

ABSTRACT

The advancement in technology had lead to the industrial revolution and higher level competition for survival and to secure the level of standard to be as a competitor otherwise the industry may be out of the competition and loss the value in the market. In this case study the data collected analyzed the data and observed that the Pet Food Plant have low overall equipment effectiveness as compared to the word-class overall equipment effectiveness which means that it requires to improve in OEE. After the implementation of TPM through the proposed model which improves OEE from a low value of 52.33% to 73.54%. Based on these results, global maintenance management, and production planning were suggested to improve their maintenance procedures and improve the productivity. Also, the Plant needs to focus on improvement of their inspection work start from the raw materials inventory to the work in process finished with finish goods inventory. After the detailed analysis, the pillars of TPM are identified and on the basis of it general framework for TPM implementation in Pet Food Plant of Food Processing unit of IB Group is developed.

KEYWORDS: TPM Pillars, OEE (Overall Equipment Effectiveness), Frame Model.

INTRODUCTION

In these days all the industry wants to increase the productivity by reducing the unnecessary operation which reduces the maintenance cost. Maintenance is an important factor to improve productivity and quality in manufacturing industries. The goal of the TPM program has ability to increase production while, at the same time, increasing employee morale, skills and job satisfaction. TPM brings maintenance into focus as a necessary and vitally important part of the organization to reduced the losses and increase the rate of production such that is no longer regarded as a non-profit activities. Down time for maintenance is scheduled as a part of the manufacturing industries and, in some cases, as an integral part of the manufacturing process. The goal of TPM is to hold emergency and unscheduled maintenance to a minimum to increase the actual run time of the machines.

LITERATURE REVIEW

TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction. The results of implementing TPM program in terms of increased plant efficiency and productivity are outstanding [1]. In the competitive world the industrial scenario is Rapidly change and the production system having a lot of force improve productivity and enriching the Quality, performance and profit the Total productive Maintenance is one of the tool to fulfill the conditions and achieving the organization goals [2]. It can be concluded that the industry may use the model constructed by applying TPM and 5S technique in order to accelerate OEE and to improve the current maintenance system [3].

Global maintenance management and production planning were suggested by the author (Afefy [4]) to improve their maintenance procedures and improve the productivity. Successful implementation of TPM for the organization has enhanced the competencies of their employees at their level. That crafts the employees to bear more responsibility and improve the organization's core competency and maintain the reputation among the industries. The TPM

implementations improve the plant performance and productivity to world class level [5]. So productivity is first to be emphasized. The quality is at second ranking thus a lot has to be done on quality. Cost is coming next in the row, then safety and so on [6]. The effort has been made to identify the suitable areas and important factors for proper implementation of TPM practices, obstructions and success factors, fiascos in the area and its requirement for improving the competencies of the educational organizations and institutions [7].

The author (Singh [8]) evaluated actual improvement process may involve identifying the operating practices and procedures of the benchmark factories and engaging in reengineering programs. TPM is a practical and down to earth technique aimed at maximizing the effectiveness of facility that we use within our organization [9]. Plant maintenance is an important service function of an efficient production system. It helps in maintaining and increasing the operational efficiency of plant facilities and thus contributes to revenue by reducing the operating costs and increasing the effectiveness of production [10].

TPM TARGETS

1. Minimize the downtime of machine.
2. Obtain Minimum 90% OEE (Overall Equipment Effectiveness).
3. Run the machines even during lunch (Lunch is for operators and not for machines).
4. Operate in a manner, so that there are no customer complaints.
5. Reduce the manufacturing cost.
6. Achieve 100% success in delivering the goods as required by the customer.
7. Maintain an accident free environment.
8. Increase the suggestions and develop Multi-skilled and flexible workers.

METHODOLOGY

In this case study the Plant OEE (Overall equipment effectiveness) is observed to find out the current efficiency of the plant and helps to analyze the area associated with the problem which causes the low OEE. For the improvement of OEE of the Plant TPM pillars are implemented through frame model and after the implementation of TPM for 6 months analysis is performed to achieve the improvement in OEE.

