



OEE Improvement by Implementation of Mobile Maintenance in Small Scale Plastic Water Tank Manufacturing Industry

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ABSTRACT

The purpose of this thesis is to implement a new concept of maintenance that is Mobile Maintenance in SME's instead of a traditional maintenance method. To apply and analysis the benefits of mobile maintenance, this concept is implement in small scale industry Utkarsh Polyworld Water Tank manufacturing industry. The need of this concept is to improve the overall equipment effectiveness and reduce the breakdown and the rejection. Therefore in this thesis before and after implementation of mobile maintenance, OEE is calculated. The results are very effective and the changes are setup in industry was very simple and not affected the ease of the worker but with the help of this new maintenance approach industry worker are very comfortable and also improve their productivity. This method also help the industry a confidence to achieve their target because they are well aware about the effectiveness of the manufacturing machine and also confident about their machine working without any breakdown.

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

I. INTRODUCTION

Design/methodology/approach—The design of this thesis is mainly concern with problem faced by the SME's in maintenance time. It means the most of the SME's have only one man production machine and if that machine will not work effectively the industry is very seriously suffered economically and productively. Therefore to solve this issue researcher find a best solution with the help of literature survey and the solution is mobile maintenance concept which is very simple and effective. To adopt and implement this concept researcher trained the concern persons in 5 days and implement mobile maintenance concept within 10 days after that an analysis have been done before and after implementation of mobile maintenance.

Practical implications – This thesis work is very effective and functional for owner because its implementation does not required special recourses and training but only need a heartily participation and consistency. The mobile maintenance method drastically improves the overall equipment effectiveness.

In today scenario small and medium scale industries are facing competition from similar or giant industries. Therefore the SME's are trying different type of

industrial tools to enhance their productivity and profit by using their limited resources. The SME's are now mainly utilized some lean manufacturing methods because these methods mainly helpful in reducing the defects, wastage and accidents but at the same these SME's are not focusing on their maintenance and operations departments. The maintenance and operations departments are the biggest, and each includes 30 percent of the total manpower and also energy costs, maintenance costs can be the major part of any operational budget due to this SME's are not able to achieve as much as profits after adopting the so many industrial tools and concepts. The character of maintenance in SME's manufacturing systems is becoming even more significant to companies implementing the maintenance as a profit generating trade element.

Madhya Pradesh state is now growing rapidly in SME's sectors and provides so many help to them. Madhya Pradesh state having enough resources but due to the lack of expert knowledge, lack of adoption of industrial good practices, SME's situated in Madhya Pradesh are not growing well. Therefore in this research work with the help of literature survey and expert's opinion and effective tools is find out and applied in one of the SME's to validate the results and convert the maintenance issues in profitable business. For this purpose 'Total Productive Maintenance' is an industrial method study and will apply one of its pillar to solve SME's maintenance problems.

As all of the some facts above, there were many employees unwilling to work long term as was the relationship with the employees working in Utkarsh Poly Tank manufacturing factory. To change this awful condition, it was decided to implement a 5S system within the factory.

What is 5S? 5S may be the first step for the company to embrace Lean; this study will focus on 5S. 5S stands for five different characters which are sort, set in order, shine, standardize, and sustain.

The 5S system is a tool, or system that supports a philosophy of operating in an organized fashion. The philosophy that this system supports is one of discipline, efficiency, and attention to detail (Graban, 2009). The idea behind 5S is that if a workplace is clean and well laid out, the identification of waste is much easier (Sarkar, 2005). Most of the manufacturing companies in Taiwan do not run 5S, or they do not even know what 5S is. 5S is a way to help the company to reduce the waste and enhance possible profits.

