization	Standardize
SHITSUKE	Discipline	Self- discipline

1. Seiri - Sort:

This means sorting and organizing the items as critical, important, frequently used items, useless, or items that are not need as of now. Unwanted items can be salvaged. Critical items should be kept for use nearby and items that are not be used in near future, should be stored in some place. For this step, the worth of the item should be decided based on utility and not cost. As a result of this step, the search time is reduced.

2. Seiton - Systematize:

The concept here is that "Each item has a place, and only one place". The items should be placed back after usage at the same place. To identify items easily, name plates and colored tags has to be used. Vertical racks can be used for this purpose, and heavy items occupy the bottom position in the racks.

3. Seiso - Shine the workplace:

This involves cleaning the work place free of burrs, grease, oil, waste, scrap etc. No loosely hanging wires or oil leakage from machines.

4. Seiketsu - Standardization:

Employees have to discuss together and decide on standards for keeping the work place / Machines / pathways neat and clean. These standards are implemented for whole organization and are tested / Inspected randomly.

5. Shitsuke - Self-discipline:

Considering 5S as a way of life and bring about self-discipline among the employees of the organization. This includes wearing badges, following work procedures, punctuality, dedication to the organization etc.

Pillar 2 - 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. By use of this pillar, the aim is to maintain the machine in new condition. The activities involved are very simple nature. This includes cleaning, lubricating, visual inspection, tightening of loosened bolts etc.

We know that ones the machine is start working then after the forced deterioration of that machine start which leads to the failure of the machine. So the proper care has to be taken of that machine and improve her performance and avoid BAD on that machine. For that Autonomous maintenance has to implement. 'JH tells us that the machine is like a baby and operator is like mother.'

Steps in JISHU HOZEN:

1. Initial cleanup
2. Countermeasures (Kaizen)
3. Implementing tentative standards
4. General inspection
5. Autonomous inspection
6. Standardization
7. Full Autonomous Maintenance

Pillar 3 - 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 goals:

Achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtimes. It also aims to achieve 30% manufacturing cost reduction.

Tools used in Kaizen:

1. PM analysis
2. Why - Why analysis
3. Summary of losses
4. Kaizen register
5. Kaizen summary sheet.

The objective of TPM is maximization of equipment effectiveness. TPM aims at maximization of machine utilization and not merely machine availability maximization. As one of the pillars of TPM activities, Kaizen pursues efficient equipment, operator and material and energy utilization that is extremes of productivity and aims at achieving substantial effects. Kaizen activities try to thoroughly eliminate major losses.

Pillar 4 - Planned maintenance:

There are Chapters on JIPM (Japan Institute of Plant Maintenance) books that cover the Planned Maintenance, and its definition varies from one author to another.

Planned Maintenance is the deliberate activity of building and continuously improving such a maintenance System. By: Tokutaro Suzuki.

Planned Maintenance is defined as maintenance activities performed on a pre-determined schedule of activities. By: Charles Robinson & Andrew Ginder.

It is best that the whole Maintenance Department comprises the Planned Maintenance Organizational Structure; some companies have a separate organization for line maintenance or sustaining group and Preventive Maintenance group. Both must work together towards achieving a common goal. Top Maintenance Manager must spearhead the Planned Maintenance Implementation, with close communication from the Planned Maintenance Facilitator or Engineer, whose function is to develop the legwork needed, conduct trainings on Planned Maintenance, set-up the teams, and anything related to it. If your company is big with different divisions, it is best to set up a working Planned Maintenance Committee who shall represent their division, a maintenance section manager usually is best suited for this position.

Pillar 5 - Quality maintenance:

It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like Focused Improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, and then move to potential quality concerns. Transition is from reactive to proactive (Quality Control to Quality Assurance). QM activities are to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The conditions are checked and measure in time series to very that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures beforehand.

Pillar 6 - 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. Education is given to operators to upgrade their skill. It is not sufficient know only "Know-How" by they should also learn "Know-why". By experience they gain, "Know-How" to overcome a problem what to be done. This they do without knowing the root cause of the problem and why they are doing so. Hence it become necessary to train them on knowing "Know-why". The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills is

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 - Safety, Health and Environment:

1. Zero accident

2. Zero health damage

3. Zero fires

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. A committee is constituted for this pillar which comprises representative of officers as well as workers. The committee is headed by senior vice President (Technical). Utmost importance to Safety is given in the plant.

Manager (Safety) is looking after functions related to safety. To create awareness among employees various competitions like safety slogans, Quiz, Drama, Posters, etc. related to safety can be organized at regular intervals.

3.2 Bottleneck Phenomenon:

A bottleneck is a phenomenon where the performance or capacity of an entire system is limited by a single or limited number of components or resources. The term bottleneck is taken from the 'assets are water' metaphor. As water is poured out of a bottle, the rate of outflow is limited by the width of the conduit of exit—that is, bottleneck. By increasing the width of the bottleneck one can increase the rate at which the water flows out of the neck at different frequencies. Such limiting components of a system are sometimes referred to as bottleneck points.