Calculation of OEE

Overall Equipment Effectiveness is calculated by:

$$OEE = \text{Availability} \times \text{Performance efficiency} \times \text{Rate of quality}$$

1. Availability:

$$\text{Availability (\%)} = \frac{\text{Actual Run Time}}{\text{Scheduled Run Time}} \times 100$$

2. Performance Rate:

$$\text{Performance Rate (\%)} = \frac{\text{No. of items yield}}{\text{Targeted no. of items}} \times 100$$

3. Quality Rate:

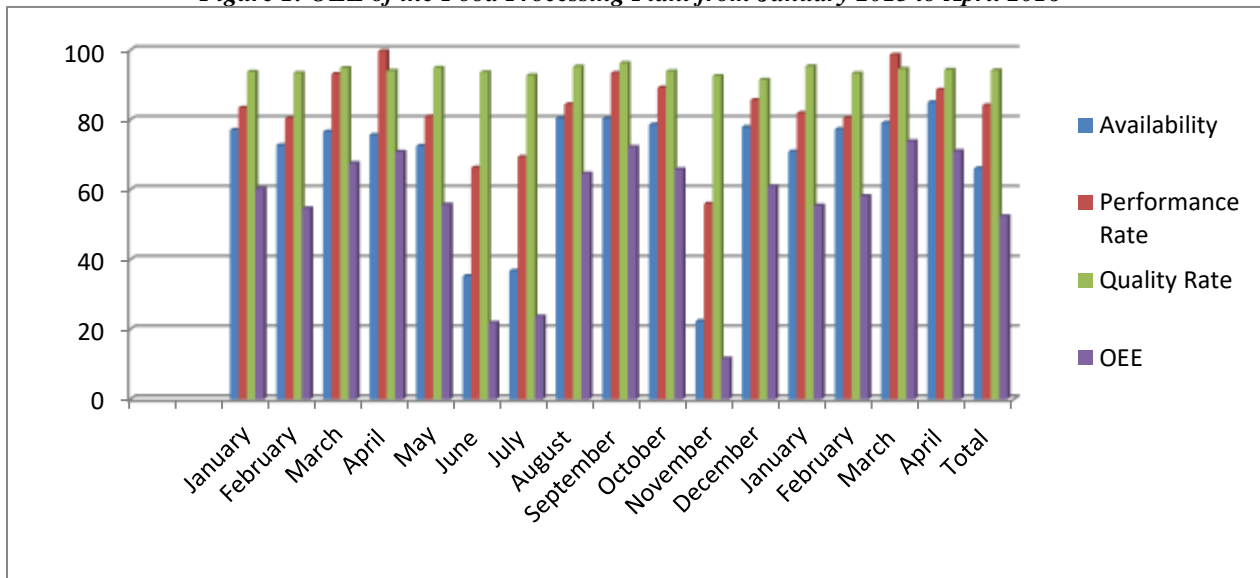
$$\text{Quality Rate (\%)} = \frac{\text{No. of items yield} - \text{Defected items}}{\text{No. of items yield}} \times 100$$

Data collected from various resources for 16 months likes observation of machines, historical data recorded register, interview and discussion session in the Food Process Plant. Data collected and analyzed using quantitative methods which is calculated by the multiplication of all the factors of OEE that is availability, performance rate and quality rate which are shown in Table 1 and Figure 1.

Table 1. OEE of the Food Processing Plant from January 2015 to April 2016

Months	Year	Availability	Performance Rate	Quality Rate	OEE
January	2015	77.10	83.40	93.70	60.30
February	2015	72.70	80.40	93.40	54.60
March	2015	76.60	93.10	94.80	67.60
April	2015	75.60	99.70	94.00	70.80
May	2015	72.50	80.90	94.90	55.70
June	2015	35.20	66.30	93.60	21.80
July	2015	36.70	69.30	92.70	23.60
August	2015	80.40	84.40	95.20	64.60
September	2015	80.30	93.40	96.20	72.20
October	2015	78.60	89.20	93.90	65.80
November	2015	22.30	55.90	92.50	11.60
December	2015	77.90	85.60	91.40	60.90
January	2016	70.90	81.90	95.30	55.40
February	2016	77.30	80.50	93.30	58.10
March	2016	79.10	98.60	94.60	73.80
April	2016	85.00	88.60	94.30	71.00
Total	2015-16	66.06	84.15	94.13	52.33

