



Analysis of Overall Equipment Effectiveness in Small PVC Garden Tube Manufacturing Industry

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Abstract— The purpose of this research work is to analysis and improved the overall equipment effectiveness of the small-scale industry because now days central as well as state governments are trying to solve the unemployment problem through the SMEs hence lots of other issues also faced by SMEs but in this work, it tries to improve the production and reduced the waste by an effective maintenance technique. For this agenda a PVC garden tube manufacturing industry is selected for the implementation of effective maintenance method with the help of literature survey, it's found that the mobile maintenance is the best suitable maintenance methods for the SMEs because it does not require special skill and resources to implement it. To validate the effectiveness of the mobile maintenance SMEs situated in Maneri 38.5 KM away from the Jabalpur is selected. For this research work two months May and June is selected and May month is used for analyzing the OEE before implement mobile maintenance and June for after mobile maintenance. The implementation of mobile maintenance does not require so many things and every worker easily understand the procedure. The outputs of the OEE three key performance factors are very good and this will give the so many benefits to the industry by increasing the production and great reduction in rejection.

Keywords:— Small Scale industry; Mobile Maintenance, Overall Equipment Effectiveness, Availability, Performance efficiency and quality rate.

1. INTRODUCTION

The center and state governments in India are focusing on strengthening the SME's sector because they know that SME's have enough potential to solve the unemployment problem and also support the economy of the country. This can be seen from the many schemes run by the central government as well as state governments like Pradhan Mantri Swarojgar Yojana, Atma Nirbhar Bharat etc. Due to this, existing small-scale businesses try to upgrade their business and lots of new small and medium scale industries are rising. Therefore, with the help of government support MSME market size is increasing day by day. The proof of this hike is that, now in India 6.3 crore MSME's are running. The Udyam Registration (MSME portal) registered 5,767,734 MSME's. The top 5 leading states are Maharashtra, Tamil Nadu, Gujarat, Rajasthan and Uttar Pradesh.

According to the provisions of Micro Small & Medium Enterprises Development (MSMED) Act 2006 the Micro, Small and Medium Enterprises MSME) are classified in two classes i.e. Manufacturing Enterprises and Service Enterprises. The enterprises we

further categorized based on investment in equipment and annual turnover.

Table 1: MSME’s Classification (Source MSME web site)

Criteria	Manufacturing		Service	
	Turnover	Investment	Turnover	Investment
Micro	Rs 5 crore (US\$ 0.6 million)	Less than Rs. 25 lakh (US\$ 0.03 million)	Rs 5 crore (US\$ 06 million)	Less than Rs 10 lakh (US\$ 0.01 million)
Small	Rs. 50 crore (US\$ 6.8 million)	More than Rs. 25 lakh (US\$ 0.03 million) but less than 5 crore (US\$ 0.6 million)	Rs. 50 crore (US\$ 6.8 million)	More than Rs 10 lakh (US\$ 0.01 million) but less than Rs 2 crore (US\$ 0.3 million)
Medium	Rs. 250 crore (US\$ 34 million)	More than Rs 5 crore (US\$ 0.6 million) but less than Rs.10 crore (US\$ 14 million)	Rs. 250 crore (US\$ 34 million)	More than Rs 2 crore (US\$ 0.3 million) but does not exceed RS 5 crore (US\$ 0.6 million)

1.2 The objective of MADHYA PRADESH MSME department

1. To produce the consumer products at reasonable cost by taking advantage of strategic geographical location of the State.
2. Balanced & integrated growth of the State.
3. To attract more Domestic & Foreign investments in the State in comparison to other States.
4. To create ecosystem for value addition in herbal, medicinal and other forest produces available in the State.
5. To generate more job opportunities and self-employment for youth of the State.
6. To setup maximum industries of priority /high priority categories.
7. To facilitate economic empowerment of the entrepreneurs belonging to weaker sections, SC/ST communities, Ex-Servicemen and women entrepreneurs.

8. To facilitate for training of the local youths as per the requirement of the local industries.
9. To attract more investments in the sunrise industries such as textile, pharma, robotics, artificial intelligence, IT & biotechnology and in the field of non- conventional energy generation.
10. To ensure judicious exploitation of available mineral resources.
11. To promote modern technique of farming, food processing and ware housing of food grain in the far-flung area of the State.
12. Overall Economic Development of the State.
13. Special incentives for investment in Non-Polluting industries.
14. To promote exports from the State.
15. Environmental Conservation.
16. To promote Gems & Jewelry industry.
17. To develop logistics facilities in the State.



