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# Implementation of Kobetsu Kaizen pillar in Improving Overall Equipment Effectiveness of Machine

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## Abstract

Total Productive Maintenance is a maintenance program which involves a newly defined concept for maintaining plants and equipment Overall Equipment Effectiveness is used as the measure of success of Total Productive Maintenance implementation. The Overall Equipment Effectiveness is product of equipment availability, performance efficiency of process and quality performance of manufacturing operations.

Kobetsu Kaizen approach is an important pillar of Total Productive Maintenance which had a major task of unifying the kaizen effort across the division. KK Pillar looks into all the losses, analyses the losses using various QC tools and comes up with suggestions that need to be implemented to reduce recurring losses.

This research is into the implementation of the KK Pillar activities in a manufacturing company that is in project business and does not have repetitive products. The main aim of this dissertation work is to reduce the losses of the machine. In this research work a case study of machine had been undertaken for the analysis for certain duration.

**Keywords**: Total Productive Maintenance (TPM), Tools of Quality, Tools used in Kobetsu Kaizen (KK) and Overall Equipment Effectiveness (OEE).

## Introduction

### Definition

Total Productive Maintenance (TPM) is often defined as “Productive maintenance involving total participation". This terminology emerged from Japanese Auto Industry .TPM was originally developed from Preventive Maintenance (PM) techniques from the US. From basic motive of upkeep of machines, TPM has now developed into a tool that encompasses entire business.

A complete definition of TPM includes the following five elements:

1. TPM aims to maximize equipment effectiveness (overall effectiveness).
2. TPM establishes a thorough system of PM for the equipment’s entire life span.
3. TPM is implemented by various departments (engineering, operations, and maintenance).
4. TPM involves every single employee, from top management to workers on the floor.
5. TPM is based on the promotion of PM through motivation management: autonomous small group activities.

### Background of TPM

The origin of TPM can be traced back to 1951 when Preventive Maintenance (PM) was introduced in Japan. However the concept of PM was taken from USA. The Japanese Institute of Plant Engineers (JIPE) was created after study of American Productive Maintenance in the year 1953 and 1962 by research group formed by twenty Japanese companies. The JIPE was converted into Japanese Institute of Plant Maintenance (JIPM) in the year 1969. By the end of the 1960s, JIPM had established and awarded a PM prize to companies that excelled in maintenance activities. Nippondenso, a Japanese automotive component manufacturer used first time Total Productive Maintenance in the year 1961 with the theme ‘Productive Maintenance with Total Employee Participation’ for improvement in manufacturing performance than it was spread to Toyota, Mazda, Nissan and their associated vendors.

Actually, in the early 1970’s, adoption of TPM began to accelerate as a means to improve manufacturing effectiveness, soon after Japan faced a decline in economy.TPM extended to United States and the Western world during 1980’s and 1990’s when companies strived to quality improvement with

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programs such as Total Quality Management.Today the concept of TPM is widely ac cepted and has been implemented in various industrie s. This interest is expressed to support a company's full utilization of its assets. [1]

**Eight Pillars of TPM**

To successfully implement TPM, it is important to keep in mind the overall guidelines that underlie all TPM activities. The eight pillars of TPM is a system for maximizing production effectiveness of any industry. The eight pillars of TPM are as follow:-

1. Focused Improvement:-Focused Improvement is the first pillar of TPM. It provides a structured, team-based approach to drive elimination of specifically identified losses in any process.
2. Autonomous Maintenance:-Autonomous Maintenance is the second of the eight pillars of TPM. It follows a structured approach to increase the skill levels of personnel so that they can understand, manage and improve their equipment and processes.
3. Planned Maintenance:-Planned Maintenance is the third pillar of TPM and aims to achieve zero breakdowns. It follows a structured approach to establish a management system that extends the equipment reliability at optimum cost.
4. Training and Education Pillar:-Training and Education is the fourth pillar of TPM. It ensures that staffs are trained in the skills identified as essential both for their personal development and for the successful deployment of TPM in line with the organization's goals and objectives.
5. Early Management:-Early Management is the fifth pillar of TPM and aims to implement new products and processes with vertical ramp up and minimized development lead time. It is usually deployed after the first four pillars as it builds on the learning captured from other pillar teams, incorporating improvements into the next generation of product and equipment design.
6. Quality Maintenance:-Quality Maintenance is the sixth pillar of TPM and aims to assure zero defect conditions. It does this by understanding and controlling the process interactions between manpower, material, machines and methods that could enable defects to occur.
7. Office TPM:-Office TPM is the seventh pillar and concentrates on all areas that provide administrative and support functions in the organization. The pillar applies the key TPM principles in eliminating waste and losses from these departments.
8. Safety, Health and Environment Pillar:-Safety, Health and Environment (SHE) is the final TPM pillar and implements a methodology to drive towards the achievement of zero accidents. It is important to note that this is not just safety related but covers zero accidents, zero overburden and zero pollution [2].