Figure 1: OEE of the Food Processing Plant from January 2015 to April 2016



Comparison of OEE with World Class Overall Equipment Effectiveness (OEE)

The OEE is equal to world class OEE which means that plant and equipment is in good condition and if the OEE is less then it means require urgent improvement the different factors of OEE otherwise it will difficult for the

industries or organization to sustain. The world class OEE is the benchmark set by the Japanese industries. A comparison between the World-class OEE and current OEE measures can provide the much needed output data for the manufacturing organizations to improve the maintenance policy and affect the continuous improvement in the manufacturing systems. The Comparison of OEE with World Class Overall Equipment Effectiveness of the machines shown below in Table 2.

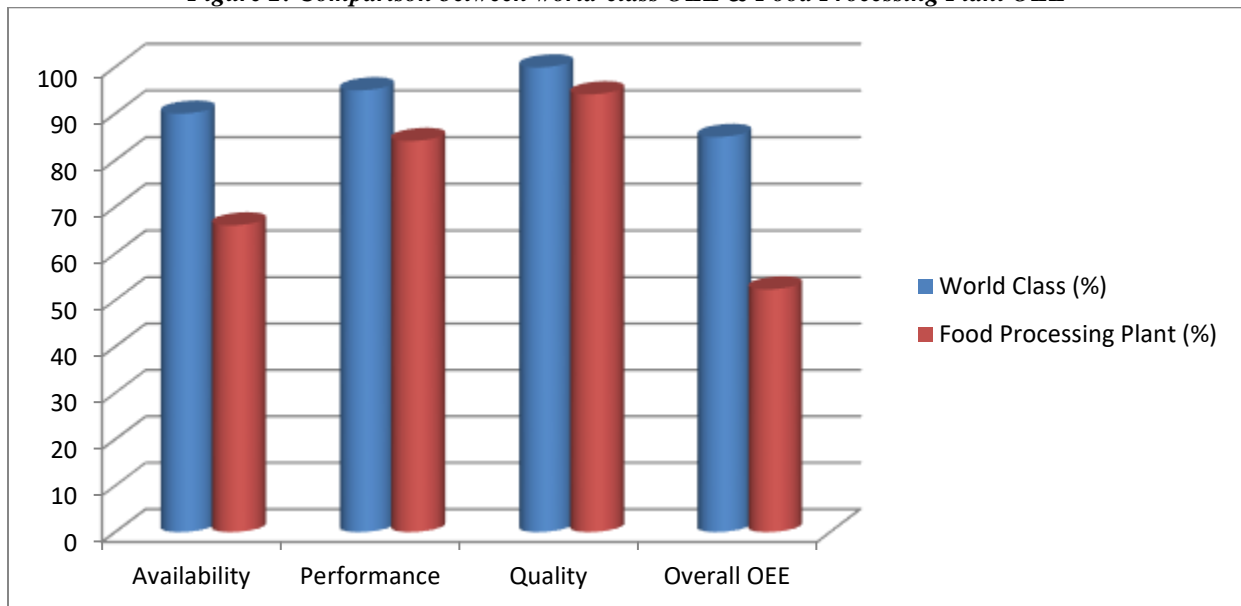
Table 2. World-class OEE

OEE Factors	OEE world class (%)
Availability	90
Performance	95
Quality	99.9
Overall OEE	85

Table 3. Comparison between world-class OEE & Food Processing Plant OEE

OEE Factor	World Class (%)	Food Processing Plant (%)
Availability	90	66.06
Performance	95	84.15
Quality	99.9	94.13
Overall OEE	85	52.33

Figure 2: Comparison between world-class OEE & Food Processing Plant OEE



The above given Table 3 and Figure 2 shows that OEE of the Food Processing Plant is less as compare to the world class OEE hence it needs to improve the OEE which leads to improve the production of the product and in this way it become easy to achieve the targeted product within the time limit. For the improvement of OEE different types of tools can be use such as TPM Pillars, barriers, to sort out the problematic area and SWOT analysis is preformed in the next part.

