Analyzing the Machine Utilization and Overall Equipment Effectiveness of Machine Shop

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Abstract:- **The existing problem in manufacturing industries is finding out the causes for low productivity. Low productivity can be caused by factors like unplanned maintenance, tool failure, machine breakdown, operator absenteeism, inefficient planning. An Effective Solution to this problem is the calculation of machine utilization in the manufacturing industry. Overall Equipment Effectiveness optimizes the process and gives us the definite result that is expected. It is not confined to a specific industry or a specific problem, it is a global solution that increases the productivity and in the recent years proven to be a boon for manufacturing industrialists.**

Keywords: OVERALL EQUIPMENT EFFECTIVENES, Productivity, Supporting delays, Nonproductive activities.

1. INTRODUCTION

Machinery is the central to the production process and manufacturers strive to optimize how it integrates with other machines and supervisory systems in their business enterprise.

A. Effective Utilization

Effective utilization implies judicious and economic use of the available resources, effective use of available resources in the key productivity at the plant level and also to higher living standards of the people.

B. Work Study

It is a generic term referred to the techniques of method study and work measurements which is used in the examination of human work in all its contents

They lead to the systematic investigation of all the factors which will affect the economy of the situation being reviewed in order to affect improvement.

C. Method Study

It is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reduced cost.

D. Work Measurement

It is defined as the application of techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level of performance.

E. Work Sampling

It is the statistical technique for determining the proportion of time spent by the workers in various defined categories of activity.

F. Performance Sampling

To measure working time and non-working time of a person on a manual task, and to establish a performance index or performance level for the person during his or her working time.

G. Overall Equipment Effectiveness

It is a way to monitor and improve the efficiency of the manufacturing process.OEE is one of the ways to optimize the performance of the existing equipment and gives ability to measure the machines for productivity improvement.

2. LITERATURE REVIEW

Overall equipment effectiveness (OEE) is a hierarchy of metrics developed by Seiichi Nakajima in the 1960s to evaluate how effectively a manufacturing operation is utilized. It is based on the Harrington Emerson way of thinking regarding labour efficiency. The results are stated in a generic form which allows comparison between manufacturing units in differing industries. It is not however an absolute measure and is best used to identify scope for process performance improvement, and how to get the improvement. If for example the cycle time is reduced, the OEE will increase i.e. more product is produced for less resource. Another example is if one enterprise serves a high volume, low variety market, and another enterprise serves a low volume, high variety market. More changeovers (set-ups) will lower the OEE in comparison, but if the product is sold at a premium, there could be more margin with a lower OEE.

OEE measurement is also commonly used as a key performance indicator (KPI) in conjunction with lean manufacturing efforts to provide an indicator of success.

OEE can be illustrated by a brief discussion of the six metrics that comprise the system. The hierarchy consists of two top-level measures and four underlying measures.

3. PROBLEM DEFINITION

Under utilization of various manufacturing units due to number of non-productive activities which in turn decreases the Overall Equipment Effectiveness [OEE].

4. OBJECTIVES

- To determine the utilization of machines and overall equipment effectiveness of machine shop by analyzing the data obtained.
- To determine the present condition of capacity, utilization of machines and reasons for less OEE.

5. METHODOLOGY

1. Identification of manufacturing units
2. Collection of data and codification of activities
3. Designing formats for main sample study
4. Conduct pilot study
5. Analyse the findings and compare with the target to be achieved
6. Suggestions for improvement
7. Check for feasibility of suggestions
8. Implementation and maintain

A. *DEFINITION OF OEE*

- OEE is a way to monitor and improve the efficiency of the manufacturing process.
- OEE is one of the ways to optimize the performance of the existing equipment and gives ability to measure the machines for productivity improvement.

B. *OEE FACTORS*

OEE can be divided into the following three metrics which will help to gauge the plants efficiency and categorize the key productivity losses that will occur within the manufacturing processes.

a. Availability
b. Performance
c. Quality

METRIC 1: Availability

$$\text{Availability} = \text{run time} \div \text{total time}$$

Definition: Percentage of the actual amount of production time the machine is running to the production time the machine is available.

Simple OEE: The total run time of the machine subtracting all unplanned downtime.

METRIC 2: Performance

$$\text{Performance} = \text{total count} / \text{target count}$$

By Definition: Percentage of total parts produced on the machine to the production rate of machine.

Simple OEE: How well a machine is performing during its operation.

METRIC 3: Quality

$$\text{Quality} = \text{good count} \div \text{total count}$$

By Definition: Percentage of good parts out of the total parts produced on the machine.

Simple OEE: How many good parts versus bad parts a machine has produced.

