ISSN No:-2456-2165

Six Big Losses Approach and Kaizen Philosophy Implementation to Improve Overall Equipment Effectivenes (OEE) (Case Study: PT. ABC, Areinforced Steel Manufacturer)

Untung Mardono, Doto, Anni Rohimah, Erry Rimawan
Magister Industrial Engineering, Mercu Buana University

Abstract:- Business Competition of Concrete Reinforcement Industries in Indonesia is quite tight where the installed capacity of all factories is 7 million tons / year with the current requirement of 2.5 million tons / year. The quality of the products of each manufacturer refers to the acceptable quality of the market and has been standardized by SNI, so that manufacturers who can provide low product prices will win the competition of reinforced steel products in the market. It encourages PT. ABC as a pioneer of steel reinforcement in Indonesia which has a production capacity of 150,000 tons / year with rolling mill technology that has been left behind compared to other competitor's production facilities to continue to make improvements in order to remain competitive in the market. Average Equipment effectiveness (OEE) from the manufacturer in 2014 - 2016 is still low at 42.5%. With the approach of analysis of Six Big Losses hence can be known problem and constraint on production operation causing low OEE and high rolling cost (rolling cost). Problems and obstacles that are analyzed and made solution improvement by using Kaizen philosophy approach, so there is potential to increase OEE to 80% which will affect the competitiveness of PT. ABC on the market.

Keywords:- *OEE, Overall Equipment effectiveness, Six Big Losses, Kaizen.*

I. INTRODUCTION

The installed production capacity of all domestic reinforcing steel producers is currently 7 million ton / year from the market requirement of 2.5 ton / year (Katalog Metal, 2009) and (IISIA Directory, 2012). This condition makes the competition of reinforcing steel marketis very tight, where the manufacturerthan can produce the product with lower price will win the competition. This condition encourages the manufacturer with large capital capabilities revitalized their production facilities with new technologies and increase production capacityto reduce production costs

Machine is the main component of business and technology is a company's strategy to involve in industrial market competition, especially in the modern manufacturing industry era. Therefore, performance of a machinemust be more attention and be important role in company to regard as World Class Manufacturing (Nayak, Kumar M N, Naidu, & Shankar, May 2013).

PT. ABC is a steel rolling manufactureras pioneer of steel reinforcement manufacturer in Indonesia. PT ABC has a strong brand image of quality, but its production facilities have been left behind with other competitors.Excluding raw material costs (75%), components of the production cost (Rolling Cost) of reinforced steel manufacturer as the following below:

- Natural gas as energy source of raw material heating by 10%.
- Electrical Energy as an energy source rolling process of 7.5%.
- Maintenance costs, man power, etc. 7.5%.

The amount of rolling cost is influenced by production volume, if the volume increases then the cost will decrease. The production volume is highly dependent on the overall performance / performance of the reinforced steel machine. Performance of reinforced steel machine is reelected asOverall Equipment Effectiveness (OEE). OEE have three parameters, which are Availability, Performance rate and Quality Rate.

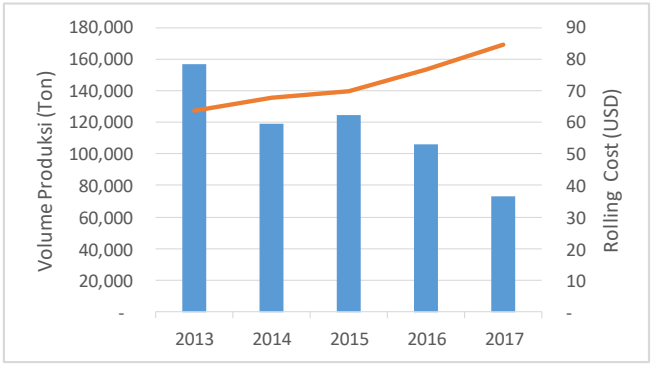

Fig 1:- (Production Volume from 2013 to 2017)
(Source: Internal Data of PT.ABC,2017)

Based on production volume data from 2013 - 2017 as shown in Figure 1, it was shown that the production volume achieved from reinforced steel mill machinery decreases and affects:

- *Production costs (rolling cost) is increasing.*
- *Product competitiveness in the market is declining.*

To improve manufacturer competitiveness of reinforced steel product, PT. ABC needs to take a corrective action so that overall machine performance provides optimal output with efficient and competitive production costs.