A bottleneck constrains the performance of a system. The roots of bottleneck focused approach in operations management can be traced back to the days of Henry Ford. In his effort to deliver an affordable car, Ford introduced the moving assembly line which exploited the economies of scale involved in producing a standard product in high volume. It was understood that the workstation with the maximum processing requirement, denoted as the bottleneck, would constrain the output of the system

3.1.1 Bottleneck machine and its importance:

Bottleneck is a machine that obstructs the system performance in the strongest manner. Bottlenecks machines in a production line have been shown to be one of the main reasons that impede productivity. Generally, the performance improvement on bottleneck machines results in a significantly higher overall system throughput than the performance improvement on non-bottleneck machines. Correctly and efficiently identifying bottleneck locations can improve the utilization of finite manufacturing resources, increase the system throughput, and minimize the total cost of production.

As we discussed above the bottleneck is constrains the performance of system so the bottleneck machine is the machine which is going to constrain the performance of the channel. Channel consist of many machines performing special tasks one by one, so if one of the machine which is going to affect the all channel performance directly that is referred as bottleneck machine.

Bottleneck machine is the heart of that channel. If that machine fails then whole channel leads to stop working. That machine is very critical in respect to the breakdowns on that machine. That's why the importance of bottleneck machine is more; hence we have to stabilize the bottleneck machine through TPM techniques and getting more and more efficiency of that channel.

A bottleneck has a terrible effect on the efficiency of production. The stages following the bottleneck must function below their capacity because they do not receive enough input to operate at full capacity. The stages before the bottleneck need to slow down production because the subsequent stages cannot handle the capacity. As a result, the overall efficiency of the system is significantly reduced.

Deciding Bottleneck machine:

Channel	1st Bottle Neck Machine	Function	Average Cycle Time	High Volume	Average PS Value
CH - 01	SGP 62 A	IR Groove Grinding	6.05	1705654	88.06
CH - 02	SGB 55 B	IR Groove Grinding	6.199	2184235	112.44
CH - 03	SGP 62 A	IR Groove Grinding	6.44	1794010	120.12
CH - 04	SGB 55 B	IR Groove Grinding	5.89	1518010	223.87
CH - 05	RTF 120	IR Groove Grinding	16.67	752601	504.58
CH - 06	SSA 62 B	IR Groove Grinding	11.39	515370	99.13
CH - 07	SSA 62 B	OR Groove Grinding	7.69	1647348	65.842
CH - 08	KN213 B	OR Groove Grinding	9.5	1202606	182.26

Deciding of bottleneck machine is one of the vital works of TPM circle department. As we discussed above, the bottleneck machine is one which constrains the channel performance. So all the TPM circle members list out the all machines as per their high average cycle time, high volume production, and average performance standard value as given in above table.

We already discussed on machine condition of SKF Company, there are many old machines present on channel but they gives good performance only if there is no breakdown. So circle members separate out the machines from particular parameters as shown in table. These machines are select from defect trend in that channel.

Defect trend is statistical database which gives all breakdown and defect record month wise on that channel. By that data circle members get the machines which are going to constrain the performance of the channel. If that machine having more breakdowns then it can create bottlenecks on that channel but only breakdowns is not only criteria for deciding the bottleneck machine there are other parameters also such as high average cycle time, high volume production, and average performance standard value.

Average cycle time: It is the minimum time (in sec.) require to process one ring on that machine.

This average cycle time is very important in selecting the bottleneck machines. Since this time is very important in production rate of the whole channel. If this value is more than it is necessary to minimize that value so it is important factor to determining bottleneck machine.

Volume: It is the total number of rings produced on that machine in one day.

This volume concept is nothing but the numbers, so it again related to the production of channel. If this number is more, then it is important to concentrate on this machine so as to increase the production rate of channel. Hence this is also one of the main criteria of deciding bottleneck machine.

PS Value (Performance standard value): It is the price for which the bearing is going to sell to customer.

It is the selling price of the bearing produced on that machine, so it is important factor in regarding the profitability of that channel. If this number is more which states that it is more important machine so we have to take more care of that machine if we want to get more profit. This is possible when that machine works more and more time hence we have to more concentrate on that machine which having more PS value.

4. METHEDOLOGY

We are going to stabilize the machine condition by reducing the breakdowns with the help of Jishu Hozen methodology. We got our two bottleneck machines as we discussed above. Now after this we implement the JH methodology on the channels.

We had brief introduction above so after getting actual bottleneck machine we have to directly move toward the steps of JH methods.

Step 1-Initial cleanup

Step2-Countermeasures (Kaizen)

Step3-Implementing tentative standards

Step4-General inspection

Step5-Autonomous inspection

Step6-Standardization

Step7-Full Autonomous Maintenance

To move forward it is important to stay with all the data and observations we have made since they are very useful in implementing JH method.

Step 1 - Initial clean up:

Right now we have breakdown history and defect trend data of each machine, so further moving towards this initial clean up step 1 of JH method it is important to gather all that data.

As name suggests initial cleaning in this step we have to actually clean the machine thoroughly so as to know how the condition of that machine is?