C. *OEE LOSSES*

Loss category	OEE metric	Loss example
Downtime loss	Availability	• Equipment Failures • Tooling Damage • Unplanned Maintenance • Process Warm Up • Machine Changeovers • Material Shortage
Speed loss	Performance	• Product Misfeeds • Component Jams • Product Flow Stoppage • Level of Machine Operator Training • Equipment Age • Tooling Wear
Quality loss	Quality	• Tolerance Adjustments • Warm Up Process • Damage • Assembled Incorrectly • Rejects • Rework

D. *FORMAT FOR DATA COLLECTION*

Sl no.	Machine name	Part name	08:-50	09:20	09:40	10:10	10:55	11:15	12:15	12:45	01:20	01:50	02:25	Remarks
1	m/c 1													
2	m/c 2													
3	m/c 3													
4	m/c 4													
5	m/c 5													
6	m/c 6													
7	m/c 7													
8	m/c 8													
9	m/c 9													
10	m/c 10													

6. DAY-WISE SUMMARY SHEETS

DAY	W	S	L	WI	WT	TC	M	IP	IE	IL	I	WW	OA	BD	NW	TOTAL
1	40	7	6	0	6	5	9	5	0	0	5	0	10	11	6	110
2	37	10	14	0	0	7	7	11	4	3	5	7	0	0	5	110
3	33	2	4	6	11	9	9	16	0	0	2	0	8	0	10	110
4	31	2	0	0	14	6	0	8	12	9	3	13	5	0	7	110
5	30	2	6	0	0	3	3	9	8	12	9	0	11	11	6	110
6	37	0	8	10	0	0	13	18	0	6	6	0	12	0	0	110
7	32	5	6	0	8	2	14	11	2	2	8	0	8	0	12	110
8	30	6	8	0	9	5	9	6	8	5	4	10	7	0	3	110
9	32	3	2	11	7	7	5	14	5	4	1	0	6	9	4	110
10	31	4	7	9	0	8	9	8	5	6	8	0	6	0	9	110
11	41	6	6	0	6	6	14	5	4	8	2	0	0	0	12	110
12	37	9	7	5	0	5	0	7	6	7	6	0	8	0	13	110
13	32	13	4	0	0	7	4	14	2	0	8	0	8	14	4	110
14	47	10	8	0	0	4	7	6	5	5	2	0	8	0	8	110
15	29	5	9	0	8	5	14	11	7	5	3	0	3	0	11	110
TL	519	84	95	41	69	79	117	149	68	72	72	30	100	45	110	1650
%	31.46	5.09	5.75	2.48	4.18	4.79	7.09	9.03	4.13	4.36	4.36	1.81	6.06	2.72	6.67	100

DAY	PRODUCTIVE ACTIVITIES	SUPPORTING DELAYS	NON-PRODUCTIVE ACTIVITIES	MAX
1	53	25	32	110
2	61	25	24	110
3	39	51	20	110
4	33	28	49	110
5	38	15	57	110
6	45	41	24	110
7	43	35	32	110
8	44	29	37	110
9	37	44	29	110
10	42	34	34	110
11	53	31	26	110
12	53	17	40	110
13	49	25	36	110
14	65	17	28	110
15	43	38	29	110
TOTAL	698	455	497	1650
%	42.3	27.6	30.1	100

PRODUCTIVE ACTIVITIES:

TABLE 1.Productive activities

Activity	Present	Target
Working	31.46%	78%
Set-Up	5.09%	10%
Load/Unload	5.75%	1%
Total	42.3%	89%

SUPPORTING DELAYS:

TABLE 2. Supporting delays

Activity	Present	Target
Maintenance	7.09%	1%
Inspection	9.03%	2%
Tool Crib	4.79%	0%
Want of Tool	4.18%	0%
Want of Information	2.48%	0%
Total	27.6%	3%

NON-PRODUCTIVE ACTIVITIES:

TABLE 3. Non Productive activities

Activity	Present	Target
Break Down	2.72%	0%
Idle Late	4.36%	0%
Idle Early	4.13%	0%
Idle	4.36%	0%
Operator unavailable	6.06%	0%
Not Working	6.67%	0%
Want of Work	1.81%	0%
Total	30.1%	0%

7. CALCULATIONS

Calculating OEE,
Availability = run time/total time
This takes account of Downtime loss
Performance = total count/target count
This takes account of Speed Loss
Quality = good coun/total count

This takes account of Reject losses
OEE = Availability x Performance x Quality

- Availability is estimated to be 42.3%
- Assuming both performance and quality to be 100%

OEE = availability × performance×quality
= 0.423 x 1 x 1
= 42.3%

8. SUGGESTIONS

A. *SUPPORTING DELAYS*

Maintenance is repair or regular changing of coolant/components.

Causes:

- Regular Maintenance work carried during shift hours.
- Coolant, Lubricant,& consumables changing done in shift hours

Suggestions:

- Regular Maintenance should be done in break times like Lunch & Overtime break.
- Preventive Maintenance, coolant change, should be done periodically.