Figure 1: Madhya Pradesh MSME Vision

1.3 Total Productive Maintenance

TPM is a Japanese concept or philosophy. TPM has been developed on the basis of productive maintenance concepts and methodologies. This concept was first introduced by M/s Nippon Denso Co. Ltd. of Japan, a supplier of M/s Toyota Motor Company, Japan in the year 1971. TPM is an innovative maintenance approach used to optimize equipment effectiveness eliminates breakdowns and promotes autonomous maintenance by involving total workforce (Bhadury, 2000).

As the name implies Total Productive Maintenance, its three words consist of following meaning:

- **Total:** This word implies for all the areas and aspects of the organization. It means total involvement of top to bottom men, department and resources.
- **Productive:** This word emphasis the continuous growing production with very less defects and waste in all manner of production or manufacturing.
- **Maintenance:** All the equipment's are in well maintain position and provide their services without extra idle or lead time due to breakdown.

Total productive maintenance has some key performance indicators by which any industry can understand the overall goal of the TPM and these key performance indicators are define in short form that is "PQCDSM". These are known as productivity (P), quality (Q), cost (C), delivery (D), safety (S) and morale (M) [Diky Herdiawan, Erry Rimawan,. (2020). Analysis of the Pilar TPM Effect on Productivity to Improving The Competitiveness of Textile Industries in Indonesia. International Journal of Advanced Science and Technology, 29(7s), 5256-5268].

Table 2: TPM KPI

KPI	Target(s)
P-Productivity	80% minimum OPE (Overall Performance Efficiency). 90% OEE (Overall Equipment Effectiveness)
Q- Quality	90% reduction in process defect rate. 75% reduction in customer returns/claims.
C-Cost	30% production costs reduction.
D-Delivery	50% reduction in finished goods and Work in Progress (WIP)
S-Safety	Zero shutdown accidents. Zero pollution incidents. Zero accident environment
M - Morale	5 to 10 times up employee improvement suggestions. Develop Multi-skilled and flexible workers.

1.4 Utkarsh Polyworld PVC Garden Tube Manufacturing Industry Profile

Utkarsh Polyworld, PVC Garden Tube manufacturing industry is situated at sector-B, Industrial Area Maneri, Mandla (M.P.). At Maneri numbers of small, medium and larger industries are situated. Utkarsh Polyworld, PVC Garden Tube manufacturing industry was established as on 06/04/2015. After all these circumstances company always strives to provide consistent quality product and provide good customer services with maintaining high level of customer satisfaction.

Table 3: Overview of Company

Turnover	1.5. Crore
Employees	8
Organization	Structured
Quality Systems	ISO Certified, Not Implemented
Marketing Network Well Developed	Well Developed
Customers	Police housing cooperation, local dealer

PVC garden tube manufacturing Process

PVC garden tube manufacturing machine is used High-Density Polyethylene as raw material, oil as lubricant and color for the manufacturing of tubes.

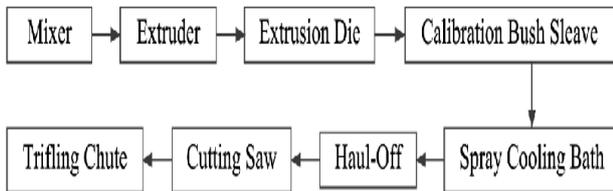


Figure 2: Flow chart of PVC Garden Tube Machine

Manufacturing steps are as follows:

Mixer & Grinder:— In mixer and grinder HDPE, oil and color are mixed uniformly and 10:10:5 quantity ratio is taken.

Extruder & Extruder Die:— Mixed raw material 100 KG quantity is feed to the hopper and with the help of heater and blower this raw material is heated and with the help of extruder it pushed towards the extruder die where the diameter and thickness of the pipe is set. After that tubes shape is goes to the water cool spray machine for cooling and straightening purpose.

Spray Cooling Bath:— Tube is manufacture in the extruder but in extruder it's in a semi solid condition due to 140°C temperature. To cool down it in normal temperature a water spray cooler is used.

