MANTECH Publications

Journal of Applied Business, Economics and Strategic Management
Volume 1, Issue 2, May-August 2018

A Study on OEE and OLE in Pump Industry at Coimbatore

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Abstract

Overall Equipment Effectiveness is one of the performance evaluation methods that are most common and popular in the production industries. Overall Equipment Effectiveness (OEE), Overall Line efficiency (OLE) and Overall labour effectiveness plays a vital role where performance and quality of the product are of importance to the organization.

It intended for minimizing the breakdowns, increasing performance and quality rate and thus improving the effectiveness of the machine/system and labour. The availability rate of the machine, performance rate of the machine and quality rate of the products are considered as main parameters for maximizing the OEE of a manufacturing system. It is found that poor performance rate contributes more than availability rate and quality rate. The objective of this work is to enhance the overall equipment effectiveness (OEE) and overall labor effectiveness (OLE) in a manufacturing company by introducing the process change.

***Keywords:** OEE, OLE, Improvement, Process Optimization & Production Improvement.*

INTRODUCTION

This paper describes the approach used by a first year postgraduate management student to introduce a performance measurement system in reputed pump manufacturing company at Coimbatore. The DMAIC (Define Measure Analyse Improve and Control) improvement cycle as defined in Six Sigma methodology was used as a framework to implement the

system. OEE (Overall Equipment Effectiveness) and OLE (Overall labour effectiveness) were selected as a performance measure during the 'measure' phase of the cycle and the data generated from the organization during production of Model-1 Pumps were used to analyse the current performance and to make recommendations for improving business performance. The impact on the organisation of using this approach is implemented and appropriate improvements were identified.

REVIEW OF LITERATURE

Dal ET. al. (2000), in his study "Overall equipment effectiveness as a measure of operational improvement – A practical analysis". His study revealed the role of OEE goes far beyond the task of just monitoring and controlling. This is because OEE takes into account process improvement initiatives, prevents the sub-optimization of individual machines or production lines, provides a systematic method for establishing production targets, and incorporates practical management tools and techniques in order to achieve balanced view of process availability, performance and quality. Moreover, OEE can be used as an indicator of process improvement and as an approach to achieve it.

Lesshammar M. and Jonsson P.(1999), in his study "Evaluation and improvement of manufacturing performance measurement systems – the role of OEE". ". His study revealed, the OEE tool is designed to identify losses that reduce the equipment effectiveness. These losses are due to manufacturing disturbances that are either chronic or sporadic. Chronic disturbances are small and hidden, and are a result of several concurrent causes. Sporadic disturbances on the other hand are more obvious since they occur quickly and have large deviations from the normal state. It is a bottom-up approach to eliminate six large losses stated by Nakajima in 1988).

STATEMENT OF THE PROBLEM

The objective of the study

1. To identify if the OEE (Overall Equipment Effectiveness) of the organization lies in the world class standard.
2. To study the OLE (Overall Labour Effectiveness).

Data and sources of data

There are two types of data Collected

Primary Data:

- Process time,
- Stop time,
- the time taken for the meeting,

- setup time,
- Unscheduled break.

Secondary Data

- Shift timing,
- General maintenance,
- Break Timings.

Methodology

DMAIC is an acronym for the five phases that make up the process

Define Phase – Defines the problem, opportunity for improvement and project goals

Measure Phase – Measures the process performance

Analyse Phase – Analyse the process to identify the root cause of poor performance

Improve Phase – Improves process performance by addressing and eliminating root causes

Control Phase – Controls the improved process and future process performance

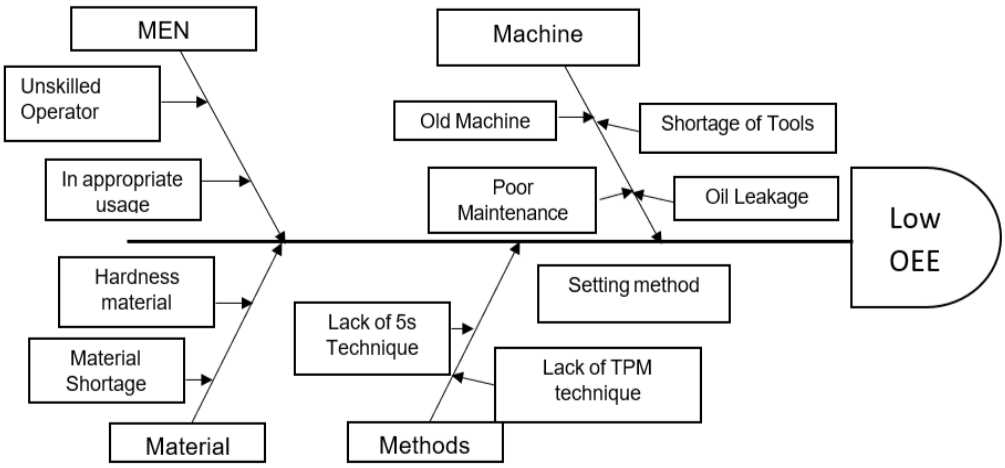
Tools used:

