Evaluation of Overall Equipment Effectiveness (OEE) by a dynamic method

Srinivasa Rao P, Malay Niraj

***Abstract*—To withstand a high competition in the global market, no organization encourages losses. Different techniques have been studying from years ago to improve productivity. But Overall Equipment Effectiveness (OEE) calculation gives the correct measure for the occurrence of various losses by the machinery. OEE is a performance measure metric used to calculate the overall equipment efficiency of the plant by a simple calculation. This paper presents a flexible and innovative approach to evaluate the OEE of the industry by considering cost, quality and time as lean surrogates for the factors of OEE.**

***Index Terms*—OEE, lean metrics, major losses, performance**

I. INTRODUCTION

Lean production has become an integral part of the manufacturing landscape in the United States for over four decades. Its link with superior performance is well accepted among academicians and practitioners. Lean production directly descended from and is frequently used as a proxy for Toyota production System (TPS), which itself evolved from Taiichi ohno's experiments and initiatives over three decades at Toyota motor company [6].

Overall Equipment Effectiveness (OEE) is an excellent technique tool used for controlling, monitoring and improving the efficiency of any manufacturing processes (machines, cells, assemble lines etc.). It is a simple, practical and powerful tool which deals with the most common losses of the manufacturing processes. Likewise it categorizes those losses into three basic categories like availability, performance; quality. The global economic recession has caused a reduced volume of orders, market saturation and lower price competition pressure. The fast changing economic conditions such as global competition, declining profit margin, customer demand for high quality product, product variety and reduced lead–time etc. had a major impact on manufacturing industries. The application of this paper improves the process performance of the critical operational process, leading to better utilization of resources, decreases variations & maintains consistent quality of the process output [4, 5].

Measurement of OEE is the best way to monitor and improve the effectiveness of manufacturing process line. It is simple and practical one. It takes help of the three factors or metrics of the productivity and measures its performance and tells about the present scenario of the plant. It also tells the factors causing losses to the production and helps the managers to improve in that in that field.OEE mainly used as a key metric in the lean production and total productive maintenance (TPM). The three main factors of OEE are availability, performance and quality. Those are related by [7]:

OEE= Availability X Performance X Quality (1)

II. LITERATURE REVIEW

In this section, the author made a brief literature survey regarding the overall equipment and its performance measurement techniques.

Lean manufacturing techniques and tools are well knowingly popularized over the last two decades and bringing a remarkable changes in all the wings of the manufacturing systems. In this contrast, particularly managers are going ahead in productivity by eliminating wastes through lean manufacturing tools and techniques. In this contrast, cost, quality and just in time (JIT) delivery and continuous improvement are playing a vital role [1].

This paper presents a systematic way for combined set of OEE and productivity measures can drive production improvements successfully. Two new productivity measures for driving improvements at the shop floor are proposed [2].

Now-a-days, more companies are going to implement lean manufacturing tools and techniques, to become alive in this competitive global market and collectively striving to give the best to the customers [3].

In another paper Farzad Behrouzi and Kuan Yew Wong developed an innovative approach to measure the lean performance of manufacturing systems by using fuzzy membership functions. In this paper the author measured the lean score of a manufacturing unit by taking the best and worst performances of lean attributes and using their fuzzy membership values [4].

Unfortunately, most of the companies are being failed to implement the best practices of lean, due to lack of clear understanding of lean and its principles. Generally it is difficult to manage lean without measuring its performance. A number of models and techniques were developed and discussed for the measurement of lean and its practices [5].

This paper presents a semantic confusion surrounding lean production by conducting an extensive literature review using a historical evolutionary perspective in tracing its main

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components. A two stage empirical method is used to measure the various components of the lean measurement data [6].

This paper presents a systematic way to monitor and control the production process by calculating the OEE of the plant considering three factors like availability, performance, quality. Calculation of OEE is a critical measure to any plant to know the effectiveness of the plant [7].

III. PROPOSED WORK

In this section, we will propose

1. The measurement of OEE is done by finding the lean metrics for the cost, quality and time.
2. Finally by using this basic method the OEE of the industry is calculated.
3. Formulation is made for the relevant metrics and corresponding industrial data is collected and implemented.

3.1. Classification of OEE and its corresponding lean metrics

Here, the author wants to find out the overall equipment effectiveness (OEE) of a manufacturing industry. The OEE score will gives us the plant equipment efficiency only. In this regard, the overall performance of the equipment is known. For calculating the OEE, three parameters like QUALITY, AVAILABILITY, and PERFORMANCE are sufficient.