Cutting Saw & Trifling Chute:— Ready tube is come out from the cooler is going to the cutting saw where according to the 100 ft length cutting saw cut ie and trifling chute rolled it in a bundle.

Plant Capacity

- Working days in a year: 300
- Working hours/day: 9 (1 shift)
- Lunch Break (Meal + Tea): 45 minutes
- Raw material tentative requirement: 180 Ton per annum
- Annual Production capacity: Ø 1/2 inch.

PVC Tube: 60 Ton per annum.

- Annual Production capacity: 0 3/4 inch. PVC Tube: 60 Ton per annum.
- Annual Production capacity: 01 inch. PVC Tube: 60 Ton per annum.

Raw Material

The main raw materials required for manufacturing PVC garden tube are HDPE, oil and color (180 MT per annum).

Infrastructure

- The basic infrastructure required is:
- Land: 18,000 sq.ft.
- Building: 12,000 sq.ft.
- Power: 30 KW
- Water: 1,000 Ltr. Per day.
- Manpower: 9 Nos. [Administrative (3), Factory Staff (3), Helper (3)]

2. LITERATURE REVIEW

2.1 Maintenance Actions in SME's

To understand the maintenance approach of the SMEs placed in Maneri Mandla district an interview was done with local SME's owner and it find out that don't have proper maintenance approach for their equipment's.

There are number of maintenance methods are available but most of the local SMEs are not aware of them. Following are the maintenance methods are as follows:

- Breakdown Maintenance
- Preventive Maintenance
- Predictive Maintenance
- Corrective Maintenance
- Maintenance prevention
- Reliability-centered
- Productive Maintenance
- Computerized Maintenance
- Total productive Maintenance

This literature survey is given us a term, known as overall equipment effectiveness which is come under the category of one of the TPM pillars that is mobile maintenance.

Table 3: Literature Survey on TPM Implementation

References	Findings	ImPLY
Karanbir Singh Sandeep Singh (2018)	Above stated information depicts that the implementations of Total Productive Maintenance (TPM) has significantly increased the effectiveness of equipment as observed by the author from 2 to 8 percent TPM also helps to decrease the downtime of associated workstations from 7 to 22 minutes. The rejection rate of all workstations slightly reduces to 22 to 33 ton per day and setup also came down 2 to 6 minutes per day.	TPM Implement ation in SME
Zhang Tian Xing Chin Jeoh Feng (2020)	The OEE was 66.90% improved from 54.23% hence meeting the target for 2020. Nevertheless, further improvements were planned on Quench A and Quench B to lift their OEE to the baseline of 65% of the six major losses, equipment setup was tackled through focused improvement, contributing significant improvement to OEE	TPM Implement ation in SME
Swapnail Raut and Nivati Raut (2017)	After implementation of TPM on the model machine i.e. BDR-01 OEE is recalculated. The OEE is increase in availability and performance of the model machine.	Enhance OEE in Medium Scale Industry
A Satish, S Rajmohan (2018)	Despite of having legendary excellence in small scale industry Indian MSME is yet to develop in order to reduction of poverty and unemployment in India. As per the details discussed in this paper, the MSME had undergone several changes and advancements.	MSME in India what went before
Abhishek Jain, Rajbir Singh (2014)	In this study, researchers have examined relevant issues in the field of TPM implementation manufacturing organizations Researchers have classified all the 148 articles published from 1988 to 2014 year wise Researchers analyzed these classified articles. The comparative report shows that SMEs are lacking to adopt improvement philosophies like TPM, especially in India otherwise sustained survival of these industries in future will be very difficult in this competitive environment	TMP Implement action

2.2 Mobile Maintenance SME's Aspect

As the name implies mobile maintenance, mean maintenance process is movable in the production area. To understand the meaning of mobile lets first understand the maintenance process procedure.

Mobile maintenance method benefits are:

- This maintenance method is best suitable for small shop floor area.
- Maintenance person can also train the machine operator so that the machine is running in good condition because of well maintained by

operator.

- Mobile maintenance person has done preventive maintenance at some time interval hence idle or breakdown time will prevent.
- The coordination between the machine operator and maintenance person is increased and helpful in overall improvement.
- This maintenance method is very economic because very few people required for maintenance purpose.
- In this method maintenance person can check the machine at any time hence downtime of machine is reduced.