- OEE
- OLE
- P-Chart
- Time study
- Fishbone diagram

Define Phase:

Problem definition:

- Due to inappropriate usage of machine
- Due to inappropriate process



MEASURE PHASE:

The parameters of OEE, OLE such as availability, performance and quality of CNC department, Winding department and Oven from Assembly department

Oven in Assembly is calculated as shown below:

Availability

3	AVAILABLITY = PLANNED PRODUCTION TIME- STOP TIME/ PLANNED PRODUCTION TIME							
4		07-May	08-May	09-May	10-May	11-May	12-May	AVG
5	AVAILABLE TIME	450	450	450	450	450	450	450
6	MEETING	35	35	30	25	25	40	31.6667
7	GEN MAINTANCE	10	20	15	5	0	10	10
8	STOP TIME	170	160	145	135	140	135	147.5
9	PLANNED PRODUCTION TIME	405	395	405	420	425	400	408.333
10								
11	A	0.580246914	0.59494	0.64198	0.67857	0.67059	0.6625	0.63814

Performance

15	PERFORMANCE=(IDEAL CYCLE TIME * TOTAL COUNT)/(PLANNED PRODUCTION TIME- STOP TIME)							
16								
17	IDEAL CYCLE TIME PER BATCH	15	15	15	15	15	15	15
18	TOTAL BATCH	4	4	3	4	4	4	3.83333
19	IST BATCH TIMING	50	50	50	50	50	50	50
20	NUM PER BATCH	75	75	75	75	75	75	75
21	TOTAL COUNT	360	360	300	370	350	360	350
22	PPT	405	395	405	420	425	400	408.333
23	STOP TIME	170	160	145	135	140	135	147.5
24								
25	P	0.914893617	0.91489	0.82692	0.75439	0.75439	0.81132	0.82947

Quality:

29	QUALITY = GOOD COUNT/ TOTAL COUNT							
30	GOOD COUNT	354	352	296	362	344	353	343.5
31	TOTAL COUNT	360	360	300	370	350	360	350
32								
33	Q	0.983333333	0.97778	0.98667	0.97838	0.98286	0.98056	0.98333

ANALYSE PHASE:

Root cause analysis was performed to determine the causes for delay in initiating and processing customer orders

Men – In appropriate usage, unskilled Labour

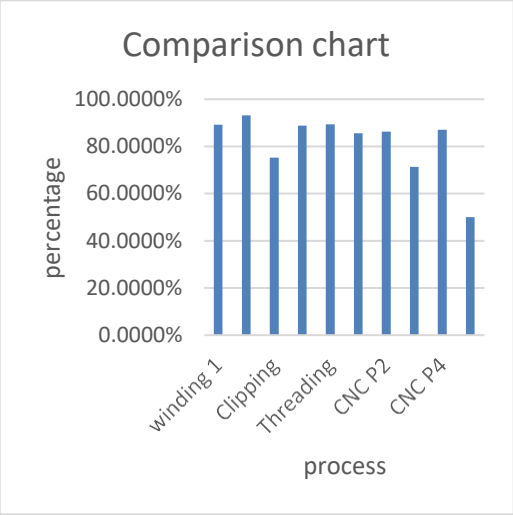
Materials – Material Shortage, Hardness Material

Machine – Old Machine, Shortage of tools, poor maintenance, Oil Leakage.

Methods – Lack of 5S Technique, Setting method, Lack of TPM technique.

Process Name	OEE
winding 1	89.2400%
winding 2	93.1200%
Clipping	75.2654%
Coil inserting	88.8100%
Threading	89.3000%
CNC P1	85.5400%
CNC P2	86.1651%
CNC P3	71.2990%
CNC P4	87.0675%
Oven	49.9328%

The above data is the OEE of the machines from Winding, CNC and Assembly Departments

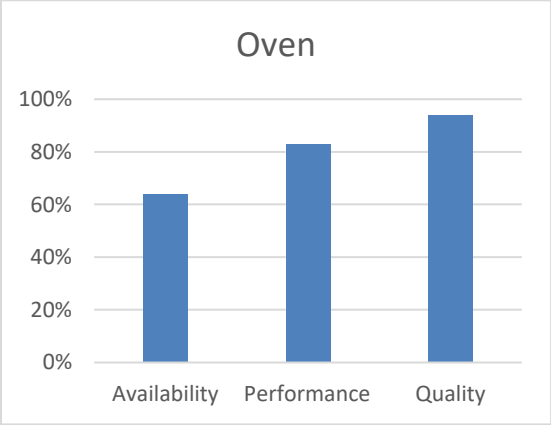


On comparison of the data found in the chart the OEE for oven is comparatively lesser than that of other OEE's of the machines.