Any machine or any equipment which is under working for a long time is have some wear and tear of its components which is known as the forced deterioration of the components . While working continuously in company all machines are subjected to force deterioration. This force deterioration is one of the most factor by which machine sscan fail or leads to breakdown. So forced deteriorated areas and sources are should be eliminated. This is done in step 1 Initial clean up. It is not just cleaning the machine but also inspect the machine for such forced deteriorated areas and sources.

So it referred as "Cleaning is inspection".

The data we have gather before that data is needed to find out the forced deteriorated areas and sources. This can be easily get to know with past history and defect trend. This forced deteriorated areas and sources are leads to abnormalities on that machine.

Abnormality: Abnormalities are the results of forced deteriorations of components. Anything which is not normal is referred as abnormality.

There are types of abnormalities as follows:

1. Dirt
2. Leak
3. Splash/Spillage
4. Loose
5. Missing
6. Worn out/Wear
7. Extra
8. Abnormal position
9. Holes/Gap
10. Hanging
11. No identification
12. Abnormal noise
13. Vibration
14. Vibration
15. Discolouration
16. Jurky movement
17. Hard to access
18. Not working
19. Excess heat

After finding out the maximum forced deteriorated areas and abnormalities next is to collect that data in a particular manner, which leads to next new concept evolved that is Tag Matrix.

Tag matrix: The tabular representation of abnormalities along with their type and location is called as Tag Matrix.

Tag matrix is very useful while deciding the next activity on that machine since now we can locate the areas which are more affected (containing more abnormalities).

Tag matrix is excelling representation of list of abnormalities so along that we should have to put tags to that location. Tags are very useful to locate the abnormalities on particular machines. These tags are of two types

1. White tag
2. Red tag

1. White Tag:

White tags are containing very simple types of abnormalities which can be easily remove by operator or some other person from maintenance.

They are referred as less hazardous to the machine so priority of this tag is less as compared to red. These types of tags are as shown below

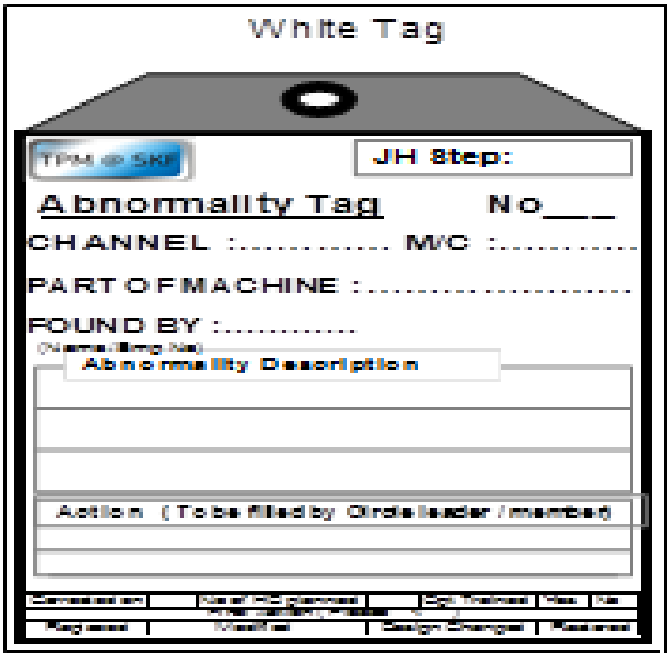

Fig. 4.1 White Tag

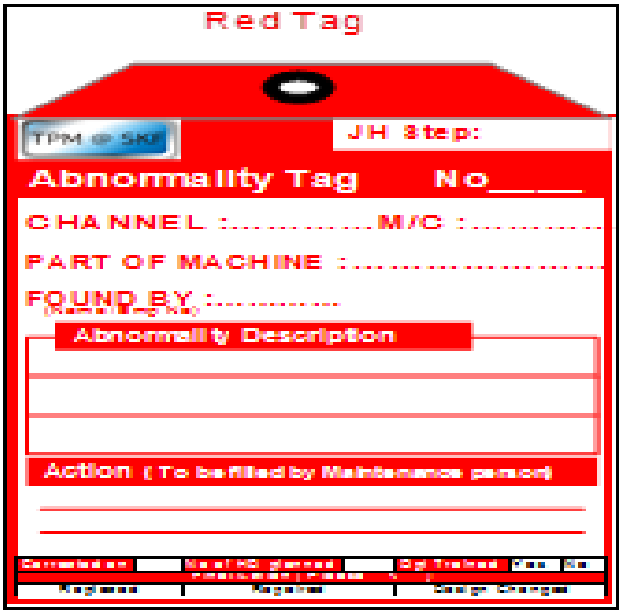

Fig. 4.2 Red Tag

It contains all the information about abnormality, channel, location, and who find that abnormality.

2. Red Tag:

Red tag contains all big and problematic abnormalities which cannot be resolve without help of maintenance department. This type of tags can be hazardous to machine and easily make machine failure. So it is very important to resolve quickly hence colored as red so as to take attention quickly. They are as shown above.

It also contains all the information about abnormality, channel, location, and who find that abnormality, but the priority of resolving tag is more is of red tag. Up to this now we have completed step one and we know how much area of machine is forced deteriorated and may leads to failure. We have location wise details also in tag matrix so here ends the step 1 initial clean up.

