Effectiveness improvement of critical machines in a fabrication industry

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Abstract- Today the world is highly competitive. In order to be successful in today's world it is essential to be highly productive. Productivity can be improved in many ways. In this paper the scope for implementation of Overall Equipment Effectiveness (OEE) in a fabrication industry are presented. Using Overall Equipment Effectiveness one can determine the present condition of the machines, worker-skill and utilization of machine in the industry and also identify the scope for improvement. Two critical machines have been identified and studied and the results are presented.

Index Terms- OEE, Productivity, Critical machines, Worker- Skill.

I. INTRODUCTION

The present work is based on the study conducted in a fabrication industry. The industry specializes in MMU/ Doped emulsion Pump truck, /Straight Emulsion Pump, Slurry pump trucks, etc. In today's competitive world it very crucial to stay ahead of the competition to survive. This can be done through effective utilization of resources already available at one disposal. Overall Equipment Effectiveness is a very useful tool in that respect. The firm under consideration faces a constant problem of low performance and even lower utilization of available resources. The present work is about increasing the overall equipment effectiveness of critical machines in the industry.

II. BACKGROUND

The present scenario of the company was studied. The usage of available equipment's, difficulties faced by the industry, the possibilities to overcome the difficulties was also studied. The main purpose of the study was to understand the existing work system in the industry. Identification of critical machines was also done.

The study was carried out in the following order:
1) Investigation of the existing work system in the industry.
2) Identification of critical machines in the industry.
3) Determining the existing OEE levels of the critical machines.
4) Comparing the existing OEE levels to that of world-class OEE.
5) Identifying the scope for improvement.

III. OVERALL EQUIPMENT EFFECTIVENESS

OEE can expressed as the ratio of the actual output of the equipment divided by the maximum output of the equipment under the best performance condition. OEE is used to determine the overall performance of the equipment and to determine how effectively the machine is running. OEE depends on three basic components: Availability, Performance and Quality.

A. SIX BIG LOSSES

OEE is a simple tool that will help to measure the effectiveness of their equipment. It takes the most common and important sources of productivity loss, which are called six big losses and given in Table I.

Table 1: Six big losses

Major Loss event	OEE Metric	Loss category	Example of Loss category
Machine breakdowns	Availability	Down time	Equipment failures, Tooling damage, Unplanned maintenance
Machine adjustments/setups	Availability	Down time	Process warm-up, Machine change over's, material shortage
Machine stops	Performance	Speed	Product misdeeds, component jam, product flow stoppage
Machine reduced speeds	Performance	Speed	Level of machine operator training, Equipment age, Tool wear
Machine bad parts	Quality	Quality	Tolerance adjustments, worm up process, damage,
Machine production bad parts	quality	quality	Assembled incorrectly, rejects, rework

These losses are quantified as availability, performance rate and quality rate in order to estimate OEE as given in equation (1).

OEE = Availability × Performance × Quality (1)

B. OEE CALCULATION METHOD

Planned production time = Shift length – break
Operating time = Planned production time - downtime loss
Availability = (Operating time / Planned production time)
Actual cycle time = (Operating time / No of products produced)
Performance = (Standard cycle time / Actual cycle time)
Quality = (Good product / Total product)
OEE = Availability × Performance × Quality

C. CASE STUDY

The case study was carried out in a Fabrication industry located in Nagpur. The overall equipment effectiveness has been measured to know the present situation of the industry. Two critical machines have been identified and studied using overall equipment effectiveness calculations. OEE of various kinds of machines gives the best understanding of the issues.
Calculation of availability denotes how effectively the machine is operating. Ability of workers and machines can be given by performance efficiency. Quality rate gives how efficiently the machine is being utilized.

D. IDENTIFICATION OF CRITICAL MACHINES

There are many methods that can be used to identify criticality of machines like Grading of Machine, More Cycle Time, Lowest Output, Employee Suggestion, etc.

E. GRADING OF MACHINE

The five factors which are used to categorize the machine are frequency of operation, volume of operation, failure, availability of alternatives and cost factor.

Table 2: Criticality of machine

Sr.no	Type	Points	Rank
1	Critical Machines	11-15	1
2	Rank 2 Machines	8-10	2
3	Rank 3 Machines	8 and below	3

The average points above two in each criteria is considered as having a significant effect in deciding the criticality of the machinery which is shown in Table II and 2 bottle neck machines were found out and shown in Table III. 5 bottleneck machines were selected based on criteria, all of which comes under the grading of machines criterion.