IMPROVE PHASE:

Existing:

- Target for 8hrs shift is 360p
- So there are Four Batches each contains 90p
- Per batch there are two shifts (75+15).
- The first shift takes 50mins and the second shift takes 15mins.
- Due to in appropriate temperature maintenance, this gets repeated for every batch.
- Each Shift requires 10 mins for resting
- The oven is switched on from the starting of the shift till the end of the shift.



Availability: 64%

Performance: 83%

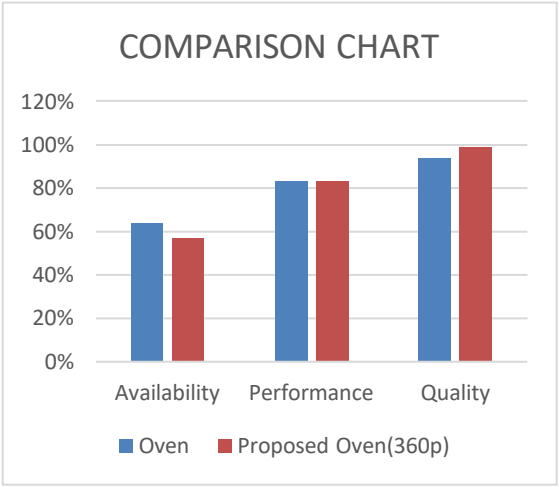
Quality: 99%

Overall equipment efficiency is 49.93% (For 8hrs Shift)

Proposed:

Proposal 1:

- Target for 4hrs Shift is 360p
- Is contains single batch which contains 360p.
- Per batch there are Five Shifts (75)
- The first shift takes 50 mins and the consecutive shifts takes only 15 mins.
- Since there is single batch there is no requirement to re-heat to bring to the appropriate temperature.
- Since there are five shifts repeated loading and unloading are happening in the oven. During the period of loading and unloading the pieces which are unloaded from the oven gets its resting period. Hence there is no separate resting time required.
- The oven is switched off as soon as the fifth shift is unloaded. This reduces indirect Cost.



Availability: 57%

Performance: 83%

Quality: 99%

Overall equipment efficiency is 47.41% (For 4hrs Shift)

	Existing (**8hrs** shift)	Proposed (**4hrs** Shift)
Availability	64%	57%
Performance	83%	83%
Quality	94%	99%
Overall Equipment efficiency	**49.93%**	**47.41%**

Proposal 2

- Target for 8hrs Shift is 750p
- Is contains single batch which contains 750p.
- Per batch there are ten Shifts (75)
- The first shift takes 50 mins and the consecutive shifts takes only 15 mins.
- Since there is single batch there is no requirement to re-heat to bring to the appropriate temperature.
- Since there are ten shifts repeated loading and unloading are happening in the oven. During the period of loading and unloading the pieces which are unloaded from the oven gets its resting period. Hence there is no separate resting time required.

The oven is switched off or been moved to Painting section as soon as the Tenth shift is unloaded. This reduces indirect Cost.

Overall equipment efficiency is 86.52% (For 8hrs Shift)

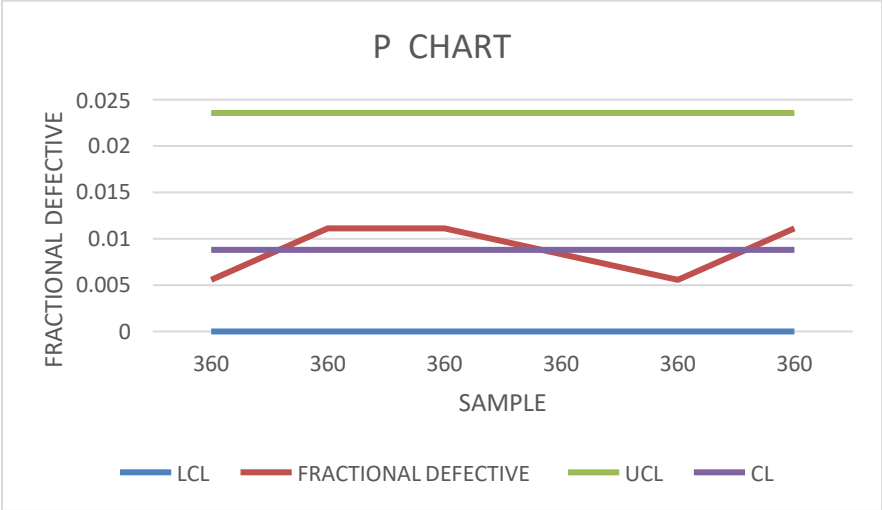
	Existing (**8hrs** shift)	Proposed (**8hrs** Shift)
Availability	64%	89%
Performance	83%	98%
Quality	94%	99%
Overall Equipment efficiency	**49.93%**	**86.52%**