Step2 - Countermeasure (Kaizen):

This step is actually making resolved those abnormalities in the form of creating countermeasures on those abnormalities. These countermeasures are similar to kaizen which is one of the TPM pillar.

We had a brief introduction of this kaizen pillar above. Kaizens are the new ideas which can remove abnormalities.

Objective:

- Prevent causes of dust and dirt and scattering.
- Improve places which are difficult to clean and lubrication and Reduce the time required for clean-up and lubrication.
- Remove all hard to access areas.
- Countermeasures on the abnormalities.

The most important work in this step is removing all hard to access areas which can make problem to operator for his work. Hard to access area is the area where operator cannot reach and access that area of that machine. These areas can make difficulties in daily cleaning, lubrication, inspection, tightening of the machine. So these areas have to be eliminating by doing easy access to that locations.

Step 2 involves eliminating more and more abnormalities by doing Kaizens so it is very important step to set a bench mark on that machine and to improve the machine condition.

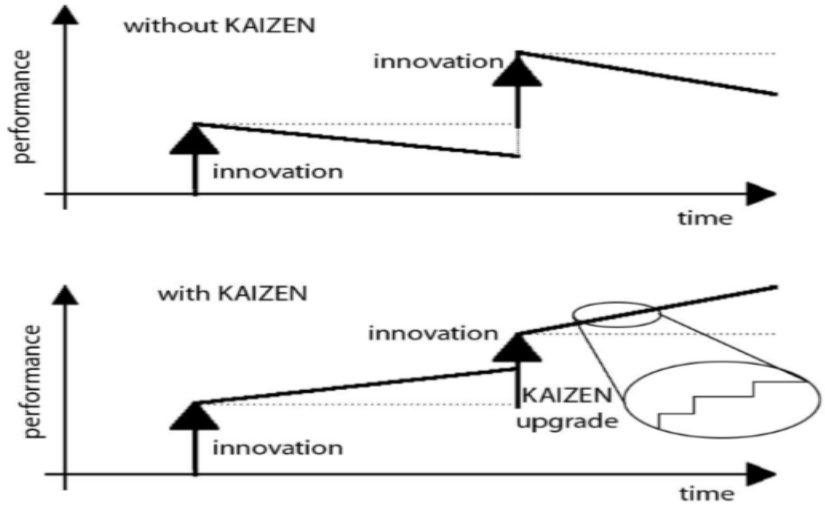

Fig. 4.3 Kaizen

The aim of Kaizen method in corporation is to transfer the effect of change on employees and motivate them to search for another possible improvement. Effort of this method is to implement big and also small changes and after this we are able to achieve more productive corporation. There is a traditional improvement opposite the KAIZEN. In traditional improvement, the impact of the innovations is gradually disappearing. The figure shows us a gradual improvement by small steps after big innovations, instead of loss of performance without the gradual improvement. Corporations dealing with mass production do not have any restrictions for application of the KAIZEN method.

Step 3 – Implementation of Tentative Standards:

After step 1 and 2 all the abnormalities and hard to access areas are eliminated and now we are with new machine condition which is well upgraded by kaizens. But we discussed earlier that whenever the machine is subjected to continuous working then it is undergoing forced deterioration. We cannot stop the forced deterioration of the machine components so for that

we are going to make such tentative standards for that which can act as healing action on forced deterioration. Means these standards are going to heal that forced deteriorated part.

These tentative standards contain making CLIT, means cleaning, lubrication, inspection, tightening schedule. One may say that step – 3 includes making cleaning, lubrication, inspection and tightening schedule so as to heal the forced deterioration effect. This is very important step to get the machine condition equal to its original condition. As shown in fig the tentative standards help the machine to achieve the machine's original condition.

S we know the machine undergoing working for long time machine condition is also goes down so this step can help to improve that condition to its original condition.

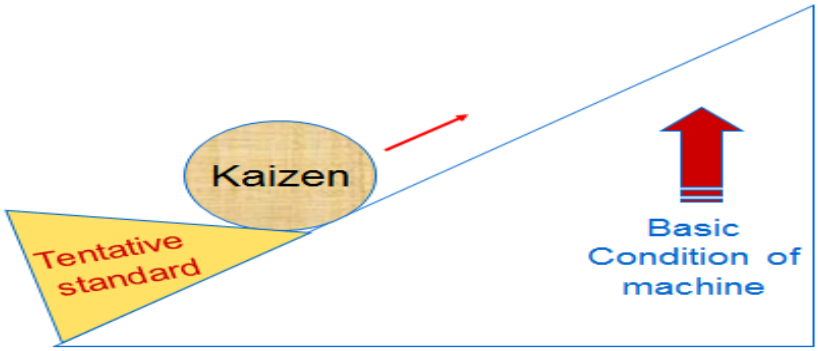

Fig. 4.4 Effect of Tentative Standard

CLIT Sheet:

'The sheet which contains Cleaning, Lubrication, Inspection, and Tightening scheduled along with the frequency and method is called as CLIT sheet.'

Objectives:

1. Sustain and control cleaning, oiling, and lubricating activities.
2. Prevent equipment deterioration.
3. Learn techniques in preparing oiling standards.
4. Devise and implement visual controls.