- Make sure the availability of spare parts and machine all the time.
- Increase reliability and reduce maintenance cost.
- Reduce near to zero equipment failure and breakdown.
- Direct or indirectly reduce overall cost of production.

2.3 Overall Equipment Effectiveness on SME

OEE is considered as the most efficient and effective tool (McKone et al., 1999) for driving plant improvement and it continuously focuses the plant on the concept of zero waste. The mobile maintenance is applied in “Utkarsh Polyworld” plastic water tank manufacturing small scale industry to improve the overall equipment effectiveness and if the results are positive than it can be useful for maximum SME’s Situated in Jabalpur district SME’s because this result will get the confidence to the other SME; s too.

OEE formulas

A - availability of the machine. Availability is the proportion of time machine is actually available out of time it should be available:

$$\text{Availability} = \frac{\text{Valuable Operating time}}{\text{Available Operating time}}$$

Valuable operating time is the operating time + break downtime; operating time is the total production/capacity per hour; available operating time is the total time available for production.

PE, performance efficiency – the second category of OEE is performed. The formula can be expressed in this way:

$$\text{Performance Rate (Speed)} = \frac{(\text{Cycle time} \times \text{Nos. of Final Goods processed})}{\text{Valuable Operating time}}$$

Cycle time is the time taken to producing one unit; Cycle time is equal to 1/Capacity per hour.

Q-refers to quality rate, which is the percentage of good parts out of total produced sometimes called yield. We can express a formula for quality like this:

$$\text{Quality (Yield)} = \frac{(\text{Total Production} - \text{Rejection})}{(\text{Total Production})}$$

3. AIM OF THE RESEARCH

The main aim of this research is to reduce product defects, reduce downtime, reduce scrap and increase productivity by applying good maintenance method. At present maximum SMEs are having only single unit production machines and this will become problem when single production machine shut down due to some problem and SME’s lacking in completing target due to which they are having financial losses. These major problems are arising due to poor maintenance approach of the industry.

There are lots of maintenance methods are available but very few of them suitable for SMEs because SMEs has very limited resources and also has financial constraints. Therefore, in this research main objective is to find out the best maintenance approach by which SMEs can solve are their problems written in starting of this topic.

To achieve the above target in this study one of the TPM pillar is used for solving the maintenance issues in SME’s by applying “Overall Equipment Effectiveness” through Mobile Maintenance in Utkarsh Polyworld PVC garden tube manufacturing industry.

4. PROBLEM STATEMENT

After the detail literature survey and discussion with experts it’s found that the SMEs are facing maintenance issues. Downtime, breakdown and idle time are the major issues in the SMEs. Therefore, in this thesis main focus is given to the maintenance method. The case study has to be conducted in a PVC garden tube manufacturing industry situated in Maneri at district Mandla. The production and culture of this industry is very similar to other SMEs of plastic product industry because raw material is similar and the manufacturing method that is extrusion is also same.

The main problems are faced by “Utkarsh Polyworld PVC tube Manufacturing industry” related to maintenance are as follows:

- Industry doesn't have proper method to calculate the performance of the industry.
- The industry is having only one production machine and if any issues come with the machine whole production is stop, therefore must need a best maintenance method.
- The industry doesn't have proper maintenance method, therefore to trained in suitable maintenance method like the "Mobile Maintenance" and "Over All Equipment Effectiveness" is one of the big tasks.

5. RESEARCH METHODOLOGY

The goal of this research work is to provide a very effective maintenance method to Utkarsh Polytenk Plastic water tank manufacturing industry and at the same time to increase the overall equipment effectiveness of the production machines. To achieve the above written goal a research block diagram is prepared that will give the at a glance view of the work.