Area of problems in the Pet Food Plant

The problem which hamper the entire system of the Pet Food Plant of the IB Group are analyze through the inspection of the machine start from raw material to finish product and packaging of goods. Problem of the Plant were identified according to their working condition and on the basis of it problem identification chart is prepared as shown in Table 4. This chart shows the problem occurs at different location and its effects on work and how to eliminate these problems under the different circumstances.

Table 4. Problem Areas in the Pet Food Plant

S. No	Description of Problem	Location	Effects	Cause	How to eliminate it	Responsibility
1.	Maintains of Hygiene	In every part of Plant	Bad smell and spoil of Food	Low maintenance of Plant	ISO certified every year	Management department
2.	Insects and foreign particles	In every part of Plant	Spoil of Food	Improper insulation and incubation	Proper pest control	Housekeeping department
3.	Oil split out while cleaning	Every machines	Oil wastage	Oiling method is not proper	Improve oiling method	Maintenance department
4.	Improper packing and handling of goods	Packing and storage	Harmful to finished goods	Unavailability of handling system	Guidance and usage of handling system	Packaging department
5.	Sudden breakdown and mechanical faults	Machine area	Failure of machine	Negligence	Continuously checkup of preventive maintenance	Maintenance department
6.	Rejection of goods	At machine area	Low profit	Improper operating	Proper operating the machines	Operation department
7.	Sudden breakdown due to electrical faults	Machine area	Stop production	Negligence	Proper electrical maintenance	Electrical department
8.	Accident and deaths	At any part	Death and harms	Improper training and guidance	Proper safety kits and training	Safety department
9.	Harmful chemicals	At floor	Indirect losses	Negligence	Place chemical in proper place	Product Ion department
10.	Inconsistent of operators in working	Overall	Stop process	Negligence	Arrange co-operator	Product Ion department
11.	Fatigue of operators	All area	Indirect losses	Lack of awareness	Provide extra operators	Product Ion department
12.	Floor area not clean	Overall	Looks bad	Negligence	Clean it on daily basis	Product Ion department

Proposed Framework

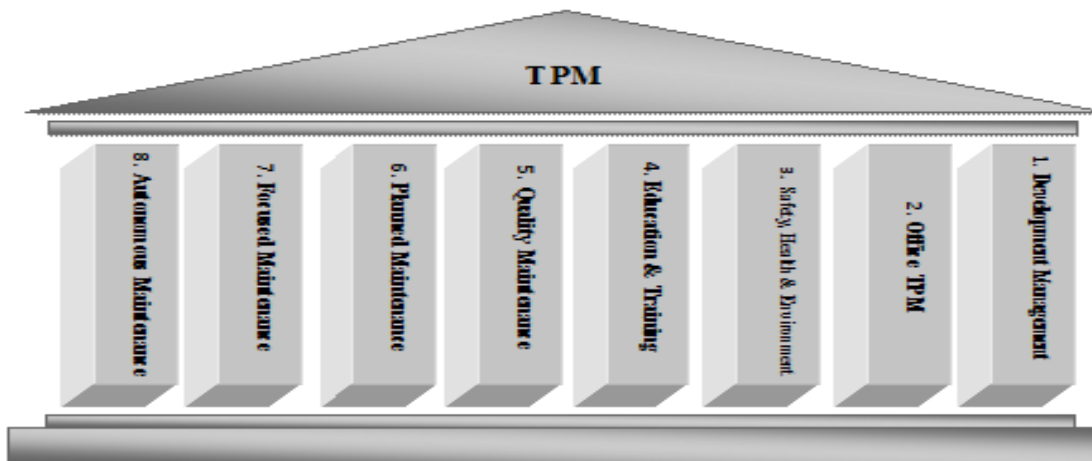
Frame work which helps to provides the information and plans the different activities for the improvement for the entire system. TPM pillars that serve as path to effective TPM implementation program leads to improve the factors