**Significance of Kobetsu Kaizen Pillar**

Kaizen activity had taken root in Precision Engineering Division by the time the division embarked on TPM journey. Till the time Kobetsu Kaizen (KK) pillar activity was started, operators, supervisors & managers were doing kaizens when faced with a problem. Kaizens were localized and for problem on hand. The need for looking at larger picture & making informed changes was not perceived.

KK Pillar had a major task of unifying the kaizen effort across the division .Hence the KK pillar had to train the people on focused kaizen activity. KK pillar also have to educate the teams in the seven step methodology towards identification and implementation of kaizens.

Precision Engineering Division in a project based industry is the business of making products for their customers. Precision Engineering Division embraced TPM as part of change management and as an approach for all operations. TPM approach was certainly going to help the division grow in all aspects. Losses during manufacturing of products, losses in non-production activities were mounting. Our costs were high and we were finding it tough to get orders in the competitive environment. There was a large scope for improvement in utilization of resources of the division. It was necessary to channelize the thoughts& ideas of all the employees of the division towards loss & cost reduction. That is where the division took up the KK drive. Also KK is the pillar which the activity of rest of the pillars.

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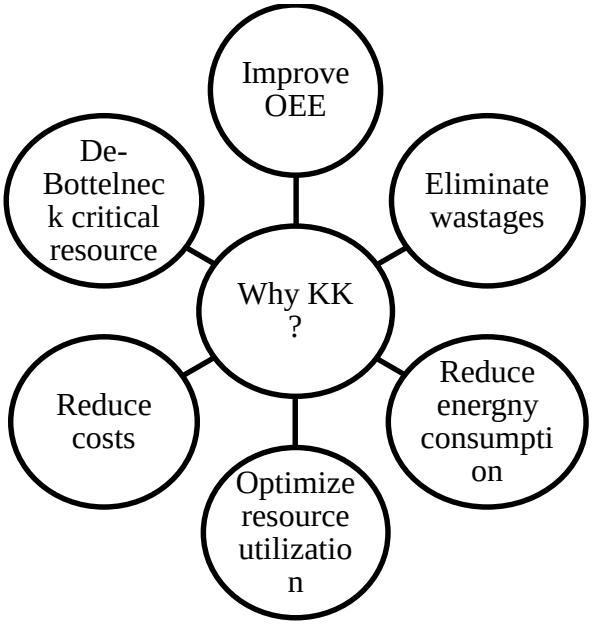


***Figure 1.1 Why KK Pillar?***

## Literature review

Binoy Boban and Jenson Joseph E [3] proposed a plan to implementation TPM through the various pillars of TPM. They had discussed the 5S and kaizen among the various pillars. After a small implementation of TPM in company, they found that the OEE is increased by 4% and also it had been noted that the change in maintenance policy in the company changed their performance and quality. So they concluded that the implementation of TPM in rest of all machines of the company will leads to more equipment effectiveness in the company thereby they can achieve more quality and profit.

PradeepKumar Shetty and Dr.L.Lewlyn. R. Rodrigues [4], had compared Overall Equipment Efficiency (OEE) of different diesel generator-sets in one of the Institutions Power Houses. On the basis of collected data and calculated OEE of the four power house they find out Availability, Performance efficiency, Quality rate. By using this data they calculated OEE of the four power house and compared the results and then concluded that by improving speed efficiency, OEE can be improved.

HemlataSahu, J.M.Batham and A.Bangar[5],had studied implementation of TPM in Jamna Auto Industry and they compared previous month data before implementing TPM and after implementing TPM data. After comparing the data they find out that there is reduction in the maintenance cost and improvement in quality performance of product.