Interpretation:

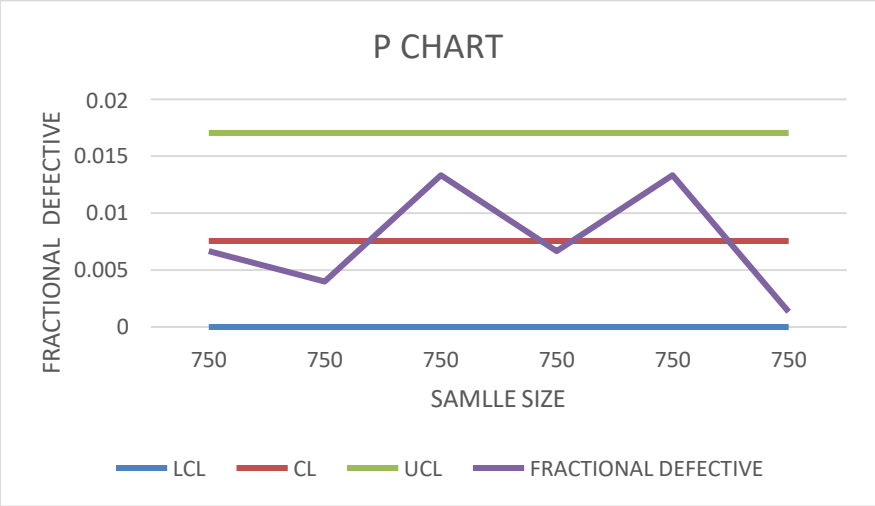
Using proposed method OEE was increased from 49.93% to 86.52% and the production capacity was improved, employees felt that lesser work load and indirect cost was reduced to the organization by switching off the oven immediately after use.

Control Phase

For Proposal 1



For Proposal 2



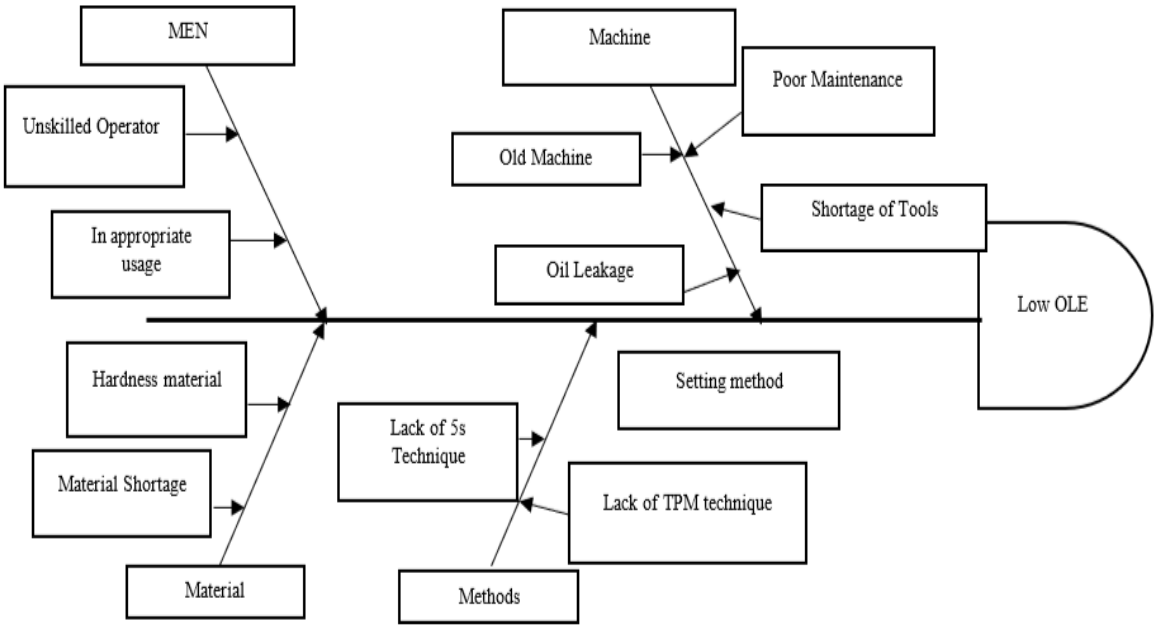
Interpretation

The defective observed after implement seems to stay within the upper control limit and lower control limit respectively. Hence the process is under control.

Also, the operator of oven was instructed to report to his supervisor about after effect of implementation every fortnight.

Define (OLE)

To find the Overall labor efficiency in Assembly department for the better understanding of the Man power Utilization



Measures

There are two types of data Collected

- Primary and
- Secondary.

Primary Data

Time study was taken to identify the information about the machines such as Stop time, time taken for meeting, setup time, unscheduled break etc.