A. Problem Formulation

PT. ABC must be competitive and excellent company. Therefore, many problems must be reduced and minimalized. Problem formulation in this research is.

- What is the value of OEE reinforced steel manufacturer PT. ABC and is the value appropriate the world class manufacturer level?
- What factors and problems caused the low value of OEEreinforced steel manufacturer?
- What improvement can be taken to improve the performance of reinforced steel manufacturer?

B. Research Objectives

Based on the introduction, the purpose of this research is.

- Calculate OEE reinforced steel Manufacturer PT. ABC and compare with OEE's standard of world class manufacture.
- Find the factors and causes of low value of OEE reinforced steel manufacturer PT. ABC with Six Big Losses approach.
- Determine the corrective action using Kaizen philosophy.

II. LITERATURE REVIEW

A. Kaizen philosophy

Kaizen means continuous improvement (Imai, 1999). The kaizen philosophy holds that our way of life whether it is work life or social life should focus on continuous improvement (Imai, 1999). Although the improvements in kaizen are small and gradual but the Kaizen process is capable of bringing dramatic results follow the times.

B. Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is a product of operations with six big losses in machinery / equipment. The six factors in the six big losses can be grouped into three main components in OEE to measuring the performance of machinery or equipment, i.e, downtime losses, speed losses and defect losses.

According to Nakajima (1988), OEE is a comprehensive measure that identifies machine or equipment productivity levels from performance in theory. This measurement is very important to know which areas need to be increased either productivity or efficiency of machine / equipment. OEE can show bottleneckareain production process. OEE is also a measuring tool for evaluating and improving the right way to ensure increased productivity of machine / equipment.

Measurement of OEE (Overall Equipment Effectiveness) is a measurement on machine's performance, which is influenced by value of three factorsi.eAvailability, Performance Rate and Quality rate.

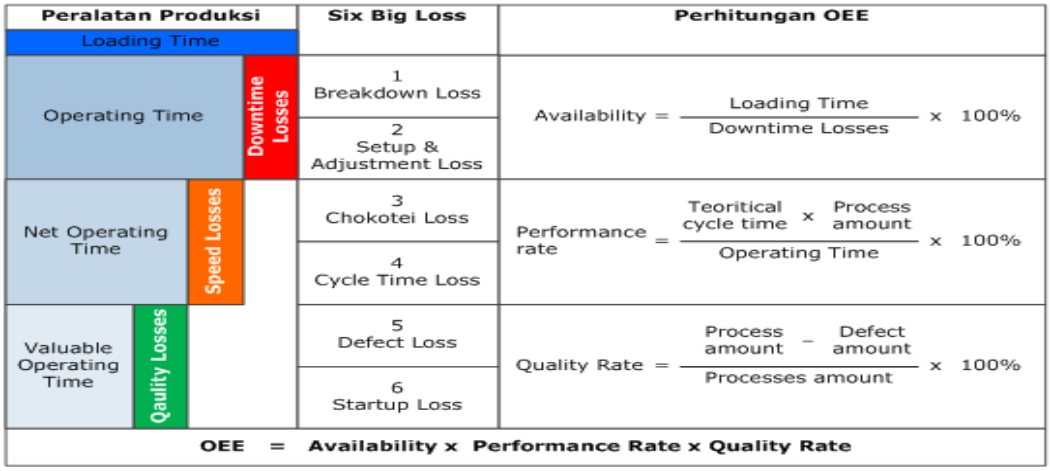

Fig 2:- Relation between OEE and Six Big Losses
(Source: Nakajima, 1988)

World Class Manufacturing OEE's standard and this three factor shown by table 1 below:

Availability	90%
Performance	95%
Quality	99%
OEE	85%

Table 3. World Class Manufacturing OEE's standard
Source: Nakajima,1988

- *Six Big Losses*

Activities and actions taken not only focus on preventing damage to machinery / equipment and minimizing machine / equipment downtime. However, many factors can cause losses due to low efficiency of machinery / equipment (Nakajima, 1998). Low productivity of machinery / equipment that causes losses to the company is often caused by ineffective and efficient use of machinery / equipment. There are six equipment losses that cause low performance of machinery and equipment. These six losses are known as six big losses categorized into 3 main categories based on the aspects of the loss, namely:

- Downtime losses,
- Speed losses and
- Defects losses.