A.Bangar, Hemlatasahu and Jagmohanbatham [6], had done a case study in Jamna auto industry to improve OEE (Overall Equipment Effectiveness) by implementing Total productive maintenance. They had compared previous month data before implementing TPM and after implementing TPM data and then with this data they implemented kaizen methodology. After that they reduce 80% problem analyzed by Pareto chart and OEE of industry improved up to 96%.

Ashok Kumar Sharma et al. [7], had described that to improve productivity it is essential to improve the performance of the manufacturing systems. They had discussed the maintenance (Total Productive Maintenance) as strategy to improve manufacturing performance, 5S as the base of Total Productive Maintenance (TPM) and Overall Equipment Effectiveness (OEE) as a measure of effectiveness.

Melesse Workneh Wakjira and Ajit Pal Singh [8], had done a case study in Ethiopian malt manufacturing industry to evaluate the effectiveness of TPM implementation steps.OEE value in boiler plant was calculated and analyzed before and after implementation of TPM in industry and it was identified that the major industry losses were are shut down, production adjustment, equipment failure, process failures, normal production loss, abnormal production loss, quality defects, and reprocessing.

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After analyzing the calculated data it was found that bottle neck was boiler plant for malt manufacturing process due to which productivity was going down. So they selected this plant as equipment for OEE calculation and they found that after implementing TPM in the plant the OEE calculation was improved.

Andrea Sutoova et al. [9], describe the approach of kobetsu kaizen pillar and its implementation process. The case study was done on analysis of breakdown losses in the printing press. Data from the maintenance record was analyzed for the two months. With the help of Ishikawa diagram and Why Why analysis break down losses was reduced on two equipment units' i.e. pressure roller and cooling drum unit. There was a 78% decrease of downtimes caused by pressure rollers and 84% decrease of downtimes caused by cooling drums.

Harsha G. Hegde, N. S. Mahesh, and Kishan Doss [10] had done a case study in improving the breakdown losses of machines through the implementation of TPM in the company .This study had been addressed to three aspect i.e. Availability, Performance and Quality which quantify OEE and through effective implementation of TPM techniques such as Preventive Maintenance, Cleaning with Meaning, Pokayoke & Kaizen the OEE of the machine was improved which also represent annual earning of Rs.5 lakhs.. To achieve this target, efficient maintenance was in place, Autonomous maintenance teams were developed and better communication and team- work was promoted.

Wasim. S. Hangad and Dr. Sanjay Kumar [11] had done a case study in a medium scale industry based on the interviews and the observations. That is the reason that the both qualitative and quantitative methods were used in the project. Machineries like, CNC Punching, Bending, welding and Powder Coating are there in company out of which punching and bending machine was selected as bottleneck machines because is was hindering the production of the cell .While implementing TPM works on major 8 pillars .It works on methodologies like CLITA,JSA (Job Safety Analysis), PM Analysis for achieving its goal of success. The results of implementing an effective program in terms of increased plant efficiency and productivity are outstanding.

## Problem statement and objectives

### Problem Statement

A project based industry had been taken for the research work which is one of the largest and the oldest conglomerates based in India. Based on earlier calculation of OEE in the Precision Engineering Division researcher had analyzed that out of four cell of the division i.e. (Large Boring Cell, Small and Medium Cell, Turning Cell and Machine Shop-19) Machine Shop-19 is having least OEE . Machine Shop 19 is having 19 machines in the workshop and all the machines are conventional type machines. There is no CNC machine in this cell. All kind of heavy machining jobs are done here. In this cell all types of operation can be done on one machine like drilling, milling, turning, threading, etc.

The major influence on OEE is because of Setup and adjustment losses which is described as time lost on machine before actual cutting starts, loading and unloading of jobs on machine, time taken for aligning parts before tacking, interval between last cut of one job and first cut of next job and Cutting blade loss which is described as changing of tools / cutters / inserts between operations, changing of FCAW Torches, Gas Shields, Loading of universal heads, Tool or cutter set up time.

So the researcher had decided to work on these losses through kaizen implementation through KK Pillar approach.

### Objectives

- To optimize effectiveness of all machines.
- To improve the major losses in the machines.
- To improve the overall OEE of the machines.
- Getting the people to focus towards achievement of divisional goals.

## Research methodology

### KK Pillar Approach

Kaizen activity had taken root in Precision Engineering Division by the time the division embarked on TPM journey. Till the time KK pillar activity was started, operators, supervisors & managers were doing kaizens when faced with a problem. Kaizens were localized and for problem on hand. The need for looking at larger picture & making informed changes was not perceived.