Table 3: Critical machines

Sr.no	Machine name	1	2	3	4	5	Total	Rank
1	Bending Machine	3	3	2	3	3	14	1
2	Welding Machine	3	3	2	3	1	12	1
3	Shearing Machine	2	2	1	2	3	10	2
4	Gantry Machine	2	1	1	3	3	9	2
5	Rolling Machine	1	1	1	3	3	9	2
6	Grinding Machine	3	3	1	1	1	9	2
7	Automatic Profile Cutting m/c	1	1	1	2	3	8	2
8	Radial Drilling Machine	1	2	1	2	2	8	2

Based on the results obtained bending machine and welding machines were identified as critical machines.

III. DATA COLLECTION AND ANALYSIS

Data collected during the month of November and December for 10 shifts for bending machine.

Table 4: Operation parameters of bending machine

Production Parameters / Shifts	1	2	3	4	5	6	7	8	9	10	Total/ Overall
Total Production	281	433	421	424	307	265	311	392	403	313	3550
Scrap	8	18	15	16	11	17	16	14	18	13	146
Total Available Time	420	420	420	420	420	420	420	420	420	420	4200
Scheduled Downtime	300	240	240	240	300	300	300	240	240	300	2700
Unscheduled Down Time	23	15	12	18	13	13	15	26	22	14	171
Operating Time	97	165	168	162	107	107	105	154	158	106	1222
Ideal Run Rate/min	4	4	4	4	4	4	4	4	4	4	4
Availability	80.8	91.7	93.3	90.0	89.2	89.2	87.5	85.6	87.8	88.3	88.6
Performance	72.4	65.6	62.6	65.4	71.7	61.9	74	63.6	63.8	73.8	66.8
Quality	97.2	95.8	96.4	96.2	96.4	93.6	94.9	96.4	95.5	95.8	95.9
O.E.E (%)	56.9	57.6	56.4	56.7	61.7	51.7	61.5	52.5	53.5	62.5	56.7

From the data analysis it can be concluded that the OEE of bending machine was 56.7 % from 10 shifts during the month of November and December.

Data collected during the month of November and December for 10 shifts for welding machine.

Table 5: Operation parameters of welding machine

Production Parameters / Shifts	1	2	3	4	5	6	7	8	9	10	Total/ Overall
Total Production (Welding in meters)	81.1	80.6	78.5	77.3	81.6	79.3	82	81.1	76	73.2	790.7
Scrap	2	0	1	3	0	2	3	3	3	4	21
Total Available Time	420	420	420	420	420	420	420	420	420	420	4200
Scheduled Downtime	60	60	60	60	60	60	60	60	60	60	600
Unscheduled Down Time	43	45	52	58	43	45	51	48	62	72	519
Operating Time	317	315	308	302	317	315	309	312	298	288	3081
Ideal Run Rate/min	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Availability	88.1	87.5	85.6	83.9	88.1	87.5	85.8	86.7	82.8	80.0	85.6
Performance	71.1	71.1	70.8	71.1	71.5	69.9	73.7	72.2	70.8	70.6	71.3
Quality	97.5	100	98.7	96.1	100	97.5	96.3	96.3	96.1	94.5	97.3
O.E.E (%)	61	62.2	59.8	57.3	63	59.6	61	60.3	56.3	53.4	59.4

From the data analysis it can be concluded that the OEE of welding machine was 59.4 % from 10 shifts during the month of November and December.

IV. Results and Discussions

Bending Machine and Welding Machine were identified as critical machines through grading of machines. Grading of machines was done based on the frequency of operation, volume of operation, failure, availability of alternatives and cost factor. The existing OEE level of bending machine and welding machine are 56.7 % and 59.4 % as shown in figure: 1 and figure: 2 along with availability, performance and quality respectively. Since the existing OEE levels of the critical machines are less than the world-class OEE level i.e. 85% as shown in figure: 3, it can be concluded that there is scope for improvement of OEE of both the critical machines respectively.