Secondary Data

Basic Data was given by the organization (Shift timing, Scheduled Break Timings).

The data was collected for the period of 2 weeks (12 samples)

Oven in Assembly is calculated as shown below:

Availability

1	ASSEMBLY							
2	2 EMPLOYEE							
3	AVAILABLITY = PLANNED PRODUCTION TIME- STOP TIME/ PLANNED PRODUCTION TIME							
4	TIME SPLIT UP	TIMES IN MINS 7	8	9	10	11	12	AVG
5	AVAILABLE TIME	960	960	960	960	960	960	960
6	MEETING	40	35	40	50	30	50	40.8333
7	GEN MAINTANCE	0	0	0	0	0	0	0
8	SHEDULED BREAK	30	30	30	30	30	30	30
9	UN-SHEDULED BREAK	0	0	0	0	0	0	0
10	STOP TIME	400	420	390	390	410	400	401.667
11	PLANNED PRODUCTION TIME	890	895	890	880	900	880	889.167
12								
13	A	0.550561798	0.53073	0.5618	0.55682	0.54444	0.54545	0.5483

Performance

17	PERFORMANCE=(IDEAL CYCLE TIME * TOTAL COUNT)/(PLANNED PRODUCTION TIME- STOP TIME)							
18								
19	IDEAL CYCLE TIME PER BATCH	1.3	1.3	1.3	1.3	1.3	1.3	1.3
20	TOTAL COUNT	360	360	300	370	350	360	350
21	PPT	890	895	890	880	900	880	889.167
22	STOP TIME	400	420	390	390	410	400	401.667
23								
24	P	0.955102041	0.98526	0.78	0.98163	0.92857	0.975	0.93426

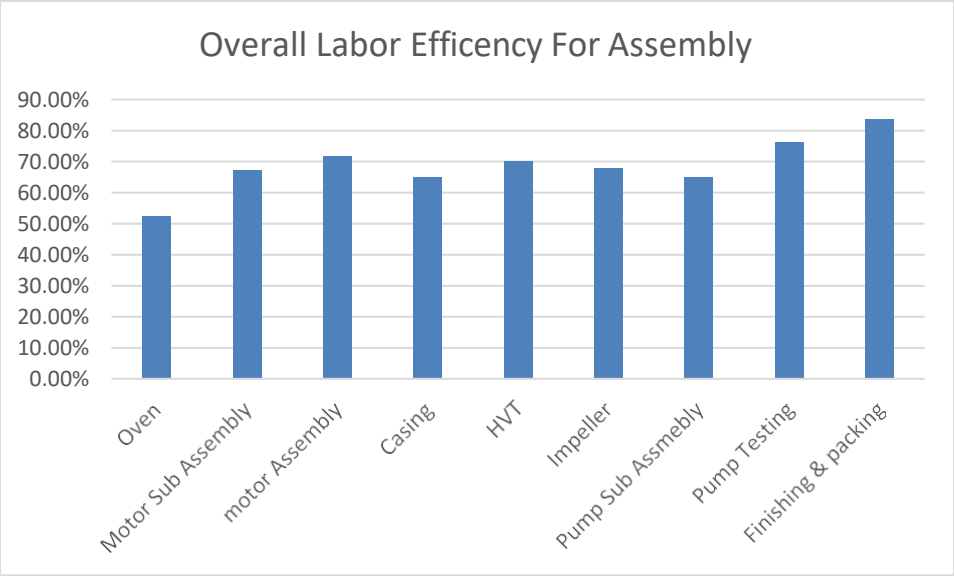
Quality

28	QUALITY = GOOD COUNT/ TOTAL COUNT							
29	GOOD COUNT	360	360	300	370	350	360	350
30	TOTAL COUNT	360	360	300	370	350	360	350
31								
32	Q	1	1	1	1	1	1	1

Analyse

Process	Overall Labour Efficiency
Oven	52.43%
Motor Sub Assembly	67.38%
motor Assembly	71.61%
Casing	65.00%
HVT	70.00%
Impeller	68.00%
Pump Sub Assembly	65.00%
Pump Testing	76.14%
Finishing & packing	83.70%

The above data is the Overall Labour efficiency in assembly.



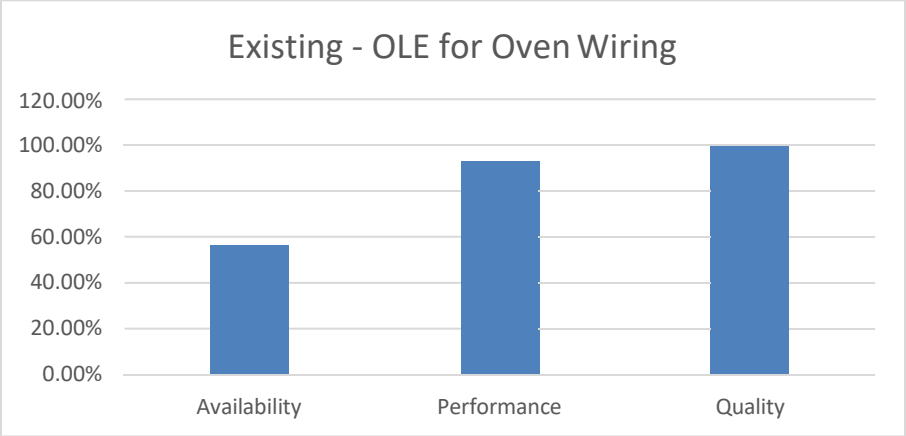
On comparison of the data found in the chart the OLE for oven is comparatively lesser than that of other OLE's.