KK Pillar had a major task of unifying the kaizen effort across the division .Hence the KK pillar had to train the people on focused kaizen activity. We had to educate the teams in the seven step methodology towards identification and implementation of kaizens. The KK Pillar had to work simultaneously on loss elimination and improvement activities. Improvement of OEE, Debottlenecking of critical machines and reducing manufacturing costs were three important activities assigned to KK Pillar.

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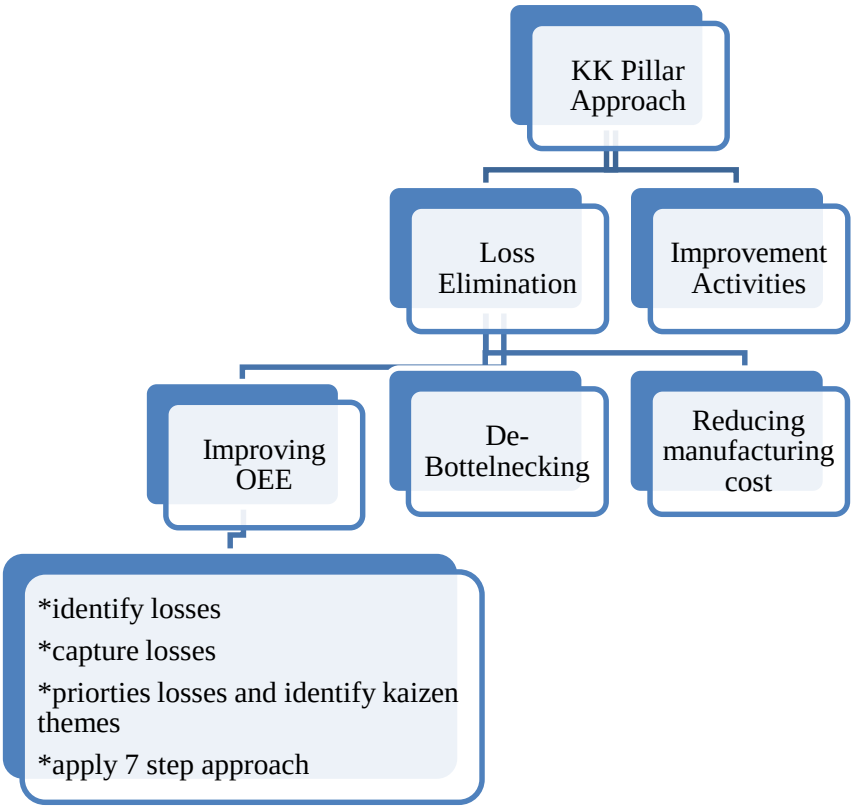


***Figure 4.1 Approach of KK Pillar.***

In this dissertation work analysis on loss elimination activity of KK pillar has been carried out. The analysis of improvement in OEE and reducing losses with the help of kaizens is the main aim of the project work. For the purpose of identifying the losses and prioritizing the following process is implemented.