From the three aspects of the above losses, kinds of losses are spelled out as follows:

- Downtime consists of two kinds of losses, namely breakdown and setup and adjustment.
- Speed losses consist of two kinds of losses, namely idling and minor stoppages and reduced speed.
- Defects consist of two kinds of losses, namely defects in process and reduced yield.

The six losses above concluded that there are three types of losses associated with the production process that must be anticipated, namely downtime loss that affects the availability rate, speed loss affecting performance rate, quality loss affecting the quality rate (Nakajima, 1988).

III. METHODOLOGY

This research process to improve performance of PT. ABC follow the method below:

A. Field Study

Field study is collecting data and conducting field observations. This methodintended to Determine the relevance's level of data to the current field conditions.

Table 1 World Class Manufacturing OEE's standard

B. Literature Studies

Literature Studies is intended to study theoretical knowledge and previous research related to performance improvement methods of a manufacturing industry.

C. Identify the Problem

After doing the observation in the field then identified the problem so that can solve the problem

D. Analysis and Discussion

The data that have been processed then analyzed and determined the improvement steps.

E. Conclusion and Suggestions

After finishing the proposition and discussion, the conclusion in this research is find factorsand problems on the reinforced steel manufacturer and how to solve them.

IV. RESULT AND DISCUSSION

The performance level of PT. ABC is reflected from the parameter of Overall Equipment Effectiveness (OEE) Performance which is divided into 3 (three) components, namely:

A. Availability

Steel reinforcement manufacturer included in continuous process category, Availability influenced by:

- Shut down: planned all machines off due to holiday / holiday and overhaul.
- Stand still time: planned mill not producing / removing product in partially shutdown engine condition.
- Delay time: machine is prepared to produce but there is engine damage, production process constraints and equipment settings.

Utility operation time average from 2014 – 2016 at PT. ABC shown in figure 3 below :

2016 shown that production productivity is 29.21 tons / hour and design productivity is 30.0 tons / hour.

B. Performance rate

Performance rate is the productivity to be able to exclude prime or standart products in every hour compared with the productivity of design. Average operation data from 2014–

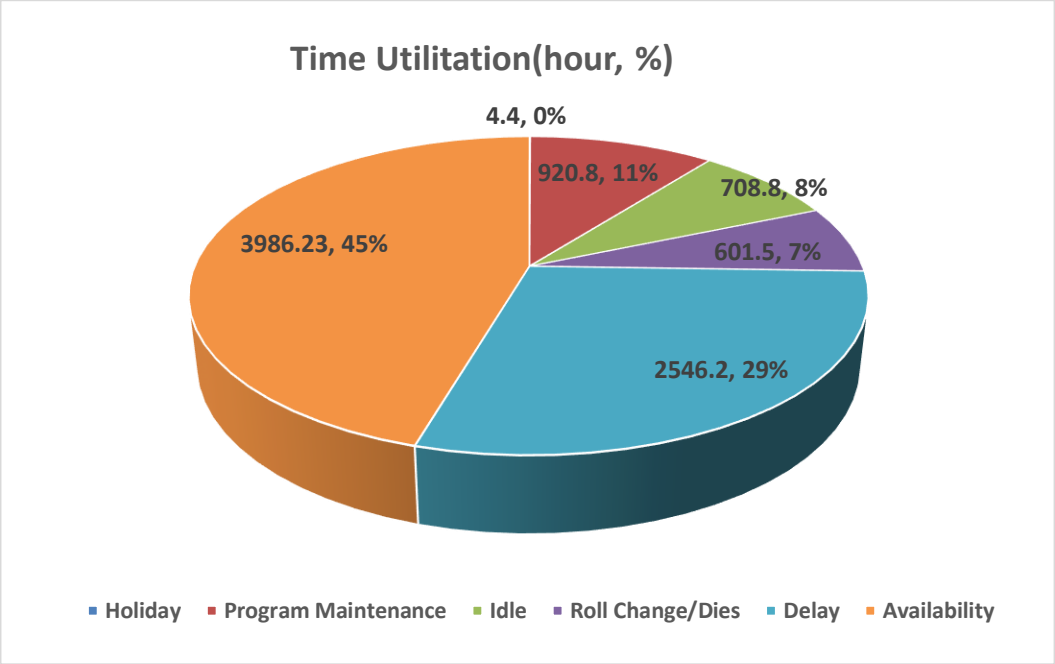

Fig 3:- Operation time utility from 2014 – 2016
(Source: internal data,2017)

