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EVALUATION OF DEGREE OF LEANNESS TO THE OVERALL EQUIPMENT OF THE INDUSTRY

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Abstract: A wide range of management techniques are being used to calculate the performance of the overall equipment effectiveness (OEE) from years long ago. In order to achieve a high quality range of production, it is very important to learn about various meaurement approaches for its equipment measurement. Here the author tries to attempt one simple technique for finding it by using fuzzy membership values through a measure of lean score. This study presents the evaluation of degree of leanness to the overall equipment of the industry by using the fuzzy membership values. It helps in systematically and analysis of individual process and helps in calculating the overall equipment efficiency of the plant and helps to overcome the major losses causing machines.

Keywords: OEE, Lean metrics, fuzzy membership values, performance, lean score

I. INTRODUCTION

In today's competitive world, efficiency and effectiveness has become buzzwords to the industry. More and more productivity of the organization depends on the more and more values of the efficiency and effectiveness. Overall equipment effectiveness(OEE) is a performance measure which is used to evaluate the present stage of the production with minimum calculations. It also helps in finding the worst performance machines in order to get a fruitful productivity. Utilizing men, machinery, material and methods effectively gives a higher productivity [1] Lean manufacturing tools and techniques have been well known from the last two decades as they are bringing a tremendous increment towards productivity in all segments of the industry. Managers are in particular in attempting these lean principles in order to enhance productivity and elimination of wastes. Lean manufacturing effort is to produce its goods with good quality, optimized cost and JIT delivery. In this present competitive world most of the companies are thriving to implement lean manufacturing in order to be alive and competitive with other companies. Due to lack of clear understanding of the lean manufacturing tools and techniques, some of them are being failed to implement them. It can be possible only after measuring its performance. [4] 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 [5]:

OEE= Availability X Performance X Quality Eq. (1)

II. LITERATURE SURVEY

In this paper the authors made an attempt to measure and analyze the existing overall equipment efficiency of critical machinery. By using minitab15 software, he made experimentation on the three factors and provides an analysis information about which is most influencing factor [1]. This paper shows a relationship between OEE and FMEA, in which all parameters of OEE are evaluated with respective to FMEA [2].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 [3]. In another paper Farzad Behrouzi and Kuan Yew Wong [4] 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. 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 [5]

III. THE PROPOSED WORK

The proposed work consists of

- Firstly, the author tries to find the surrogates to the factors of OEE with respect to cost and quality.
- Next, formulation of the individual metric has been considered and the relative data has been acquired from the industry.
- Finally, the degree of leanness to the overall equipment of the industry is evaluated by using the fuzzy membership value function and the individual performances are shown graphically.

Classification of OEE and its Metrics

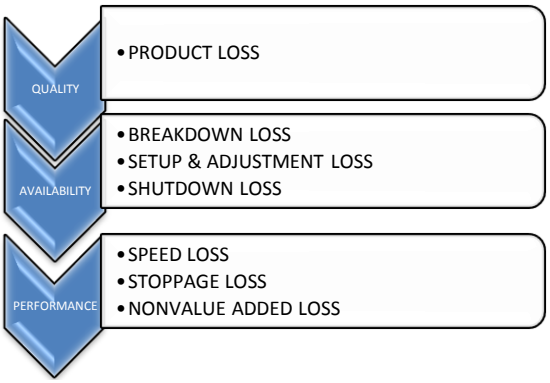


Fig 1. Classification of OEE and its metrics

Now the author wants to bring the relation between each metric. So now he tries to calculate the performance of each metric and finally to get the unique lean score. Here the author implemented some formulae's for calculation which are tabulated below in table 2.

Formulation of each metric

Product Loss	$M_1 = \left(\frac{\text{Number of start up rejects + Number of production rejects}}{\text{Total number of products}}\right) X\ 100$
Breakdowns	$M_2 = \left(\frac{Break\ down\ time}{Planned\ production\ time}\right) X\ 100$
Set up and Adjustment Loss	$M_3 = \left(\frac{Time\ taken\ for\ setup\ and\ adjustment\ loss}{Planned\ production\ time}\right) X\ 100$
Shutdowns	$M_4 = \left(\frac{Number\ of\ shutdowns}{Total\ planned\ shutdowns}\right) X\ 100$
Speed Loss	$M_5 = \left(\frac{Actual\ production}{Desired\ production}\right) X\ 100$
Stoppage Loss	$M_6 = \left(\frac{Minor\ stoppage\ time}{Operating\ time}\right) X\ 100$
Non Value Added Time	$M_7 = \left(\frac{Idle\ time + Interference\ time + Line\ balancing\ loss}{operating\ time}\right) X\ 100$

Table 1. Formulation of lean metrics

Now we have to set the fuzzy area and membership functions for each performance metric by taking two values as point A and point B. Point A represent the best performance and point B represents the worst performance of the given metric. So by using those, we can fuzzify the metrics and can bring the fuzzy membership values to each metric, where the continuous improvement is given to all the metrics. Graphically, triangular areas are obtained to show the fuzzy areas and the membership values for the each metric can be obtained from Bojadziev and Bojadziev [9].