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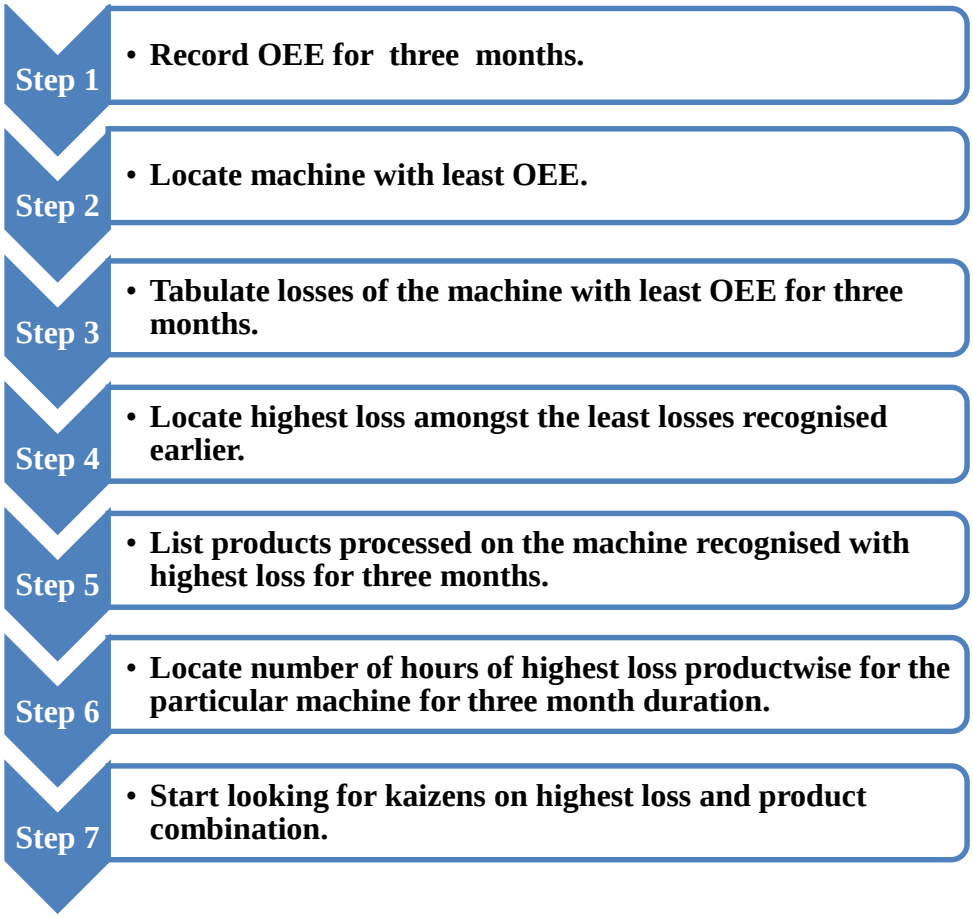


***Figure 4.2 The 7 Step for loss identification and prioritization***

**Overall Equipment Effectiveness**

OEE measurement is also commonly used as a key performance indicator in conjunction with lean manufacturing efforts to provide an indicator of success. Overall Equipment Effectiveness, or OEE, is a modern way to assess production. This measurement can be used for a variety of systems, from a single workstation to a large industrial plant or facility. OEE is a set of metrics that shows business leaders how much they are getting out of their production systems. OEE (Overall Equipment Effectiveness) is a metric that identifies the percentage of planned production time that is truly productive. It was developed to support TPM initiatives by accurately tracking progress towards achieving "perfect production".

- An OEE score of 100% is perfect production.
- An OEE score of 85% is world class for discrete manufacturers.
- An OEE score of 60% is fairly typical for discrete manufacturers.
- An OEE score of 40% is not uncommon for manufacturers without TPM and/or lean programs.

For a complete accomplishment of OEE, including information on how to calculate Availability, Performance, Quality, and OEE

**Overall Equipment Effectiveness (OEE)**

OEE breaks the performance of a manufacturing unit into three separate but measurable components: Availability, Performance, and Quality. Each component points to an aspect of the process that can be targeted for improvement. OEE may be applied to any individual Work Centre, or rolled up to Department or Plant levels.

OEE is calculated with the formula:-
OEE= (Availability) × (Performance) × (Quality)

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**Availability:**
Availability Rate= (Operating Time –Down Time)/Total Operating Time

**Performance:**

Performance = (Average Actual Production Rate/Standard Prodution Rate)

**Quality:**
Quality Rate =Good Output/Total Output

**Seven Basic Tools of Quality**

The Seven Basic Tools of Quality is a designation given to a fixed set of graphical techniques identified as being most helpful in troubleshooting issues related to quality. They are called basic because they are suitable for people with little formal training in statistics and because they can be used to solve the vast majority of quality-related issues.

The seven tools are:

1. Cause-and-effect diagram:-Ishikawa diagrams are causal diagrams created by Kaoru Ishikawa (1968) that show the causes of a specific event. Common uses of the Ishikawa diagram are product design and quality defect prevention, to identify potential factors causing an overall effect.
2. Check sheet: - Check sheet is a form used to collect data in real time at the location where the data is generated. The data it captures can be quantitative or qualitative. When the information is quantitative, the check sheet is sometimes called a tally sheet.
3. Control chart:-Control charts, also known as Shewhart charts or process-behavior charts, in statistical process control are tools used to determine if a manufacturing or business process is in a state of statistical control.
4. Histogram: -A histogram is a graphical representation of the distribution of data. It is an estimate of the probability distribution of a variable and was first introduced by Karl Pearson.
5. Pareto chart:-A Pareto chart, named after Vilfredo Pareto, is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars, and the cumulative total is represented by the line
6. Scatter diagram:-A scatter plot, scatter plot, or scatter graph is a type of diagram using Cartesian coordinates to display values for two variables for a set of data. The data is displayed as a collection of points, each having the value of one variable determining the position on the horizontal axis and the value of the other variable determining the position on the vertical axis
7. Stratification (alternately, flow chart or run chart):- A flowchart is a type of diagram that represents an algorithm, workflow or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields.