TAHUN	BAHAN BAKU (TON)	PRODUK PRIME (TON)	NETT. OP TIME (JAM)	PRODUKTIVITAS (TON/JAM)
2014	125,127.11	119,053.69	3970.74	29.98
2015	132,268.14	124,480.20	4241.30	29.35
2016	112,282.57	106,034.18	3747.41	28.30
Rata-rata	123,225.94	116,522.69	3986.48	29.21
	100.0%	94.6%		

Table 2. Production Average, Material Usage, Nett Operating Time and Productivity from 2014 to 2016
(Source: internal data,2017)

C. Quality rate

Quality rate is the ratio of standard / standard products produced to raw materials used. Gap betweenraw materials and standard products are losses include:

- Couble: Failed process on the process of forming or rolling process. This losses result in loss of material and time for handling until ready production again.
- Reject: Products that do not meet the standards both dimensions, physical properties and physical visuals. This losses lead to waste of energy, time and other costs because the selling value of reject products only 50-60% of the selling value of standard products.

- Over flow: The product is in standard quality only under 6 meters long, its caused by process delay, the effective length of raw materials is not right.
- Scale: Iron oxide that occurred due to too long furnace.

Material balance of steel reinforcement process, ie material input in the form of raw materials equal to total output product consists of prime products, couble, reject, over flow and scale.

Material balance shown in Figure 4 below:

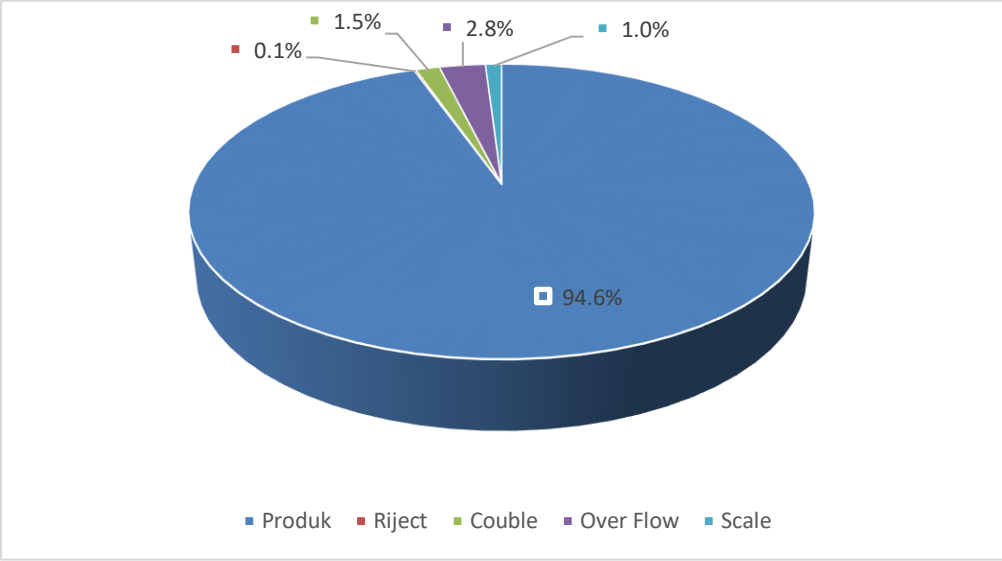

Figure.4 Material balance of PT. ABC (2014-2016)
(Source: Internal data,2017)

D. OEE Calculation

Based on previous data shown on Figure 3 and Figure.4, therefore :