OEE = Quality X Availability X Performance

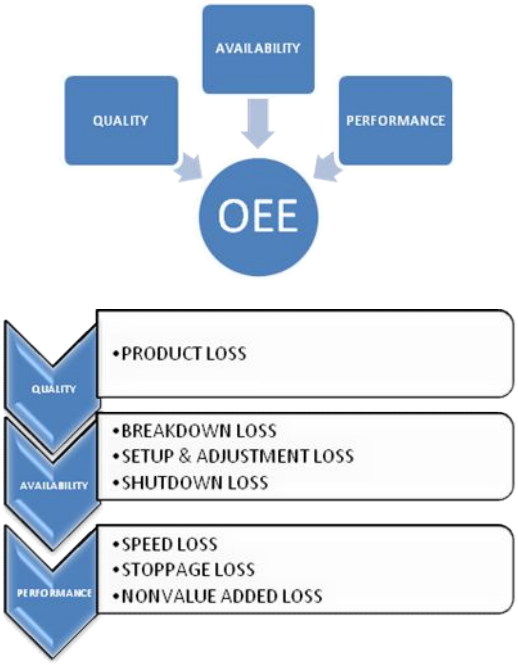

Fig 1. Classification of OEE and its Parameters

From the above Fig.1, it is known that OEE depends on those three parameters. This OEE is concerned with the physical elements of the manufacturing industry only. OEE can be a part of the improvement in the plant production.

3.2. Formulation and calculation of OEE by basic method

OEE can also take active participation in lean performance of any firm. Waste elimination can be calculated through OEE. The three factors listed from the above diagram are used to evaluate the performance of the OEE by using the below given data in table 1.

Total pieces	19374
Good pieces	19030
Operating time	362 minutes
Planned production time	420 minutes
Ideal run rate	60 pieces per minute

Table 1. Industrial data

Availability = Operating time / Planned production time (2)

Total performance = Ideal cycle time/ (Operating time / Total pieces) (3)

Run rate is reciprocal to cycle time and performance can also be calculated by

Performance = (Total pieces / Operating time) / Ideal run rate (4)

Quality = Good Pieces / Total pieces (5)

OEE = Quality X Availability X Performance

= 0.982 X 0.861 X 0.8919

= 0.7541 = 75.41 %

3.3 Formulation and calculation of OEE by lean metrics

The above are the 7 metrics to be considered as lean parameters and now we will find out the amount of loss is being occurred by every individual metric in this manufacturing company by taking the relevant data by using the below relations.

$$M_1 = \left(\frac{\text{start rejects} + \text{production rejects}}{\text{Total products}}\right) X\ 100 \quad (6)$$

$$M_2 = \left(\frac{Break\ down\ time}{Planned\ production\ time}\right) X\ 100 \quad (7)$$

$$M_3 - \left(\frac{setup\ and\ adjustment\ time\ loss}{Planned\ production\ time}\right) X\ 100 \quad (8)$$

$$M_4 = \left(\frac{Number\ of\ shutdowns}{Total\ planned\ shutdowns}\right) X\ 100 \quad (9)$$

$$M_5 = \left(\frac{Actual\ production}{Desired\ production}\right) X\ 100 \quad (10)$$

$$M_6 = \left(\frac{Minor\ stoppage\ time}{Operating\ time}\right) X\ 100 \quad (11)$$

$$M_7 = \left(\frac{Idle\ time + Interference\ time + Line\ balancing\ loss}{operating\ time}\right) X\ 100 \quad (12)$$

By substituting the relevant data in the formulae gives the individual performances of the each metric and hence tabulated in below table 2.

METRIC	**Hypothetical Performance Data**
PRODUCT LOSS	2.41%
BREAK DOWNS	4.1%
SETUP AND	6.09

ADJUSTMENT LOSS	
SHUTDOWNS	1
SPEED LOSS	0.87
STOPPAGE LOSS	4.13%
NON VALUE ADDED TIME	9%

Table 2. Individual performances of lean metrics

OEE is nothing but the overall equipment performance of the plant. So on observation of the each metric we can easily find out that which is having the best performance and the worst of it. So by knowing this, we can do further improvements in the worst scenario and this will help the managers and upper level superiors to take immediate action on that metric ,that finally improve the plant efficiency.

OEE = Quality X Availability X Performance

$$OEE = \left((1-(M_1))X(1-(M_2+M_3+M_4))X(1-(M_5+M_6+M_7))\right)$$

= (1-0.0241) X (1-0.1119) X (1-0.14)

=0.7453 = ~ 74.53%

IV. RESULTS

In this present paper, initially the author concentrated on the evaluation of overall equipment effectiveness by two approaches. One is the basic common method which is being adopted from the past few years and the next is by using the lean metrics. Initially by taking the industrial data and evaluated the OEE of the plant which gives the result 75.41%. Next is by forming surrogates to the three factors of the OEE and formulating them individually and calculating their performances individually. An individual performance gives us the best and worst performances of the machines and helps the managers to work on them to get a fruitful productivity. The result from the later method is 74.53%. The variation in these results partially supports the author approach for its sensitivity and accuracy. As the number of metrics to the OEE factors increases gives the more accurate value. Hence the author suggests that, calculating OEE results in a simple way rather than achieving it by a former method.

V. CONCLUSION

This study has given the steps for the measurement of OEE performance of the industry by using basic method and by lean metrics. Waste elimination is considered to be the most important attribute of the industry. Quality, cost and time are taken as important surrogates for the three factors of OEE. Continuous improvement plays a vital role in every industry in the present competitive global market to ensure a better product to the customers. By calculating the OEE of the plant gives the information about the performance of the plant which is used to make some improvements for achieving a better production. The author partially supports this method as the result formed is obtained by the individual performances of the lean metrics. The results obtained are very sensible and can be considered for its improvement to get a fruitful productivity. Hence the author suggests this method for its adoption in various industries.

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