CLIT sheet contain the cleaning, lubrication, inspection, tightening schedule along with the frequency and tool.

Frequency: Daily, Weekly, Monthly.

The frequency of CLIT activities will be decided by the TPM Circle in consultation with TPM Circle in light of the following facts, Part / Equipment usage and Past B/D History (Chronic or once in while).

- Recent Kaizens for BAD.
- Is there excessive vibration / temperature / moisture present.
- Is the item are exposed to be disturbed during resetting.
- Positioning of parts, equipment.
- History of Contamination , splashes , dirt accumulation

The robustness of the machine parts condition as per the existing usage condition, the frequency is decided, and follows as CLIT.

Tools: accessories, resources required to carry out the CLIT in the given period of time.

E.g.: Filler Gauge, Eyes, Nylon Brush, Cotton waste, oil cane, Vibration tester etc.

So the CLIT sheet is very important to operator to make the preventive maintenance of the machine.

This is going to turn the track of general maintenance concept by doing the maintenance by operator which can be called as preventive maintenance. This will improve the uptime of the machine since in preventive type of maintenance we are going to prejudge the future breakdowns, as the operator is there to see all the factors which lead to breakdowns.

Therefore we make preventive maintenance of machine by the workers and mainly operator of that machine. Operator is only one man which knows the machine thoroughly and completely. But these operators can feel this step – 3 CLIT is inconvenient for them because of their illiteracy. So to make them literate and give them knowledge of this step – 3 CLIT is very important in this step. This training is given by circle members to the operators; this operator training gives all knowledge of step – 3. This makes operator to make full use of step – 3 and CLIT.

One more point is all operators are of age 30 and above on channel so we have to make easy CLIT sheet which can make their work easy and understandable by each operator. Making CLIT sheet easy and understandable is done by following points:

Use of symbols and photos in CLIT:

Hence use of symbols and notations are preferred in this CLIT sheet. While photos of the machine parts are also use to make easy CLIT. Below fig are showing some symbols which are used to make easy CLIT sheet.

Making identification of each part of machine:

This is very important to identification of each machine part. This will help to invent our machine to Self-explanatory machine to operator and any other person also. For this we have made stickers for the machine parts which help in identifying all machine parts. Below figures shows photos of this type of identification technique.

One more we have placed stickers to CLIT points also since operator can easily access those very quickly. We have placed number stickers for the CLIT points so that can be arranged in a particular manner to perform a CLIT to operator. The following photos are showing examples of points stickers of CLIT.

5. CALCULATION

5.1 OEE:

When manufacturing companies run up against capacity problems today, they immediately look to increase overtime, add shifts, or purchase new equipment. Instead they should look to optimize the performance of their existing machines to increase equipment reliability, minimize changeover times, improve operator performance, and lower overall downtime. All these investments can be made to increase capacity and will pay greater dividends by allowing a manufacturing plant to spend its valuable time and money on their manufacturing process instead of new machine purchases.

The question is "How can a manufacturing company optimize the performance of their existing equipment?" The answer is Overall Equipment Effectiveness (OEE). OEE is an effective tool to benchmark, analyze, and improve your production process. The OEE tool gives you the ability to measure your machines for productivity improvements. OEE not only measures these inefficiencies but groups them into three categories to help you analyze the machine and have a better understanding of the manufacturing process. Here is a list of common concerns of many manufacturing companies:

• Reducing Bottlenecks – Increase Throughput

• Implementing Machine Operator Training

• Reducing Machine Setup Time

• Improving Machine Reliability – Implement Preventive Maintenance

• Maximizing Optimal Run Rates and Capacity

• Eliminating Down Time – Provide Down Time Reason Codes

Overall Equipment Effectiveness (OEE) is a way to monitor and improve the efficiency of your manufacturing process. Developed in the mid 1990's, OEE has become an accepted management tool to measure and evaluate plant floor productivity. OEE is broken down into three measuring metrics of Availability, Performance, and Quality. These metrics help gauge your plant's efficiency and effectiveness and categorize these key productivity losses that occur within the manufacturing process. OEE empowers manufacturing companies to improve their processes and in turn ensure quality, consistency, and productivity measured at the bottom line.

By definition, OEE is the product of Availability, Performance, and Quality.

OEE = Availability x Performance x Quality

Where,

Availability takes into consideration any Down Time Losses

Performance takes into consideration any Speed Losses

Quality takes into consideration any Quality Losses

- **Availability:**

Availability = Run Time / Total Time

By Definition: Percentage of the actual amount of production time the machine is running to the production time the machine is available.

The totals run time of the machine subtracting all unplanned downtime.

- **Performance:**

Performance = Actual Performance Hours / Available Run Time

By Definition: Percentage of total parts produced on the machine to the production rate of machine. How well a machine is running when it is running?

- **Quality:** Quality = Good Count / Total CountBy Definition: Percentage of good parts out of the total parts produced on the machine.

How many good parts versus bad parts a machine has produced.