of OEE & ultimately improves overall manufacturing performance of any organization. TPM concept is implemented in a phased manner in a Pet Food Plant of Food Processing plant. Overall equipment effectiveness (OEE) is taken as a measure of success of TPM implementation. 5S can be called as foundation stone of TPM implementation. The process of regular inspection in Japan is known as way of housekeeping. Cleaning and organizing the workplace helps us to pop up the problems. Making problems visible and seen to the people gives an opportunity of improvement.

Implementation of TPM

The implementation of TPM pillars in the plant or organization is become easy to enhance the productivity up to certain extent which is possible by reducing the losses and eliminate the barriers so that machine does not require more time than actual time and thus Implementation of TPM is beneficial to the industry. Approach of pillars framed as general frame for TPM as shown below in the Figure 3.

Figure 3: TPM Pillars



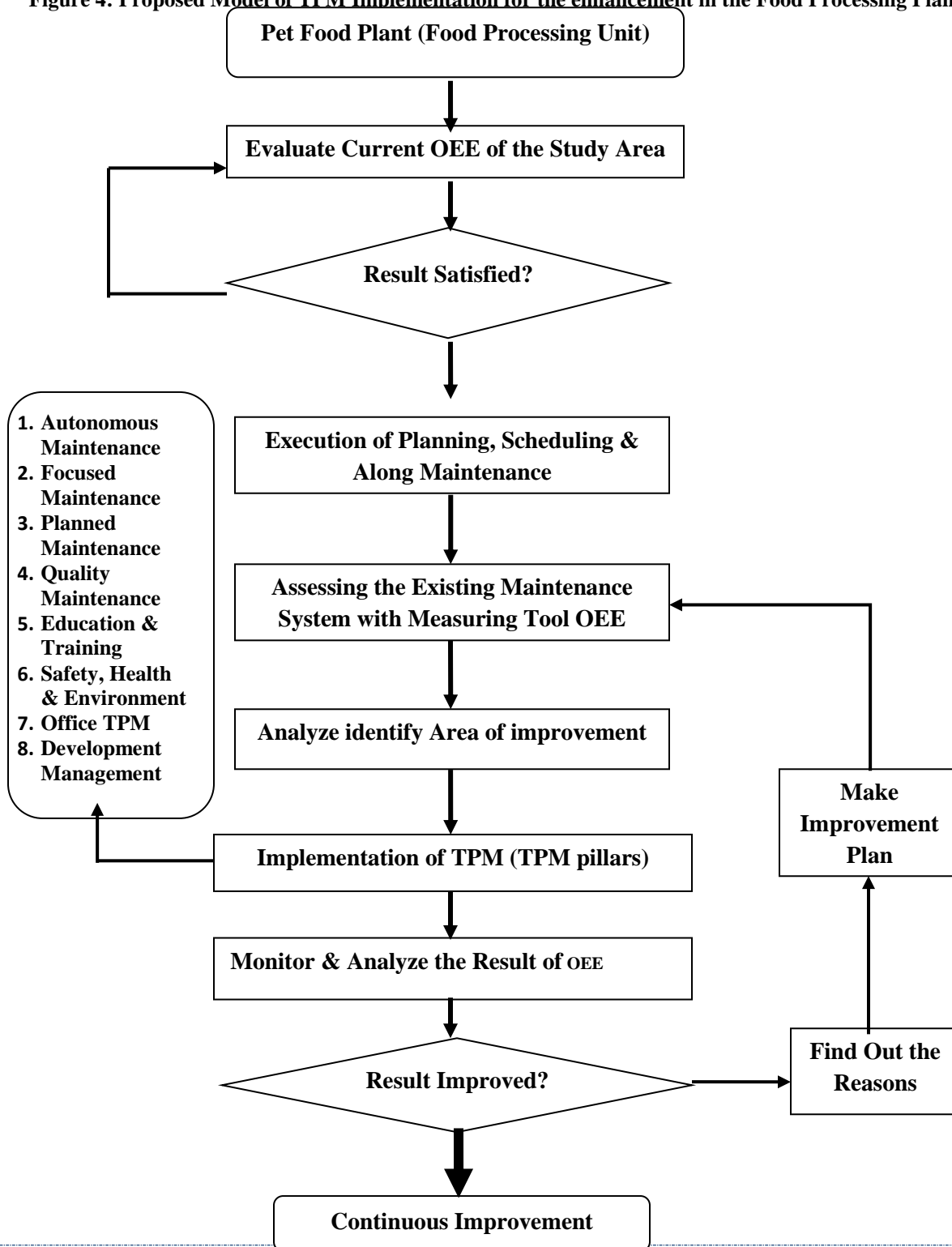
- 1. Autonomous Maintenance-** The Japanese call it JISHU HOZEN and proved by them that JISHU HOZEN help to reduce the breakdown and maintain other equipments and eliminating the defects at source through active employee participation. The operators of the machine are responsible to maintain their equipment properly on regular basis to prevent it from deteriorating. By use of this pillar, the aim is to maintain the machine in new condition. This pillar is based on the concept towards developing operators to be able to take care of initial cleaning, small task maintenance activities, Routine inspection and Understand the relation between productivity and maintenance.
- 2. Focused Maintenance-** Focused Maintenance is also known as Kobetsu kaizen in Japan. “Kaizen”, literally means “change for the betterment”. By the continuous observation of Plant, the losses can prevent and regarding that maintenance action is performed so that unwanted stoppage occurs in the machine is less. The objective of Kaizen is that "a small improvements are more effective in an organizational because it prevent or avoid the occurrences of major breakdown of large value". This pillar is aimed at reducing losses in the workplace that affect the efficiencies.
- 3. Planned Maintenance-** Objective of Planned Maintenance are to achieve and sustain availability of machines, optimum maintenance cost, improve reliability and better maintainability of machines, minimize equipment failure and break down and ensure availability of spares all the time and produce defect free products for customer satisfaction.