OEE of PT.ABC is :
OEE = Quality rate x Performance rate x availability
Which is :

$$\text{Quality rate} = \frac{\text{prime product volume (ton)}}{\text{Raw material volume (ton)}}$$

$$= \frac{116.552{,}69(\text{ton})}{123.225{,}94(\text{ton})} = 0{,}946$$

$$\text{Performance rate} = \frac{\text{Actual Productivity (ton/hour)}}{\text{Design Productivity (ton/hour)}}$$

$$= \frac{29{,}3\ (\text{ton/hour})}{30{,}0(\text{ton/hour})} = 0{,}977$$

$$\text{Availability} = \frac{\text{Net t. Operating Time (hour)}}{\textit{Calender time (hour)}}$$

$$= \frac{3986{,}23\ (\text{hour})}{8768{,}0\ (\text{hour})} = 0{,}455$$

From previous calculation, OEE value is :
OEE = 0,946 x 0,977 x 0,455
= 0,4205
= 42,05 %

The above calculation results show that OEE of PT. ABC amounted to 42.05%, meaning very far from the OEE's standard of world class manufacture in the amount of 85%.PT. ABC must make improvements to the components performance.

Improvement of performance components is done by considering the comparison of each component gap of OEE, shown in Table. 3:

OEE	WORLD CLASS	PT. ABC	GAP
Quality rate	99.00%	94.60%	4.40%
Performance rate	95.00%	97.70%	-2.70%
Plant Availability	90.00%	45.50%	44.50%

Table 3.Comparation of OEE Component

From table 3 known that the OEE components that need to be repaired by PT. ABC are:

- Quality rate
- Availability

E. Calculation of Six Big Losses

The OEE analysis highlights six major losses that cause the production equipment can not operate normally. Six (6) major losses are grouped into 3 i.e downtime losses, speed losses and quality losses. Grouping 6 major losses are as follows:

Downtime Lossesare time wasted, where the production process is not running which is usually caused by engine damage. Downtime consists of 4 kinds of losses are:

Equipment Failure Losses is a loss caused by damage to machinery and equipment. The most common machine failure is that the machine dies suddenly, so the production process

Calculation Process / Production failure losses are as follows:

$$\text{ProductionFailure Losses} = \frac{\text{Total Breakdown Couble (hour)}}{\text{Calender Time (hour)}}$$

$$= \frac{1266\ (\text{hour})}{8768\ (\text{hour})} = 0{,}1444 = 14{,}44\ \%$$

Setup time losses is a loss caused by the process of the roll or dies changing. More varied plan size of the product will make greater setup time losses.

Calculation of Setup time losses are as follows:

$$\text{Setup time losses} = \frac{\text{Total Roll/Dies Change time (hour)}}{\text{Calender Time (hour)}}$$

$$= \frac{601{,}5\ (\text{hour})}{8768\ (\text{hour})} = 0{,}07 = 7\ \%$$

Idle time Losses is a loss caused by external influences beyond the control of the management e.gblackout power supply from generators, late arrival of raw materials. This condition occurs when 90% of machines are in the shutdown position.

Calculation of idle time losses are as follows:

$$\text{Idle time losses} = \frac{\text{Total Idle time (hour)}}{\text{Calender Time (hour)}}$$

$$= \frac{708{,}8\ (\text{hour})}{8768\ (\text{hour})} = 0{,}08 = 8\ \%$$

Defect losses are material losses in the form of product defects, process failures and product excess grouped in defects in process and reduced yield. The components of the defect losses in rolling process in PT. ABC are Couble, Riject, Over flow and Scale.

stops, whereas the most common equipment breaks are suddenly broken equipment, burning dynamo, damaged bearing / damage, Programmable Logic Control (PLC) and Drive Control Module (DCM) damage. The following calculation of equipment failure losses can be seen below:

$$\text{Equipment Failure losses} = \frac{\text{Total Breakdown Equipment (hour)}}{\text{Calender Time (hour)}}$$

$$= \frac{840{,}07(\text{jam})}{8768\ (\text{jam})} = 0{,}0958 = 9{,}58\ \%$$

Process / Production Failure Losses is a loss caused by failure of rolling process, such as oversized dimensions, not synchronizedspeed, and the position changed guide. As a result, the process / machine must stop for the repair process. Failure losses this causes 2 losses i.e material and time.