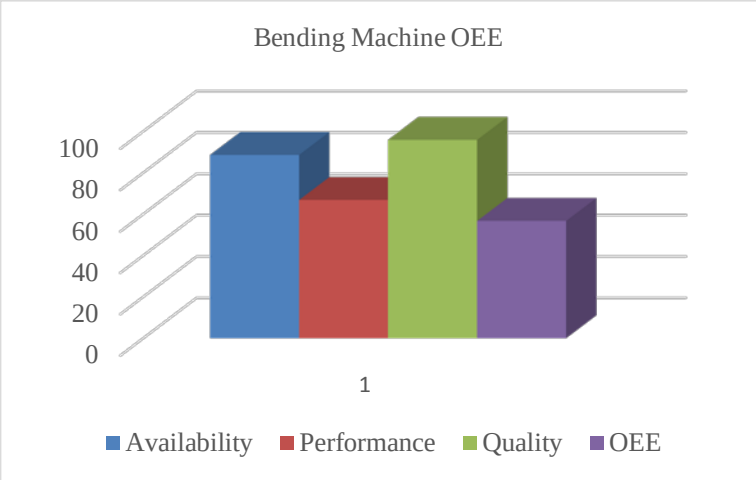

Figure 1: Availability, performance, quality and OEE of bending machine.

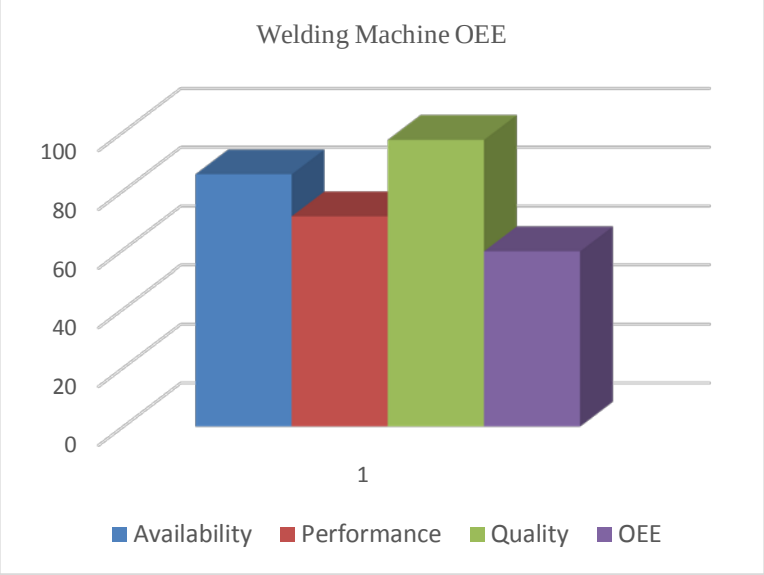

Figure 2: Availability, performance, quality and OEE of bending machine.

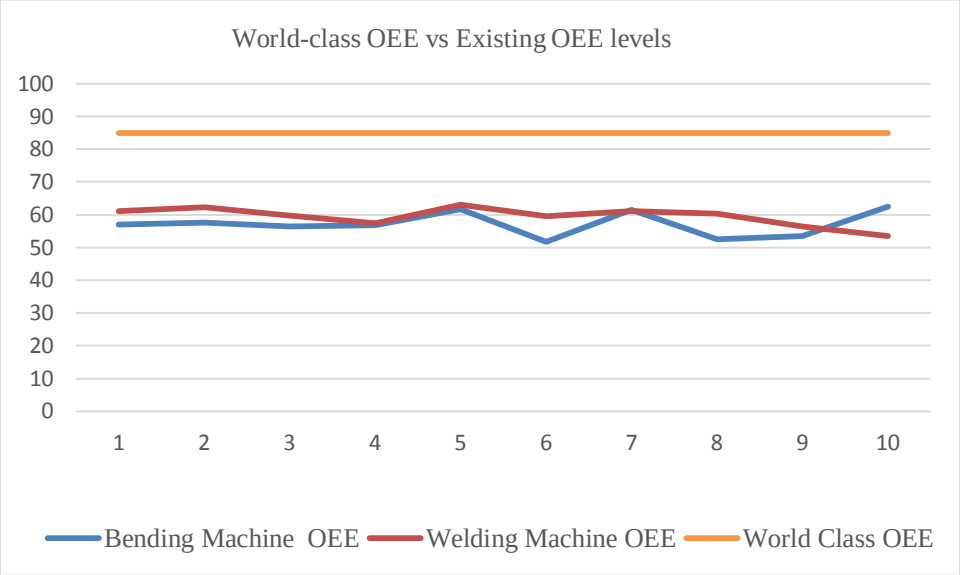

Figure 3: World-class OEE vs. Existing OEE levels.

V. CONCLUSION

Based on the study conducted it can be concluded that the both the critical machines .i.e. bending machine and welding machine have scope for improvement in OEE since the existing levels are less than that of world-class OEE levels. It can also be observed that out of availability, performance and quality factor, performance is the one that is lagging the most and bringing the OEE levels down in both bending machine and welding machine respectively.

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