Introduction to SME

From the last seven decades the MSME has emerged as a highly vibrant and dynamic sector of the Indian economy. It provides a big help against the unemployment problem with lower capital cost and also it reduces the problem of rural and backward areas by providing employment and launched their local products to the market. It also provides the big help to the large industry to achieve big production targets and also it participates immensely to the socio-economic development of the country. In India, before the starting of Micro, Small and Medium Enterprise Development (MSMED) Act, 2006, only traditional industries like coir, khadi and silk, Small Scale Service and Business Enterprises (SSSBEs), Small Scale Industries (SSIs), Cottage and Village Industries. It is all generally known as Small Scale Industries (SSI).

The MSME Act, 2006 included the all different industries and also included the service sector and medium enterprises.

Now a day, the MSME sector in India is mainly classified into two categories such as manufacturing and service industry. Based on their investments made in plant and machinery or equipment it is further classified as micro, small and medium enterprises. In Indian economy, the MSME become very important sectors for state governments because it significantly contributes in exports, new employment generation and entrepreneurship development, startup development. According to estimates of Ministry of MSME, it contributes around 30% to the total GDP of the country and in terms of exports; they are an integral part of the supply chain and contribute about the 40% of the overall exports.

IV. OVERVIEW OF 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 imply 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 equipments are in well maintain position and provide their services without extra idle or lead time due to breakdown.

Mobile Maintenance Concept

It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. Researcher proposed a TPM model in which mobile maintenance has got the place along with maintenance planning and that pillar rename as maintenance planning and mobile maintenance as shown in Figure 1. Maintenance may be preventive, breakdown, corrective, etc. pillar of maintenance planning consist two things, first is to plan the maintenance schedule in advance and second is which types of maintenance required for different types of failure in the organization. Now-a-days, Mobile maintenance is the new concept which is adapted especially by SMEs. Most of the SMEs is having fewer numbers of machines which requires very less maintenance as compared to large industries. Breakdown, corrective, preventive and other types of maintenance program are suited for large industries but SMEs needs less maintenance as compared to large industry.

This mobile maintenance concept requires a few numbers of maintenance person with a trolley in which some important tools, standard size nuts and bolts, screws, oils, grease, brushes, safety cloth and spanners and important spare parts, etc. These maintenance personals along with trolley are moving on the floor to do oiling, greasing, cleaning of machines regularly and also to do maintenance of machines so that unplanned downtime of machines will reduce. Mobile maintenance is a very important strategy, especially in SMEs. Shop floor area of SMEs is small, so that this maintenance team can check and

maintain each and every machine easily (Abhishek Jain & Rajbir Singh Bharti; OEE enhancement in SMEs through mobile maintenance: A TPM concept Article in International Journal of Quality & Reliability Management ·International Journal of Quality & Reliability Management Vol. 32 No. 5, May 2015).

Policy of mobile maintenance:

1. Achieve and sustain the availability of machines;
2. Indirectly optimize maintenance cost;
3. Improve reliability and maintainability of machines; and
4. Reduce unplanned or unscheduled downtime of machines.

Target of mobile maintenance:

1. Zero equipment failure and zero breakdowns;
2. improve reliability and maintainability by 50 per cent;
3. reduce maintenance cost by 20 per cent;
4. Increase productivity and quality of products; and
5. Ensure availability of spares all the time.

V. OVERALL EQUIPMENT EFFECTIVENESS

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 these result will get the confidence to the other SME;s too. The calculation of OEE is performed by obtaining the product of availability of the equipment, performance efficiency of the process and rate of quality of products (Ljungberg, 1998; Dal et al., 2000) which may be expressed as:

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:

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

Figure: 2.1 OEE formulas

VI. LITERATURE REVIEW FRAMEWORK

It is observe at the time of interview with local SME’s don’t have proper maintenance schedule for their machines. From the interview it’s found that most of the SME’s are conducted maintenance operation only two times one at the overhauling time second at the time of breakdown. SME’s are mainly focused to achieve their production target and maintenance and safety concern will ignore and this negligence become sever from economic point of view and

safety point of view. 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

References	Findings	ImPLY
Karanbir Singh, Sandeep Singh (2018)	Above stated information depicts that the implementation 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 to 2 to 6 minutes per day.	TPM Implement ation in SME
Zhang Tian Xiang , Chin Jeng 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
Swapnil Raut1 and Niyati Raut2. (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 in 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.	TPM Implement ation

VII. PROBLEM STATEMENT

In this research work, a case study has been conducted in a plastic water tank manufacturing industry situated in Maneri at district Mandla. The working pattern and culture of this study is very similar to other plastic product industry because raw material is similar and the manufacturing concept that is extrusion and induction moulding process is also same.