Loss Categories of Simple OEE:

On the previous page, we explained that the three Loss Categories reduce the Planned Run Time of the machine. Listed below in Table 1 are the three Loss Categories (Down Time, Speed, and Quality) of Simple OEE and examples of events that can occur in a production process of a machine to reduce productivity. These Loss Categories contribute to lowering the overall Simple OEE value of the machine.

Table 5.1 Types of losses

Simple OEE Loss Category	Simple OEE Metric	Loss Category Examples
Down Time Losses	Availability	1. Equipment Failures 2. Tooling Damage 3. Unplanned Maintenance 4. Process Warm Up 5. Machine Changeovers 6. Material Shortage
Speed Losses	Performance	1. Product Misfeeds 2. Component Jams 3. Product Flow Stoppage 4. Level of Machine Operator Training 5. Equipment Age 6. Tooling Wear
Quality Losses	Quality	1. Tolerance Adjustments 2. Warm Up Process 3. Damage 4. Assembled Incorrectly 5. Rejects 6. Rework

100% Availability = No down Time Losses - Machine has been running without any recordable stops.

100% Performance = No Speed Losses - Machine has been running at the maximum speed (target counter).

100% Quality = No Quality Losses - Machine has not produced any bad parts (bad/reject/rework.

Major Loss Events Affecting Simple OEE:

There are many events within a manufacturing process that can affect Simple OEE. The major goal behind a Simple OEE program is to minimize or reduce the causes of inefficiency in the manufacturing environment. Below in Table 2 is a list of the Major Loss Events that commonly occur to decrease the productivity and efficiency of a machine and the Loss Category associated with the Simple OEE Metric.

Table 5.2 Effect of losses

Major Loss Event	OEE Metric	Loss Category	Example of Loss Category
Machine Breakdowns	Availability	Down Time	Equipment Failures, Tooling Damage, Unplanned Maintenance
Machine Adjustments/Setups	Availability	Down Time	Process Warm Up, Machine Changeovers, Material Shortage
Machine Stops	Performance	Speed	Product Misfeeds, Component Jams, Product Flow Stoppage
Machine Reduced Speeds	Performance	Speed	Level of Machine Operator Training, Equipment Age, Tooling Wear
Machine Startup Bad Parts	Quality	Quality	Tolerance Adjustments, Warm Up Process, Damage
Machine Production Bad Parts	Quality	Quality	Assembled Incorrectly, Rejects, Rework

Sample Calculations (For Nov-2014):

We have calculated The OEE for Three month Particularly Nov 2014, Jan 2015, and Feb 2015 for only seeing outcomes of our Jishu Hozen methodology. So we collect all the data for calculation such as losses on that machine, man hours, production on that machine, etc. from that data we have calculate

OEE as follows:

Availability:

Availability = Available Run Time / Total Time

Available Run time: it is the time for which the machine is available for work excluding all losses.

Total time: It is the total time for which machine is available for work.

Total time is nothing but the available man hours.

So total time = 744 hrs/month.

Available run time = Total time – loss hrs.

= 744-130.95=613.05hrs

Availability = Available Run Time / Total Time

= 613.05/744= 82.40%

So we have calculated losses hours on both machines which are as follows:

Ch – 04

Table 5.3 Availability calculation for Ch-04

Losses	Nov-2014	Jan-2015	Feb-2015
Plan stop	3.0	18.7	9.1
Mechanical breakdown	31.250	21.7	20.1
Electrical breakdown	25.350	19.7	14.1
Resetting	33.90	23.5	25.9
Tool change	4.5	4.5	10.1
System	1.750	1.3	0
Material supply	15.7	1.2	2.0
Material F/OD	7.0	0.6	0
Wheel change	8.5	3.7	0.5
Total	130.950	94.8	81.7
Available run time	613.050	649.2	662.4

Ch – 05

Table 5.4 Availability calculation for Ch-05

Losses	Nov-2014	Jan-2015	Feb-2015
Plan stop	0.0	8.5	18.5
Mechanical breakdown	46.2	10.05	5.2
Electrical breakdown	13.5	21.5	5.3
Resetting	27.5	30.7	13.2
Tool change	3.0	8	0.5
System	0.8	2.1	0.5
Material supply	16.3	25.050	3.8
Material F/OD	42.6	20.640	7.7
Wheel change	0.8	0.5	0.0
Total	150.5	127.04	54.6
Available run time	593.5	616.960	689.4
Availability	Nov-2014	Jan-2015	Feb-2015
Ch-04	82.40%	87.25%	89.03%
Ch-05	79.77%	82.92%	92.66%

Performance:

Performance = Actual performance hrs. / Available run time

Actual performance hours: It is the actual time for which machine works in available run time.