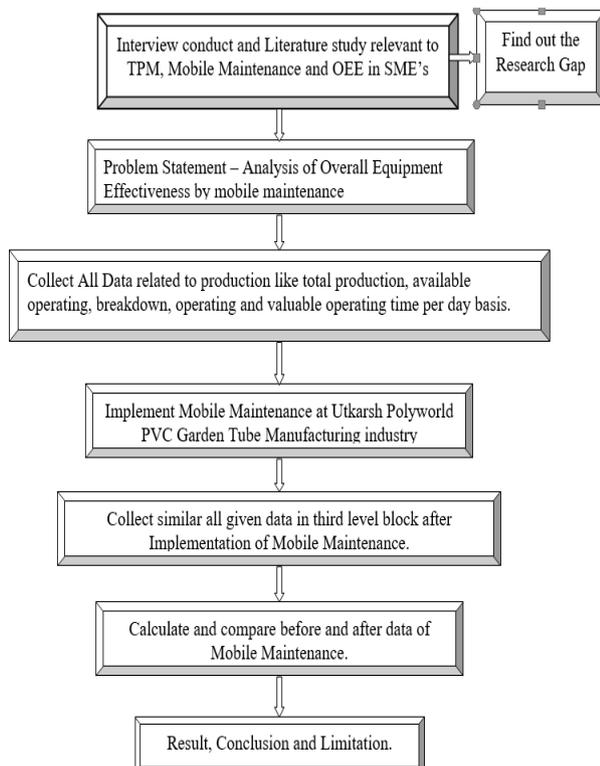


Figure 3: Research Structure

5.2 Data Collection

The collected data were analyzed and it's found that the industry is not working as per standard. For collecting the data researcher have visited 20 times to the industry. In these 20 days, 5 days were consumed for training of mobile maintenance and remaining 15 days to observe and collecting the data after implementation of mobile maintenance. To collect the data before and after implementation of mobile maintenance following steps are used:

- Monitor the complete production process from raw material feeding, tube extruding, tube cooling and cutting and after that maintenance process note down the time required and procedure.
- Write down the all data of production, maintenance and breakdown time for the month of May 2021 and June 2021.
- Conduct a seminar on mobile maintenance for all workers and taught them the mobile maintenance and overall equipment effectiveness.
- Encourage all the person of the industry from top to bottom to apply mobile maintenance and after training 20 days are continuous to apply mobile maintenance.
- After that equipment effectiveness are compared before and after implementation of mobile maintenance.

5.3. OEE Key Performance Measurement

To increase the OEE, there is requirement to concentrate on the main three performance measurement of the OEE, which are as follows:

- Availability
- Performance Efficiency
- Rate of Quality

Table 4: OEE 6 Main Factors

Overall Equipment Effectiveness	Recommended Six Big Losses	Traditional Six Big Losses
Availability Losses	Unplanned Stops	Equipment Failure
	Planned Stops	Setup and Adjustments
Performance Losses	Small Stops	Idling and Minor
	Slow Cycles	Reduced Speed
Quality Losses	Production Rejects	Process Defects
	Startup Rejects	Reduced Yield

6. OBSERVATION OF MACHINE PERFORMANCE AND MOBILE MAINTENANCE PROCESS

Utkarsh Polyworld Plant production manager has given the all-relevant data required for the calculation of OEE. The data received are as follows:

- Working days in a year: 300
- Working hours/day: 9 (1 shift)
- Lunch Break (Meal + Tea): 45 minutes
- Raw material tentative requirement: 180 Ton per annum
- Annual Production capacity: Ø 1/2 inch. PVC Tube: 60 Ton per annum.
- Annual Production capacity: Ø 3/4 inch. PVC Tube: 60 Ton per annum.
- Annual Production capacity: Ø 1 inch. PVC Tube: 60 Ton per annum.

Below given the manufacturing steps of producing 100 KG PVC Garden tube:

Table 5: PVC Garden Tube Production Steps

Steps	Process	Time Required
Step 1	Prepare 4 Buckets of Raw Materials 25Kg Each	40 Minutes
Step 2	Producing Time, Stencilling and Packing	20 Minutes
	Total Time	60 Minutes

7. MOBILE MAINTENANCE PROCESS

To analysis and improve the OEE of the industry, mobile maintenance procedure is adopted and according to it some steps are involved in maintenance procedure are as follows:

The manufacturing process is start from the grinding machines in which raw material is prepared. To prepare the raw material worker need to put the 10Kg PVC, 10 liters oil and 55 Kg in a bucket and before putting this mixture in grinder first grinder operator need to clean and check the grinder properly. To perform this operation first worker, need to arrange all the required tools to collect from tool room and take the prepare bucket from raw material side after that operator done his task. In this process its observed that the tool and raw material arrange from the 20ft away from the grinding machine. In between the arrangement process grinder operator in idle position.