4. **Quality Maintenance-** Quality Maintenance aims to assure zero defects condition, based on the basic concept of maintaining the plant and equipments in good condition to provide better quality products. The condition is checked and measured in time series to verify that measured values are within standard values to prevent defects. Quality maintenance is an interaction between man, machine, job and the method in the industry.
5. **Education and Training-** Its objective is to provide multi skills to employees, so that it can raise morale and add value to the worker performance functions effectively. Education and Training of the work is an important factor which increases the working ability of the employees as well as increase the output of the industry.
6. **Safety, Health & Environment-** Management is given suggestion for giving training to employee what to do in case of emergency and what should be the exit plan at that particular time. Management is also suggested to conduct mock drill once in a year. Several safety and health programs were conducted for the betterment of the employee and environment factor is also taken under consideration to make the atmosphere free from pollution.
7. **Office TPM/Administrative Improvements-** Earlier daily insert usage report was maintained in a notebook, and at the end of the week the person has to sit along with calculator to sum up the weekly consumption and report is prepared in MS Excel saving lots of time and effort. Some details of employees are displayed on the notice board with their information like their department, name, designation, phone number so that whenever anyone need to consult them can reach them on their mobiles, without wasting time. Office TPM gives the better planning to perform a task.
8. **Development Management-** Development Management Plans project strategies and analyzing the factors which influence project decision, prepare a design new product with customer focus, and reduce lead time from production. Management works as a link between the plant and the employees and it is very important aspect of any organization to achieve the goal.

On the bases of these pillars are considered for development of the proposed model to implement TPM. These pillars are helpful for analysis of OEE and barriers in the Pet Food Plant of Food Processing plant. For TPM implementation to be successful there must be some pillars to strengthen the foundation of strategic measures. The frame Proposed Model of TPM Implementation for the enhancement in the Food Processing Plant is shown in the Figure 4.