Improve Phase

Existing

- Target for 8hrs shift is 360p
- So there are Four Batches each contains 90p
- Each shift takes on an average of 117mins.
- Due to in appropriate temperature maintenance in oven, this gets repeated for every batch.

Each Shift requires 10 mins for resting, where during this time the employees are left ideal.



Availability: 56%

Performance: 92%

Quality: 100%

Overall equipment efficiency is 52.4%

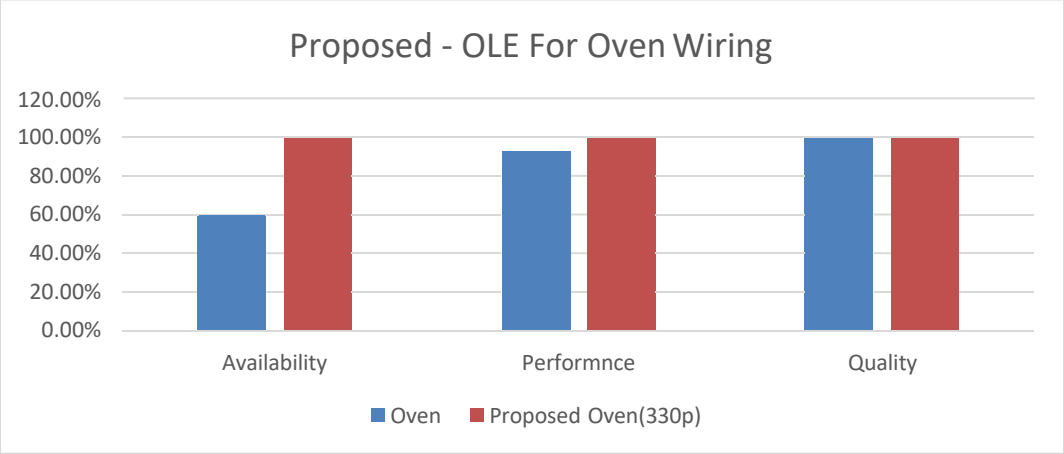
(For 8hrs Shift)

Proposed

Proposal 1

- Target for 4hrs Shift is 330p
- Is contains single batch which contains 330p.
- Per batch there are Five Shifts (75)
- Since there is single batch there is no requirement for resting time for Motor body to bring to the appropriate temperature.
- As soon as the fifth batch is unloaded from the oven, the employees start wiring from the first batch.

Where It increases the Availability which leads to improving of overall labor efficiency