Mobile maintenance trolley has all the required tools and spare parts, therefore operator don't need to go tool room for collecting tools and spare parts. Same trolley is used for grinder machine and also for extruder machine.

With the help of maintenance trolley operator can check the running extruder machine and perform inspection operation, in the same time the raw material is prepared in grinder. Therefore, in the manufacturing process operator alone can check the both machine visa-versa for maintenance purpose.

8. COMPUTATION OF THREE KEY PERFORMANCE MEASUREMENTS

Total production:— Total production mean quantity of raw material utilized to produce finished product.

Final products:— Final products mean finished products available after the rejection.

Available operating time:— Available operating time means actual time available per day after removing the lunch, tea and shift change time.

Breakdown time:— This is the downtime that is caused by the equipment failure. This time start from the time of failure of the machine to the running again of the machine.

Operating time:— It is the ratio of the total production to the capacity per hour.

Valuable operating time:— It is the addition of the operating time and breakdown time.

Calculation formulas of three key performances measurement are as follows:

Availability:— It is the ratio of valuable operating time to the available operating time.

$$\text{Availability} = \frac{\text{Valuable Operating Time}}{\text{Available Operating Time}}$$

Performance efficiency:— It is basically defining the actual production efficiency of the machine and it can be expressed in formula:

$$\text{Performance efficiency} = \frac{(\text{Cycle Time} \times \text{Nos. of final product processed})}{\text{Valuable operating time}}$$

Quality Rate:— It is the ratio of percentage of good parts out of the total produced.

$$\text{Quality (Yield)} = \frac{(\text{Total Production} - \text{Rejection})}{\text{Total Production}}$$

8.1. Calculation Of OEE For PVC Garden Tube Machine (Monthly Basis) Before Mobile Maintenance: -

Table 6: Measurement of Overall Equipment Effectiveness

S.No.	Monthly Production Factors for The Calculation of "OEE"	Before Mobile Maintenance (January Month)
	Production Factors	Production Data Values
1	Total Production	15000 Kg
2	Total Rejection	800 Kg
3	Finished Products	14200 Kg
4	Available Operating Time	225 Hour - 25 Hour = 200 Hours
5	Breakdown Time	42 Hours
6	Operating Time	200 Hour- 42 Hour= 158 Hours
7	Valuable Operating Time	158 Hour+ 42 Hour = 200 Hours

8.2. OEE Key Performance Calculation before Mobile Maintenance: -

$$\text{Availability} = \frac{\text{Operating Time}}{\text{Available Operating Time}}$$

$$\text{Availability} = \frac{(158 / 200) \times 100}{100} = 79.00 \%$$

$$\text{Performance efficiency} = \frac{(\text{Cycle Time} \times \text{Nos. of final product processed})}{\text{Valuable operating time}}$$

$$\text{Performance efficiency} = \frac{(.01 \times 14200)}{200} \times 100 = 71.00 \%$$

$$\text{Quality (Yield)} = \frac{(\text{Total Production} - \text{Rejection})}{\text{Total Production}}$$

$$\text{Quality (Yield)} = \frac{(15000 - 800)}{15000} \times 100 = 94.66 \%$$

8.3. OEE Key Performance Calculation After Mobile Maintenance:-

Table 7 : Results from OEE of PVC Tube Manufacturing Machine before and after Mobile Maintenance

S.No.	Monthly Production Factors for The Calculation of "OEE"	Before Mobile Maintenance (January Month)	After Mobile Maintenance (January Month)
	Production Factors	Production Data Values	Production Data Values
1	Total Production	15000 Kg	15000 Kg
2	Total Rejection	800 Kg	410 Kg
3	Finished Products	14200 Kg	14590 Kg
4	Available Operating Time	225 Hour- 25 Hour = 200 Hours	225 Hour- 25 Hour = 200 Hours
5	Breakdown Time	42 Hours	30 Hours
6	Operating Time	200 Hour - 42 Hour = 158 Hours	200 Hour - 30 Hour = 170 Hours
7	Valuable Operating Time	158 Hour + 42 Hour = 200 Hours	170 Hour + 30 Hour = 200 Hours

Availability = Operating Time / Available Operating Time

Availability = (167 / 200) X 100 = 83.50 %

Performance efficiency = (Cycle Time X Nos. of final product processed) / Valuable operating time