**Tools used in Kaizen:**

- PM Analysis:-PM Analysis is an advanced problem solving tool that focuses on understanding the Phenomenon (P) and the Mechanism (M) of a defect or failure.
- Why - Why Analysis:-It is a method of questioning that leads to the identification of the root cause(s) of a problem. A why-why is conducted to identify solutions to a problem that address it's root cause(s).
- Kaizen register:-It is a register in which all the implemented kaizens are registered.
- Kaizen summary sheet:-It is a format which contains kaizen theme, idea generated, problem status, counter measures, why-why analysis and result of the kaizen idea generated.

**Case Study Approach**

The Research work has been under taken in a cell of Precision Engineering Division of a project based industry which is having least OEE which was hampering overall OEE target that is 85% .In this PES division there are four cells:-

- Large Boring Cell (LBC):-In this cell only heavy machines are there on which all types of boring operations are done. There are 20 heavy machines in this large boring cell.
- Small and Medium Cell (SMC):-In this cell all precision type of operation are performed on these CNC machines. This cell is having 18 CNC machines on which according to the customer requirement different operation are performed on the CNC machines.
- Turning Cell (TC):-There are 27 machines in this cell out of which most of the machines are lathe machines and some are vertical turret lathe machines. In this cell mostly machining of circular type of jobs are done.
- Machine Shop 19: This cell is having 19 machines in the workshop and all the machines are conventional type machines. This cell is having fabrication shop also. There is no CNC machine in this cell. All kind of

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heavy machining jobs are done here. In this cell on one machine all types of operation can be done like drilling, milling turning, threading, etc.

Out of these four cells researcher had selected one cell for data analysis for the period of three month. The Precision Engineering Division had classified the loss type into 16 losses associated with TPM terminology that are Failure losses - Breakdown loss, Setup / adjustment losses, Cutting blade loss, Start-up loss, Minor stoppage / Idling loss, Speed loss, Defect / rework loss, Scheduled downtime loss, Management loss, Operating motion loss, Line organization loss, Logistic loss, Measurement and adjustment loss, Energy loss, Die, jig and tool breakage loss and Yield loss.

But the major influence on OEE is because of Setup / adjustment losses which is described as time lost on machine before actual cutting starts, loading / unloading of jobs on machine, time taken for aligning parts before tacking, interval between last cut of one job and first cut of next job and Cutting blade loss which is described as changing of tools / cutters / inserts between operations, changing of Flux Cored Arc Welding (FCAW) Torches, Gas Shields, Loading of universal heads, Tool or cutter set up time.

All these losses are feed in the Baan Enterprise Resource Planning (ERP) software. The software attempts to integrate business processes--including manufacturing, accounting, human resources and customer relationship management--into a single, coherent system. There are different versions in Baan Enterprise Resource Planning (ERP) software out of which this division is using Baan IV modules .Baan IV modules use all these standard module for their calculation purpose i.e. Common (tc), Finance (tf), Project (tp), Manufacturing (ti), Distribution (td), Process (ps), Transportation (tr), Service (ts), Enterprise Modeller (tg), Constraint Planning (cp), Tools (tt), Utilities (tu), Baan DEM ( tg). From the Baan ERP system the data had been collected for the calculation of OEE of the machine.

With the aim to reduce these losses through kaizen implementation through KK Pillar approach this research work has been under taken.

## Expected Outcomes

- Increase in confidence and ability to perform complex job by operator and staff.
- Increase ownership of the equipment and workplace by operator.
- Change in attitude and behavior of employee.
- Multi skill abilities of operators.
- Improvement in the knowledge and skill of employee.
- Overall improvement culture has built up.
- Employee thinking will change from narrow minded to widely and deeply.
- Improvement in major losses of the machines.
- Overall OEE of the machines will improve.

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