Actual performance hours = Available run time – Performance losses of machine

= 613.05-152.5 = 460.55 hrs

Performance = 460.55/613.05= 75.12%

Ch-04

Table 5.5 Performance calculation for Ch-04

Performance losses	Nov-2014	Jan-2015	Feb-2015
Start loss	9.85	4.4	1
Cycle time loss	38.4	28.96	14.98
Operating loss	13.7	3	0
Machine adjustment	90.55	36.99	11.13
Total	152.5	73.35	27.11
Actual performance hrs.	460.55	575.83	635.24
Performance	75.12%	88.70%	95.91%

Ch-05

Table 5.6 Performance calculation for Ch-05

Performance losses	Nov-2014	Jan-2015	Feb-2015
Start loss	1.2	2.4	2.3
Cycle time loss	29.05	35.84	13.17
Operating loss	0.4	9.54	8
Machine adjustment	19.75	22.11	17.15
Total	50.45	69.87	30.62
Actual performance hrs.	543.05	547.09	658.78
Performance	91.50%	88.68%	95.56%

Quality

Quality = (Good jobs / Total produced jobs)*100

= 172490/172490*100 = 100%

Ch-04

Table 5.7 Quality calculation for Ch-04

	Nov-2014	Jan-2015	Feb-2015
Total produced jobs	172490	221459	76288
Scrap	0	85	0
Good jobs	172490	221374	76288
Quality	100%	99.96%	100%

Ch-05

Table 5.8 Quality calculation for Ch-05

	Nov-2014	Jan-2015	Feb-2015
Total produced jobs	83587	93515	54670
Scrap	0	0	0
Good jobs	83587	93515	54670
Quality	100%	100%	100%

6. RESULTS AND CONCLUSION

After all the observation and calculations we found following results. Below graph gives specific values of parameters like availability, performance, quality, and OEE with respect to that month. Here we get to know that each month is getting improving all this parameters. So Jishu Hozen methodology gives these satisfactory results in these months for channel 04.

Ch - 04

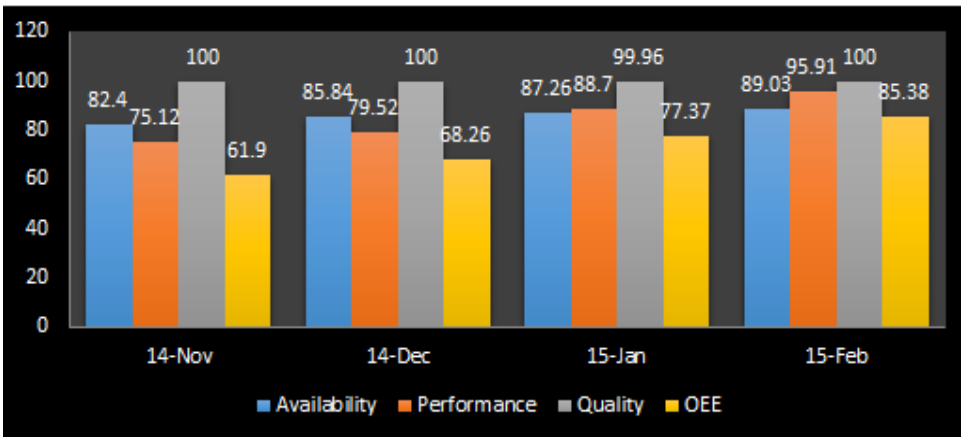

Fig. 6.1 Graph of parameters with respect to months

Ch - 05

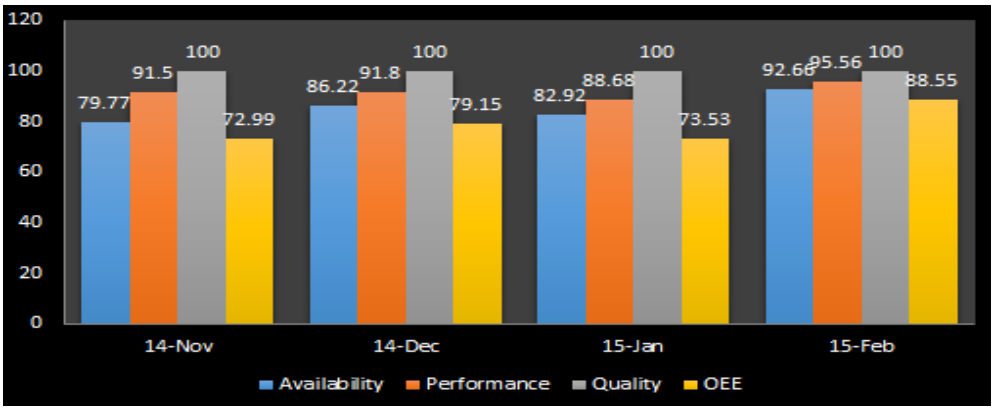

Fig. 6.2 Graph of parameters with respect to month

Below graph shows month wise analysis of all losses. We know that we cannot make all losses to zero hence we should minimize them as much as possible. So this is the effect of Jishu Hozen methodology that all the losses are going to decrease and all the efficiency parameters are getting increasing, which leads to improving machine basic condition.