Performance efficiency = {(0.01 X 14590) / 200} X 100 = 72.95 %

Quality (Yield) = (Total Production - Rejection) / Total Production

Quality (Yield) = {(15000 - 410) / 15000} X 100 = 97.26 %

9. OEE IMPROVEMENT

Table 9: OEE Improvement Table

S. No.	OEE Key Performer	Before Mobile Maintenance (January Month)	After Mobile Maintenance (February Month)	OEE Improved
1.	Availability	79.00%	83.50%	4.5
2.	Performance efficiency	71.00%	72.95%	1.95
3.	Quality Rate	94.66%	97.26%	2.6

After the implementation of mobile maintenance, OEE is improved and this improvement can be seen from the below table and the graph:

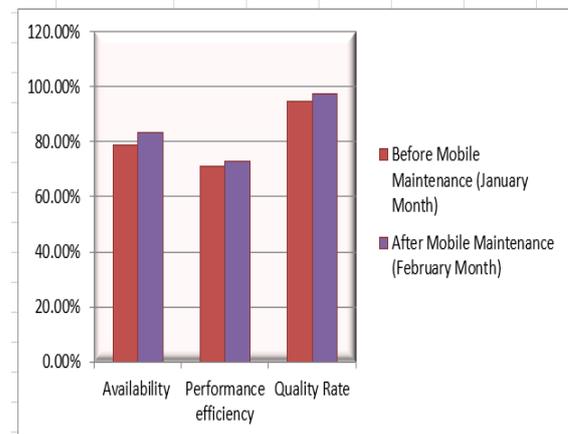


Figure 4: OEE Progresses Before & After Mobile Maintenance

9.1. Results from OEE on Break down Time

The breakdown and idle time are the big issues in PVC garden tube manufacturing industry because before production starting this machine needs to preheat for 2 hours and if there is any power cut in between the production process for 30 minutes to an hour machine again need to preheat for an hour.

Table 10: Breakdown Time Comparison

S. No.	Production Factors	Before Mobile Maintenance (January Month) (In Hour)	After Mobile Maintenance (February Month) (In Hour)
1.	Breakdown Time	42	30

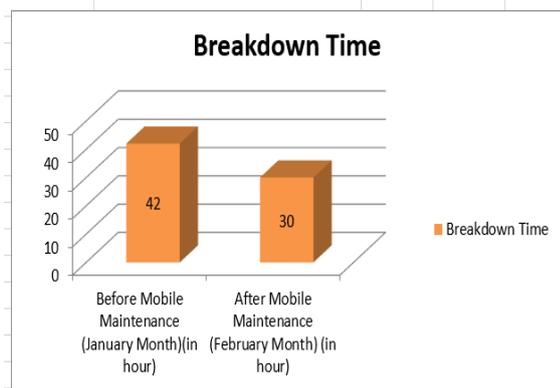


Figure 5: Breakdown Time Before & After Mobile Maintenance

10. CONCLUSIONS

This thesis work shows, that the mobile maintenance and little time saving changes in the working area can give the improved OEE. Before and after implementation of mobile maintenance for the duration of one month that is May and June gives very good results. The availability, performance efficiency and quality rate are very effectively improved by 4.5%, 1.95% and 2.6%. Breakdown is also reduced by 12 days from 42 to 30 days and this reduction in 12 days will also reduce the rejection about 50%. This reduction in rejection will improved the OEE three key performance areas.

All the improvements are shown with the help of graph in figure 9.1 and 9.2.

Therefore, this thesis work proved that the mobile maintenance is very appropriate maintenance method for the growth and ease of work for the small and medium scale industry.

11. LIMITATION

This research was conducted on a small-scale PVC garden tube manufacturing industry situated Maneri industrial area at district Mandla, which has only one extruder and grinder machine, cooling chiller and very limited resources therefore changes made as per the manufacturing procedure. Hence most of the changes and calculations are same for other industry but geographic and local factors of other industries may be different

therefore all the changes are not suitable for other industries. Mobile maintenance definitely improved the OEE but its implementation changes as per the machinery, man power and product of the industry.

12. FUTURE SCOPE

As its seen from the results that the OEE increase with the help of mobile maintenance but the work is not give individual concern to the six big losses those come under the three key performance factors. Therefore this is the big area available for the future work because by focusing those six losses major improvement will get the organization.

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