Calculation of Defect losses are follows as:

$$\text{Defect in process} = \frac{\text{Riject (ton)}}{\text{raw material (Ton)}}$$

$$= \frac{(1{,}941)(ton)}{123{,}225.9\ (\text{ton})} = 0{,}001 = 0{,}1\ \%$$

$$\text{Reduced yield} = \frac{\text{Couble+Over Flow+Scale (ton)}}{\text{Bahan Baku (Ton)}}$$

$$= \frac{(166.2 + 3{,}188.2 + 1{,}232.3)(ton)}{123{,}225.9\ (\text{ton})}$$

$$= \frac{(6361{,}52)(ton)}{123{,}225.9\ (\text{ton})} = 0{,}05162 = 5{,}2\ \%$$

F. OEE Calculation Analysis

The calculation result that has been done, result the average value of OEE year 2014-2016 is equal to 42,058%. The value is still far from the value of OEE World Class manufacture that is equal to 85% .Value of OEE will cause significant economic losses and corporate competitiveness is very low. Between 3 (three) OEE constituent components, the components that greatly affect low value of OEE Reinforced Steel Manufacturer is Availability and Quality rate.

G. Six Big Losses Analysis

Based on the analysis the losses can be sorted from the highest losses as follows:

Process failure losses amount 14,44 %
Equipment failure losses amount 9,58 %
Idle time losses amount 8 %
Setup time losses amount 7 %
Reduced yield amount 5,2 %
Defect in process amount 0,1 %

Factors that cause high process failure losses are high couble or process failure. This loss affects time and material loss. Another factor are the condition and conventional engine technology. These two factors are the main priorities that need improvement to increase the value of OEE.

H. Proposed improvement

From the analysis of losses that have been done, known that process failure losses is the highest losses. Two main causal factors are the high *couble* of 1.5% and the required handling time of 1265.9 hours and the conventional engine / engine condition, low reability so that the high engine repair delay is 840.07 hours or 9.58%. Therefore the improvement that must be done is as follows:

- With the existing conventional engine, the dimension of the size bar that comes out of the roll or dies is unstable and difficult to control, the operator must perform routine checks on: dimension bar size, wear roll / dies, guide condition and gap / roll distance.
- Investing for replacement of 7 (seven) units of conventional stand with new technology stand with main benefits: dimension bar stable size, no bearing wear, higher reliability spare part, speed rolling / roll time.
- Conducting preventive maintenance programs to improve the reliability of the equipment, so that machine damage can be prevented and predicted.

V. CONCLUSION

Based on research conducted and analysis and calculation of the dataobtained, it can be concluded as follows:

1. Measurement of effectiveness level of PT. ABC in 2014 - 2016 using OEE method obtained OEE value of is 42.058%. The value is still far from the value of OEE World Class manufacture that is equal to 85%.
2. Factors that greatly affect the low value of OEE is the value of Availability and Quality rate.
3. Cause factors that do not achieve Availability is the high failure process. The high process failure is caused by high *couble* or process failure, which losses affect the time and material loss. Another factor is the condition and conventional engine technology
4. Proposed improvements provided are:

a. Within the existing conventional engine, that dimension bar size comes out of the roll or dies is unstable and difficult to control, the operator must perform routine checks on: dimension bar size, wear roll / dies, guide condition and gap / roll distance.
b. Investing for replacement of 7 (seven) units of conventional stand with new technology stand with main benefits: Dimension bar stable size, no bearing wear, higher reliability spare part, speed rolling / roll time.
c. Conducting preventive maintenance programs to improve the reliability of the equipment, so that machine damage can be prevented and predicted.

REFERENCE

[1]. Mai, M. (1988).Genba Kaizen: Pendekatan Akal Sehat, BerbiayaRendahPadaManajemen. PustakaBrinamanPressindo.
[2]. Nakajima, S. (1988).Introduction to TPM (Total Productive Maintenance). Productivity Press, Inc.
[3]. Nayak, D. M., Kumar M N, V., Naidu, G. S., & Shankar, V. (May 2013). International Journal of Innovative Research in Science, Engineering and Technology.EvaluationOfOee In A Continuous Process Industry On An Cetak Line In A Cable Manufacturing Unit, 2(5), 1629-1634.