After the detail literature survey and interview with industrialist and company owner it's found that these SME's are not follow and maintenance methods in their plant. Due to this they are facing so many big and small issues related to maintenance work. Therefore in broad sense it's found that these SME's are lacking in maintenance area. The main problems are faced by "Utkarsh Polyworld Plastic Water Tank Manufacturing industry" related to maintenance are as follows:

- Industry doesn't have proper maintenance procedure.
- The industry is lacking in the availability and reliability of the main roto mould induction machine, which is the only production machine in the plant.
- The industry doesn't have the proper knowledge about the "Mobile Maintenance" and "Over All Equipment Effectiveness" and also doesn't have the statics about the maintenance work.
- The above written all three point clearly define the problem faced by the industry. Therefore this research work is further followed by the research methodology which will provide the solution of these problems.

VIII. RESEARCH STRUCTURE

The goal of this research work is to provide a very effective maintenance method to Utkarsh Polytank 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. Planned research block diagram will help the proprietor of Utkarsh Polytank to easily understand the research work and at the same time aware about the terminology used in the work and role of the each technical word.

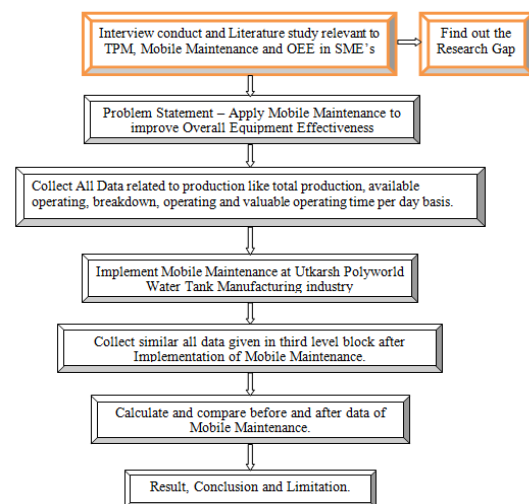


Figure 7.1 Research Flow Chart

IX. DATA ANALYSIS AND FINDINGS

9.1 Observation of Machine Performance and Mobile Maintenance Process

For the calculation of OEE, the whole production data from the starting to the end of the manufacturing of the water tank is taken from production manager and data collected in a paper and arrange it as per the requirement. The data collected 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: 78 Ton per annum
- Annual Production capacity: 500 liters. Tank: 7200 pieces.
- Annual Production capacity: 750 liters. Tank: 3600 pieces.
- Annual Production capacity: 1000 liters. Tank: 3600 pieces.

Following are the steps follows in the manufacturing of producing one plastic water tank of 500 Liter capacity are given in below table:

Table 5.1. Water Tank Manufacturing Steps Timing

Steps	Process	Time Required
Step 1	Installation of Mould & Filling of Raw Material	20 Minutes
Step 2	First Layer Preparation	10 Minutes
	Second Layer Preparation	5 Minutes
	First Layer Preparation	10 Minutes
Step 3	Cooling of Mould	30 Minutes
Step 4	Removal of Water Tank From Mould	15 Minutes
	Total Time	90 Minutes

Calculation of Three Key Performance Measurements

Total Production :- 6500 kg

Total Rejection:- 220 kg

Final Products :- (6500 – 220 = 6280 kg)

Available Operating Time :- (240 hour – 23 hour = 217 hour)