Tool crib, it is operators going far from workplace & searching for Tools, there by machine remains idle.

Causes:

- Regularly used tools and fixtures not kept at the workplace.
- Tools store is far from shop.

Suggestions:

- Regularly used tools, fixtures should be kept at the workplace.
- Tools store should be near to the Machine Shop.

Want of tool, is defined as machine idling due to non-availability of required cutting / supporting / inspection tools.

Causes:

- Poor planning activities of production planning.
- Lack of job preparation.
- Less co-ordination between Methods, Tooling, and Planning Depts , while process planning.

Suggestions:

- In Shop, Engineering Dept should be located.
- Tools should be designed according to process' feasibility of usage.
- Establishing effective communication between Methods, Tooling, & Planning Depts.
- Mini Store with good quality & spares of tools should be started.

B.*Want of information*, defined as machine waiting for NC Programming, its corrections etc.

Causes:

- For storage of large size programs extra computers not available.
- Designed CNC Programming may not be feasible due to lack of interaction between programmers and operators/supervisors.
- Skilled Programmers not available.

Suggestions:

- For programs storage, computer should be used.
- Programmers should interact with their end user.
- Training required for operators & programmers skills improvement.

NON-PRODUCTIVE ACTIVITIES

Breakdown, defined as failure of machine due to some components failed.

A. *NOT WORKING*

Causes:

- Delay in rectification of the problem, operators are idle throughout the shift.
- Low quality spare parts, bearings used for replacing worn parts.

Suggestions:

For regular maintenance, spare parts should be of good quality readily available for immediate rectification.

Idle late, is defined as operators coming late after Tea/Lunch/Break.

Causes:

- Operators extending their break duration.

Suggestions:

- Shop supervisors & Top management should manage them to avoid these delays.
- Canteen, Tea delays should be sorted out & disciplinary action should be taken against late comers without genuine reasons.

Operator unavailable is defined as operator not in duty or has gone out of division with permission in work.

Causes:

- Operators Absent with permission only, but machines idle.
- Absenteeism due to various other reasons.

Suggestions:

- Supervisors should assign other operator to the machines for which operators are on leave.
- All operators should be trained on other machines to become Multi-Skilled.

Causes:

- Unknown reason.

Suggestions:

- Supervisors should try to know the reasons for Not Working even if all facilities are provided.

RESULTS

1. Minimizing the non productive activities by taking appropriate measures.
2. Also reducing supporting delays (inspection, maintenance)
3. Increasing the machine utilization. Thus increasing the overall equipment efficiency, increasing productivity.

RESULTS AFTER IMPLEMENTATION OF THE SUGGESTIONS

TABLE: 5*Non Productive activities*

Activity	Present	Target
Break down	2.40%	0%
Idle late	2.70%	0%
Idle Early	2.40%	0%
Idle	3%	0%
Operator Absent	6.70%	8%
Not Working	5.70%	0%
Want of Work	1.40%	0%
TOTAL	24.30%	8%

OEE Calculations

From above results we can estimate OEE for the Machine Shop

Availability can be estimated as 42.3% from working percentage.

Even if Performance & Quality are 100%

OEE = AVAILABILITY × PERFORMANCE × QUALITY

= 0.531 × 1 × 1

= 0.531

= 53.1%

World Average OEE for manufacturing plants is 60 %,

And for World class manufacturing plants it is equal or more than 85 % .

Table:7 Productive Activities

Activity	Present	Target
Working	42.20%	78%
Set-up	6.04%	10%
Load/Unload	4.50%	1%
TOTAL	53.10%	89%

- In terms of activity occurrences the machines were working for 53.2% of the reading so OEE can be estimated as 53.2%.
- Inspection activity is7.5%, it should be reduced but compared to Maintenance, 5.7% & not working activity,5.7% it can be considered later. The Downtime Loss due to biggest reasons is Inspection activity and Maintenance.
- Solution for Breakdown is only Preventive Maintenance. Identifying PM Status should be carried out for all machines & ensure strict adherence to future PM Plans.

  The main reasons for idleness are cultural & work practices norms. Addressing these is a major task that requires significant Management Commitment. Other companies controlled it by taking following measures, such as

TABLE:6. *Supporting Delays*

Activity	Present	Target
Maintenance	5.70%	1%
Inspection	7.05%	2%
Tool Crib	3.90%	0%
Want of Tool	3.00%	0%
Want of Information	2.50%	0%
TOTAL	22.60%	3%

CONCLUSION

- Flow lines.
- Disciplinary Procedures.
- Checking in & out of Shop.
- Making rest areas inside shop.
- Lunch/canteen services inside the shop.

  Management By Walk-Around. (MBWA)

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