$$\mu_{F(M_i)} = \begin{cases} 1 \\ 1 - \left(\frac{M_i - a}{(b-a)}\right) \\ 0 \end{cases} \qquad \begin{cases} if\ M_i \le a \\ if\ a < M_i < b \\ if\ M_i \ge b \end{cases}$$

Eq. (2)

From the fuzzy set areas the author says that the point A is fixed and its all values equal to zero, as it indicates the best performance of all metrics and the values at A must be reduced as much as low he can. At point B the worst performance has to be noted at that period. Fixing the points A and B as arbitrary and can be changed to different values by the manufacturer's analyst and individual performances has been calculated and shown in graph.1. Now, it is time to calculate the lean score by taking average of all the performance metrics membership values. This score will be used as for lean evaluation the firm and used for the better improvement in the particular areas of the manufacturing unit. Lean performance score can be calculated from Farzad Behrouzi and kuan Yew Wong [8]

$$\text{LEAN SCORE} = \left(\sum_{i=1}^{7} \frac{\mu_F(M_i)}{7}\right) X\ 100$$

Eq. (3)

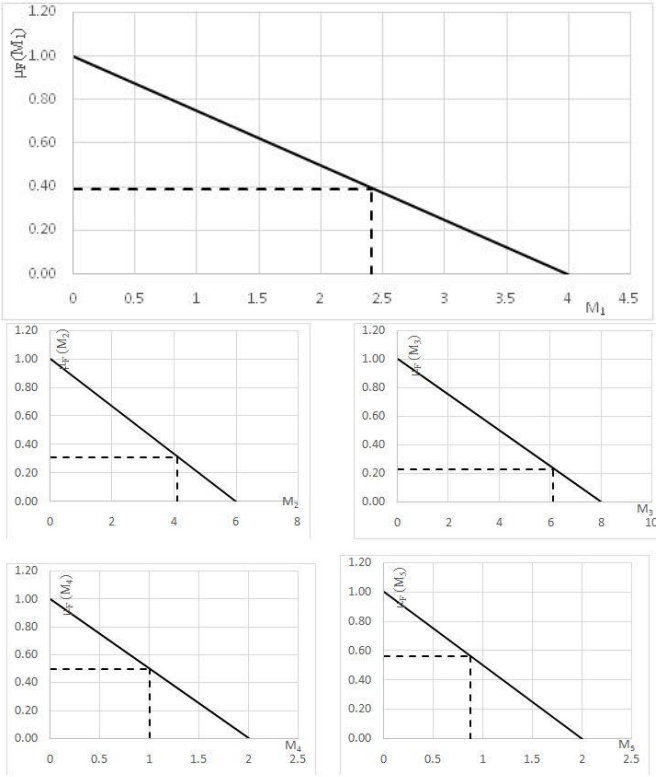
Calculation of lean score

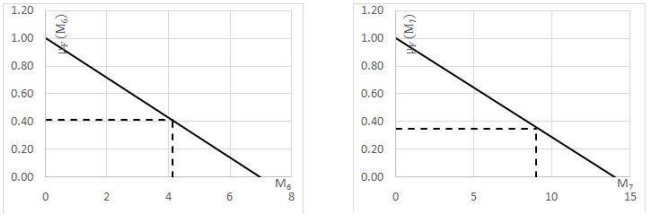
Metric	Hypothetical Performance Data	Point A	Point B	Membership value
Product Loss	2.43%	0	4%	0.3925
Breakdowns	4.17%	0	6%	0.305
Set up and Adjustment Loss	6.22%	0	8%	0.225
Shutdowns	1%	0	2%	0.5
Speed Loss	0.87%	0	2%	0.565
Stoppage Loss	4.12%	0	7%	0.41
Non Value Added Time	9.1%	0	14%	0.35
LEAN SCORE	39.20			

Table 2. Calculation of lean score

Graphical representation of the individual lean performances

Graph.1 illustrates the individual performances of the each metric from the fuzzy triangular areas as shown in the graph.1. Here the fuzzy areas are formed within the given range of values and the individual performances are calculated on Y-axis from the corresponding hypothetical data shown on X-axis. The average performance gives the lean score.





Graph.1 Graphical representation of fuzzy membership values for lean attributes

IV. RESULTS

In this paper the author firstly concentrated on the factors of OEE and next he drew the surrogates for them basing on quality, availability and time. Next he formulated the metrics and calculated the individual metric performances by using industrial data. Later on he calculated the lean score by using fuzzy membership value function. Hence the result partially supports the author's formulation for its worldwide adoption in various industries to get a fruitful productivity.

V. CONCLUSION

This study has given steps for the measurement of degree of leanness to the overall plant equipment. This paper presents an optimistic approach for its measurement by calculating the performances of the individual metrics and later on tried to find the lean score by using fuzzy membership values. This is a simple way to find out the critical evaluation of the plant equipment effectiveness. The result partially supports this study to help managers and higher level officers to do improvement in the worst performance metric and to get a fruitful productivity.

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