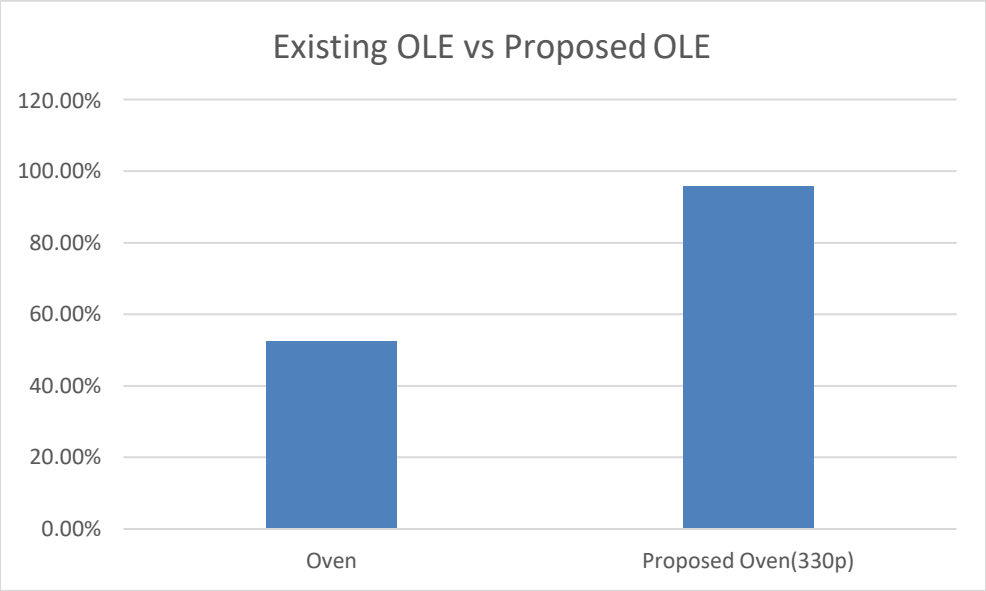


Availability: 97%

Performance: 97%

Quality: 100%

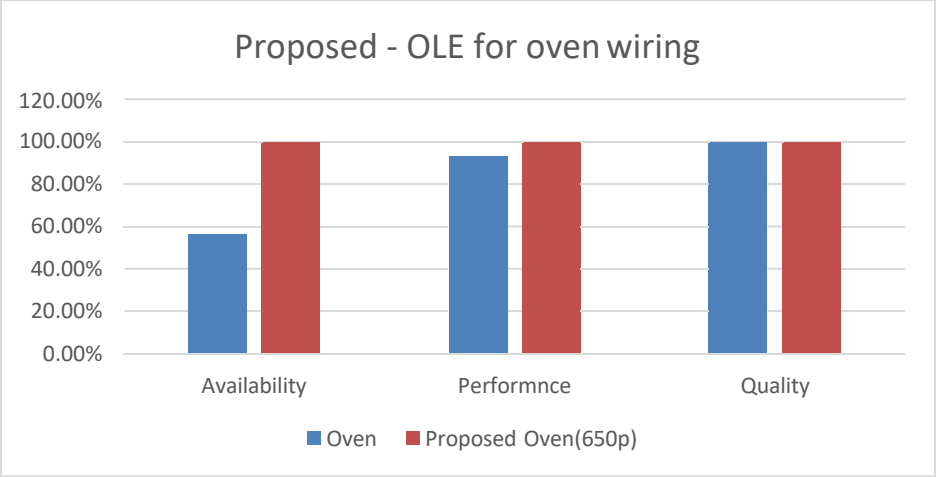
Overall equipment efficiency is 95.56% (For 4hrs Shift)



	Existing (8hrs shift)	Proposed (4hrs Shift)
Availability	56%	97%
Performance	92%	97%
Quality	100%	100%
Overall Equipment efficiency	52.43%	95.57%

Proposal 2

- Target for 8hrs Shift is 650p
- Is contains single batch which contains 650p.
- Per batch there are Five Shifts (75)
- Since there is single batch there is no requirement for resting time for Motor Body to bring to the appropriate temperature.
- As soon as the tenth batch is unloaded from the oven, the employees start wiring from the first batch.
- Where It increases the Availability which leads to improving of overall labor efficiency.

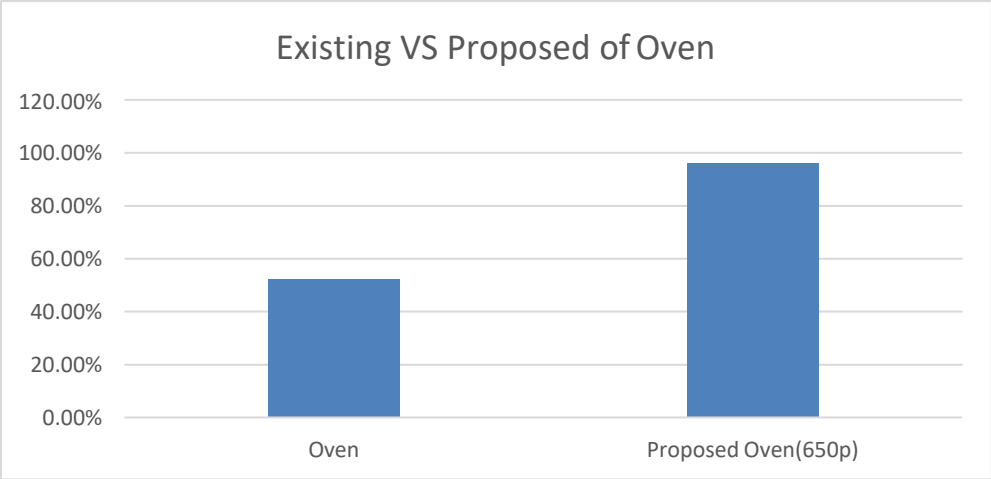


Availability: 98%

Performance: 97%

Quality: 100%

Overall equipment efficiency is 96.20.52% (For 8hrs Shift)



	Existing (8hrs shift)	Proposed (8hrs Shift)
Availability	56%	98%
Performance	92%	97%
Quality	100%	100%
Overall Equipment efficiency	52.43%	96.20%

Interpretation

Using proposed method OLE was increased from 52.43% to 96.20% and the production capacity was improved, employees felt that lesser work load and indirect cost was reduced to the organization.