Model for the TPM Implementation

Figure 4: Proposed Model of TPM Implementation for the enhancement in the Food Processing Plant



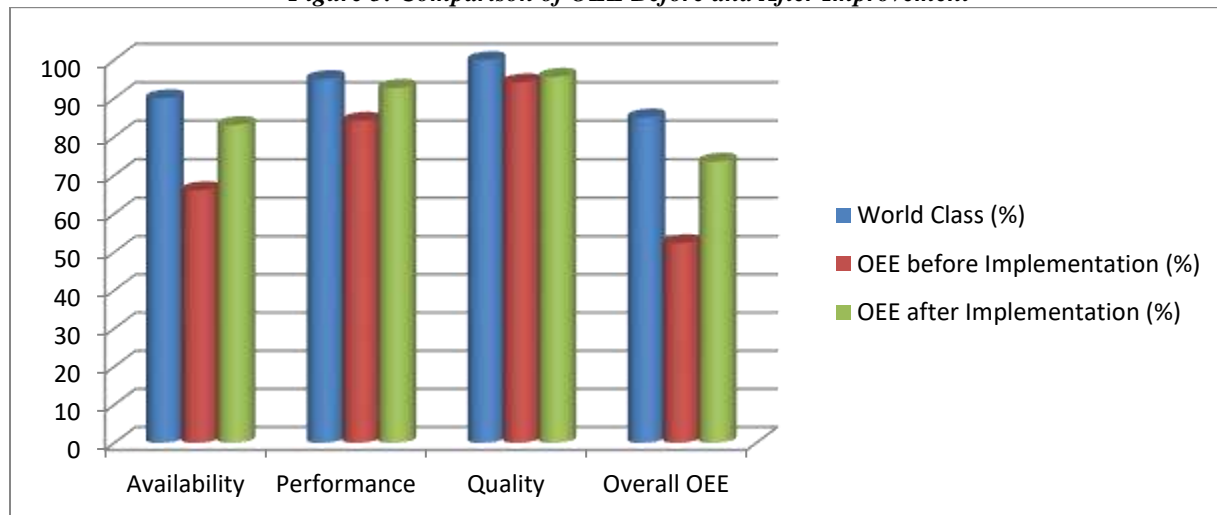
COMPARISON THE RESULT OF OEE BEFORE AND AFTER IMPROVEMENT

TPM is a fundamental tool to perform continuous program which provides the maintenance to the machines and plant so that it works efficiently and reduce the unwanted stoppage to achieve the efficiency as per the bench mark set by the world class OEE. After the implementation of TPM in the Food Processing Plant Further the OEE of the 6 months is calculated and compared with the previous OEE as shown below in the Table 5 and Figure 5

Table 5. Result of OEE before and after Improvement

OEE Factor	World Class (%)	OEE before Implementation (%)	OEE after Implementation (%)
Availability	90	66.06	83.03
Performance	95	84.15	92.68
Quality	99.9	94.13	95.56
Overall OEE	85	52.33	73.54

Figure 5: Comparison of OEE Before and After Improvement



CONCLUSION

The pillars of TPM is very essential for the development of the Plant because it help to reduce the uncertainty of the Plant up to certain extent as it has used in these case study and the result obtained by the implementation of TPM model the total OEE of the plant increases. The effective implementation of total productive maintenance (TPM) leads to many benefits such as improved productivity, quality, and flexibility and also reduction in cost. TPM focus on maintaining the plant or equipment in good condition by the improvement in equipment availability, performance and quality with assuring health and safety of employees and protection of environment. Overall Equipment Effectiveness has improved from 52.33% to 73.54% indicating the improvement in productivity and improvement in quality of product. However, by the obtained result of OEE there is a need for further study due to fast changing in technologies and emphasizing the importance of having improvement in productivity by providing short training, safety & education programs to the employees.

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