Ch.-04:

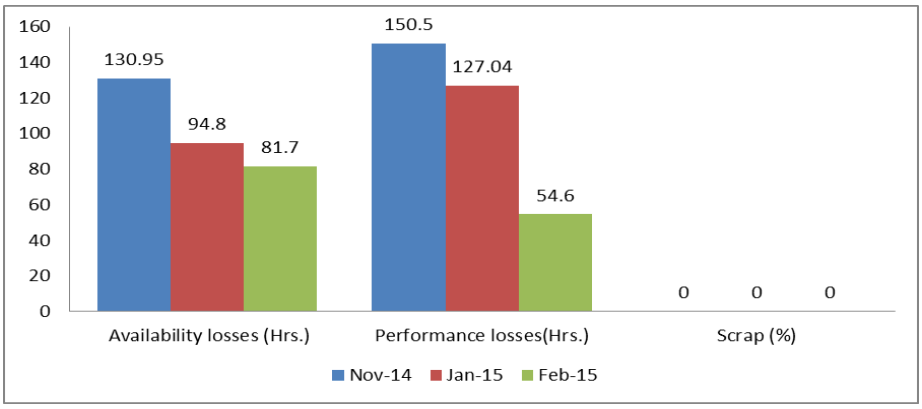

Fig. 6.3 Graph of losses with respect to month

Ch-05:

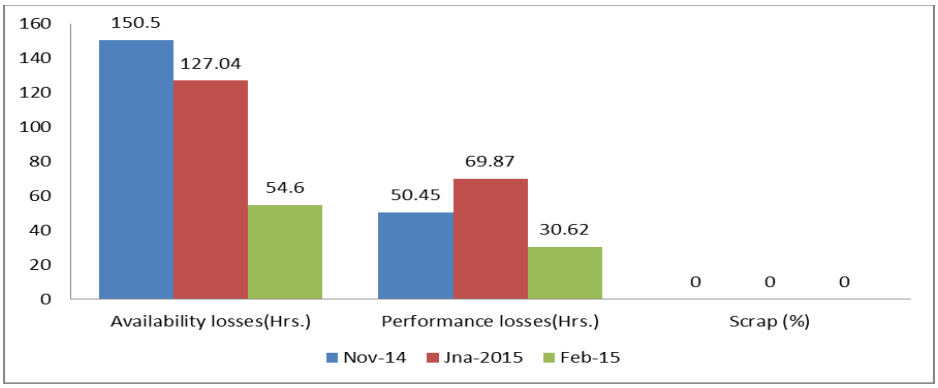

Fig. 6.4 Graph of Losses with respect to month

OEE:

After all the results we moved to achieve our main goal that is Overall equipment efficiency. As we know OEE is the function of Availability, performance and quality so if they are improving ultimately the OEE is going to increase. We can see in below graph the OEE distribution with respect to months it is increasing monthly. So after achieving increased OEE all the objectives of this project are accomplished. Since OEE is getting improved by all these small objectives like uptime, zero BAD, and machine basic condition. So finally uptime is getting more due to increased availability, zero BAD is achieved by increasing performance and quality and by all these things machine basic condition is getting improved.

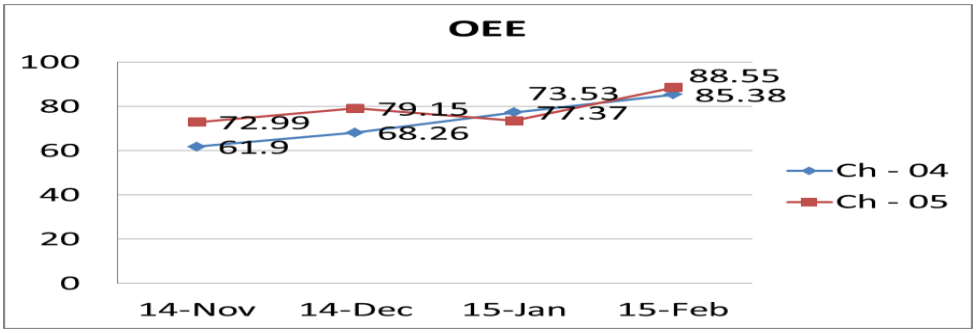

Fig. 6.5 Graph of OEE with respect to month

REFERENCES

[1] Roman Bednar, "Individualization Of Lean Concept In Companies Dealing With Mass Production", 2012.

[2] Iftekhar Aziz, Sazedul Karim, Md. Mosharraf Hossain., "Effective Implementation of Total Productive Maintenance and Impacts on Breakdown Time and Repair & Maintenance – A Case Study Of A Printing Industry In Bangladesh"

[3] Disha M Nayak , Vijaya Kumar M N, G.Sreenivasulu Naidu, Veena Shankar, "Evaluation Of OEE In A Continuous Process Industry On An Insulation Line In A Cable Manufacturing Unit"

[4] Arash Ghodrati, Norzima Zulkifli, . "The Impact of 5S Implementation on Industrial Organizations' Performance"

[5] Farhad Anvari and Rodger Edwards," Evaluation of overall equipment effectiveness based on market"

[6] Mfowabo Ncube, "The impact of total productive maintenance(TPM) on manufacturing performance at the colt section DaimlerChrysler in the estern cape

[7] Xu Chuanjie," Research on Implementation Plan of 5S Management in University Library"

[8] Hemant Singh Rajput1, Pratesh Jayaswal2," A Total Productive Maintenance (TPM) Approach To Improve Overall Equipment Efficiency".

[9] Chan, F.T.S., Lau, H.C.W., Ip, R.W.L., Chan H.K., Kong.S. "Implementation of Total Productive maintenance: a case study", International Journal of Production Economic, Vol. 95, pp. 71-94.