Control Phase

For Proposal 1

Also, the operator of oven was instructed to report to his supervisor about after effect of implementation every fortnight. Only one employee is involved and 360 products are given target, after implementation error rates are kept notified to the supervisor every day and found no deviation in error rates before and after implementing this proposal.

For Proposal 2

Also, the operator of oven was instructed to report to his supervisor about after effect of implementation every fortnight. Two employees are involved and 650 products are given target, after implementation error rates are not expected to deviate.

FINDINGS

- OEE of all the parameters were calculated
- Availability of CNC process 1 is calculated to be 94%, performance if calculates to be 92% and Quality 100%.
- Availability of CNC process 2 is calculated to be 94%, performance if calculates to be 95% and Quality 98%.
- Availability of CNC process 3 is calculated to be 94%, performance if calculates to be 82% and Quality 92%.
- Availability of CNC process 4 is calculated to be 94%, performance if calculates to be 95% and Quality 97%.
- Availability of Winding department clipping process is calculated to be 88%, performance if calculates to be 56% and Quality 99%.
- Availability of Winding department Coil insertion process is calculated to be 92%, performance if calculates to be 88% and Quality 100%.

- Availability of Winding department Threading process is calculated to be 84%, performance if calculates to be 51% and Quality 100%.

- Availability of Assembly unit Oven process is calculated to be 64%, performance if calculates to be 83% and Quality 94%.

- The OEE of each machine were calculated, Winding 1 is 89%, Winding 2 is 93%, Clipping is 75%, Coil Insertion is 88%. Threading is 89%, CNC Process 1 is 85%, CNC Process 2 is 86%, CNC Process 3 is 71, CNC Process 4 is 87 and Assembly unit Oven process is 49%.

- On comparison of OEE of each machine from winding, CNC department and oven in assembly, oven was found to be comparatively less.

- Overall labor effectiveness was also calculated in assembly line and each workers OLE is calculated

- Availability of Assembly unit oven process is calculated to be 54%, performance if calculates to be 93% and Quality 100%.

- Availability of Assembly unit Motor sub-assembly process is calculated to be 82%, performance if calculates to be 86% and Quality 99%.

- Availability of Assembly unit Motor assembly process is calculated to be 91%, performance if calculates to be 79% and Quality 100%.

- Availability of Assembly unit Casing process is calculated to be 87%, performance if calculates to be 82% and Quality 100%.

- Availability of Assembly unit HVT process is calculated to be 69%, performance if calculates to be 76% and Quality 94%.

- Availability of Assembly unit Impeller process is calculated to be 67%, performance if calculates to be 82% and Quality 100%.

- Availability of Assembly unit Pump Testing process is calculated to be 95%, performance if calculates to be 78% and Quality 100%.

- The OLE of Assembly unit Shop Floor workers were calculated, Oven is 52%, Motor Sub-Assembly 67%, Motor Assembly 71%, Casing 65%, HVT 70%, Impeller 68%, Pump Sub Assembly 65%, Pump testing 76%, Finishing and packing 83%

- On comparison of Assembly unit Shop Floor workers oven was found to be comparatively less.

SUGESSTIONS

- Changes were proposed for oven process. It was implemented and total production of shift in oven was done within half of the usual time. 360 Products per day is achieved within 4 hours shift which was previously achieved in 8 hours shift.

- Through which proposed changes achieved 57% of availability, 83% of performance and 99% of Quality and 47% of Overall Equipment effectiveness in 4hours shift.

- Changes were proposed to achieve the new target of 750 per day in 8 hours shift.

- Through which proposed changes achieved 87% of availability, 98% of performance and 99% of Quality and 86% of Overall Equipment effectiveness in 8hours shift.

- Since a new changes was implemented in Oven the employee efficiency was also improved from 56% Availability to 97%, 92% performance to 79% and 100% quality was maintained in 4hours shift.

- It also paved way to improve availability from 56% Availability to 98%, 92% performance to 97% and 100% quality was maintained in 8hours shift with Overall labor Effectiveness 96%

- Effective utilization of ERP can reduce the time wasted in waiting for information.

CONCLUSION

The company has taken up the challenge to implement the proposed methodologies (Oven heating, Wiring) in the plant. These steps have not only helped the company in extracting more profits but also helps in making a mark in Pump industry. The learning from these Internship projects has been immense. It has the essence of the fact that small contributions can make large differences. The plant management agreed to take up the recommendations with the higher management in the company so that these can be implemented with ease. Learning experience to be part of such important goals.

To accomplish this purpose DMAIC are fully evaluated and the effectiveness of these methodologies is tested assuming common scenarios in industry and analysing the experimental results. This project is organized as follows:

1. The various advantages that they offer to measure OEE and OLE are discussed.

2. This Project presents how the DMAIC can be implemented to measure the OEE and OLE more effectively and accurately.

3. Different common scenarios are presented and experimental results are analyzed to prove the functionality and accuracy of these methodologies.

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