Breakdown Time :- 30 hour

Operating Time :- (6500 kg / 36 kg/hour = 180.5 hour)

Valuable Operating Time :- (180.5 hour + 30 hour = 210.5 hour)

9.2 OEE Key Performance Calculation Before Mobile Maintenance:-

Availability = Operating Time / Available Operating Time

Availability = (180.5 / 217) × 100 = 83.17 %

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

Performance efficiency = {(0.027 × 6280) / 210.5} × 100 = 80.55%

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

Quality (Yield) = {(6500 – 220) / 6500} × 100 = 96.62%

9.3 OEE Key Performance Calculation After Mobile Maintenance

After Mobile Maintenance:-

Total Production :- 6500 kg

Total Rejection:- 110 kg

Final Products :- (6500 – 110 = 6390 kg)

Available Operating Time :- (240 hour – 23 hour = 217 hour)

Breakdown Time :- 22 hour

Operating Time :- (6500 kg / 36 kg/hour = 180.5 hour)

Valuable Operating Time :- (180.5 hour + 22 hour = 202.5 hour)

Availability = Operating Time / Available Operating Time

Availability = $(180.5 / 202.5) \times 100 = 89.13\%$

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

Performance efficiency = $\{(.027 \times 6390) / 202.5\} \times 100 = 85.2\%$

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

Quality (Yield) = $\{(6500 - 110) / 6500\} \times 100 = 98.30\%$

X. RESULTS FROM OEE OF MACHINE BEFORE AND AFTER MOBILE MAINTENANCE

This research work shows an improvement in three key performance factors of OEE by implementing the mobile maintenance for the comparison of the two months, one month before and one month after the implementation of mobile maintenance. The production data were collected for January month without mobile maintenance and February month with mobile maintenance. The comparison is shown in below table:

Table 10.1 OEE Improvement Table

S.NO	OEE Key Performer	Before Mobile Maintenance (January Month)	After Mobile Maintenance (February Month)	O E E Improved (In %)
1	Availability	83.17%	89.13%	5.96
2	Performance efficiency	80.55%	85.20%	4.65
3	Quality Rate	96.62%	98.30%	1.68

Table 10.2 Comparison Table of Before and After Implementation of Mobile Maintenance

Measurement of Overall Equipment Effectiveness			
S.N O.	Monthly Production Factors for The Calculation of "OEE"	Before Mobile Maintenance (January Month)	After Mobile Maintenance (February Month)
	Production Factors	Production Data Values	Production Data Values
1	Total Production	6500 kg	6500 kg
2	Total Rejection	220 kg	110 kg
3	Finished Products	6280 kg	6390 kg
4	Available Operating Time	217 hour	217 hour
5	Breakdown Time	30 hour	22 hour
6	Operating Time	180.5 hour	180.5 hour
7	Valuable Operating Time	210.5 hour	202.5 hour

These reductions greatly improve the OEE key performance factors and it can be easily seen from the OEE comparison table:

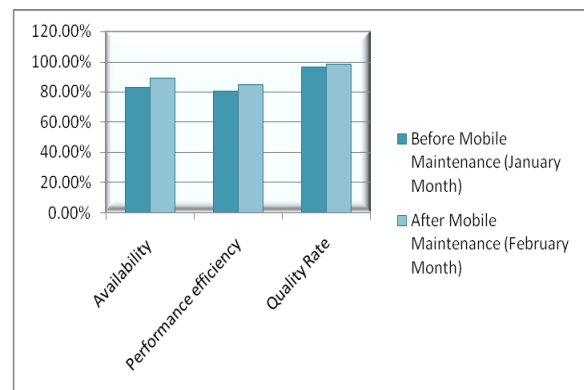


Figure 10.3 OEE Improvements Before & After Mobile Maintenance

XI. RESULTS FROM OEE ON BREAK DOWN TIME

In the observation of the production process of the industry it was found that the breakdown is the one of the big problem of the plant. The main causes of the breakdown are uneven cooling of the mould and the vibration of the machine due to improper fastening of the mould. By implementation of mobile maintenance in the industry the uneven cooling of the machine is controlled by the maintenance person by checking the temperature in between the process and at the same time the fastening and removing of mould is done very effectively in short time because the maintenance person has all the required instruments in one trolley. These small changes very effectively reduce the breakdown time its shown in the below graph:

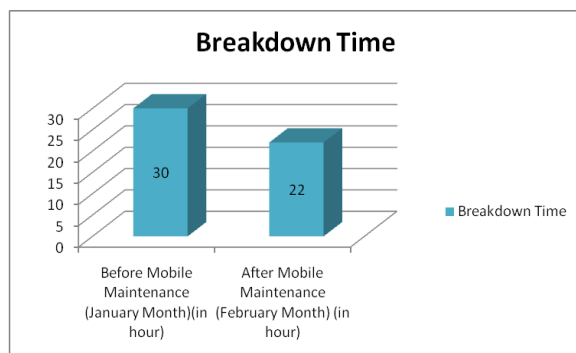


Figure 11.1 Breakdown Time Before & After Mobile Maintenance

XII. DISCUSSION OF MOBILE MAINTENANCE ON SME'S

With the help of this study on a SME's that have limited worker and resources can be achieve good OEE with the help of the mobile maintenance. In this study researcher has taken very small changes as per guidelines provided by the previous research work. In the duration of one month without disturbing the work in progress and also don't use the extra recourses,

researcher get the very good results. The availability, performance efficiency and quality rate is very effectively improved by 5.96%, 4.65% and 1.68%. These changes in the maintenance processes are as follows:

A trolley is provided with all the required tools and instruments to the machine and maintenance operator for installation and maintenance purpose.

Quality check and disassembly of mould take place near the machine just 10 feet away from the roto mould machine by which product handling and maintenance work take place in very short time due to which breakdown time reduce from 30 hour to 22 hour.

Temperature check and machine checking has been increased by three times that was only one time before mobile maintenance, therefore rejection is reduced and at the same time also reduce breakdown time.

XIII. CONCLUSION

Today, the optimum cost and quality concern of the product is playing a very important role to satisfy customers. Now a day's competition is increase day by day therefore to maintain the good quality with best profit and productivity, SME should essentially focused on their maintenance process and overall equipments effectiveness.

When machines are reliable to manufacture products of best quality than the product demand and company reputation will automatically increased. In this research work for maintaining machines, maintenance department are trained about mobile maintenance. This mobile maintenance method is the part of the improvement of the overall equipment effectiveness. This plastic water tank manufacturing industry has accepted this mobile maintenance and got the

improvement in the productivity by reducing breakdowns and rejection. The availability, performance efficiency, quality rate and OEE have increased by this new mobile maintenance concept. Researchers have concluded that OEE key performance factors of the industry will increase by implementing this mobile maintenance method and the comparison of before and after are shown in Table 9.2 and Table 9.3.

Without mobile maintenance method industry OEE key performance factors of machine was availability 83.17%, performance efficiency 80.55% and quality rate 96.62% and after implementation it has been increased by 89.13%, 85.20% and 98.30%

IVX. LIMITATION

This thesis work is conducted on a small scale plastic water tank manufacturing industry which has only one automated machine and cooling fan. There is no complex method involved in it and plant required very few man, machine and material. Hence the nature of industry not fit to all therefore for other small scale industry some parameters have changed. The observation process also not suit for all industry because in this industry no part processing required also no verity of operations involved. Therefore observation process and training process has to be adopting as per manufacturing process take place.

VX. FUTURE SCOPE

Due to covid-19 industry is not working fully for yearly in 2019 and 2020. Due to less Market demand and worker problem industry only provide data for full running month that was December and January. Therefore for comparison is done only for two months. If that analysis can be performed for the quarterly or half yearly basis, industry gets better result. So for

future scope point of view economic aspect can also be considered.

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