ISSN No:-2456-2165

KaizeninWorld Class Automotive Company With Reduction of Six Big Lossesin Cylinder Block Machining Line in Indonesia

Ahmad Rozak, Amalina Shadrina, Erry Rimawan
Magister of Industrial Engineering, Mercu Buana University
Jakarta, Indonesia

Abstract:- Cylinder block machining line in automotive manufacturing in Indonesia has launched a world-class company if reviewed from the achievement of productivity level of production activity and a number of quality products that are calculated using the Overall Equipment Effectiveness (OEE) value that is valued above 85% as mention in JIPM Total Productive Maintenance (TPM) world company standard. Even though it has reached the average OEE from September till November 2018 was 87%, so there was still an opportunity to make improvements of 13%, this company still continues to increase the value of OEE through Kaizen activities. Kaizen is carried out to make improvements to increase the value of Availability, Performance Efficiency, and Rate of Quality. The steps taken to improve OEE, starting with measuring OEE, are continued by calculating six major loses then looking for the biggest factor that affects the increasing OEE value. After that, look for the causes of the problems analyzed using Fishbone Diagrams. Things to do to increase the OEE value are to make improvements at the frequent breakdown machine and the long line stop machine as the priority of the problem. Within one month, we can increase OEE become 92% in December 2018.

Keywords:- *Total Productive Maintenance, Overall Equipment Effectiveness, Six Major Losses, Kaizen.*

I. INTRODUCTION

Machines are a common issue between maintenance and production. Because the maintenance part is considered a waste of money, while the production part feels that damage but also make money (Soemarno, 2008). Generally a product produced by humans, nothing is impossible to damage, but the age of its use can be extended by making known improvements to maintenance (Antony, C. et al. 1992). One of the factors supporting the success of the manufacturing industry is determined by the smoothness of the production process. So that if the production process is smooth, the effective use of machinery and production equipment will produce quality products, the right time to complete the manufacture and the low cost of production. The process depends on the condition of the resources owned such as humans, machines or other supporting facilities, where the conditions in question are conditions ready to carry out production operations, both accuracy, ability or capacity (Wulandari, 2018).

Cylinder block machining line of world class automotive company in Indonesia is a manufacturing company engaged in the manufacture of car engine, machines line that are the object of research is one of the several machines lines in the manufacture of car engine,this line processes cylinder block casting product by feeding the surface of machinery area before assembled with others component become car engine. Current Cylinder Block Machining Line'sOEE average value from September till November 2018 was 87.03%, it had not achieved company target 95%, even though it had achieved world class Manufacturing OEE's standard 85%.

Machines are critical units that impact to the smoothness of the production process, the impact can be as stop production, down speed of machinery, and product defect/reject, to overcome these problems appropriate steps are needed in maintenance of machinery, one of which is implementation of Total Productive Maintenance (TPM).The goal of implementing Total Productive Maintenance is to improve the efficiency and effectiveness of manufacturing companies as a whole. In other words the goal of TPM is to achieve ideal performance and achieve zero loss, which means without defects, without breakdown, without accidents, without waste in the production process and changeover process (Nakajima, 1988). Evaluation of the application of Total Productive Maintenance is done by using the Overall Equipment Effectiveness (OEE) value as an indicator and looking for the causes of ineffectiveness of the machine by calculating the six big losses to find out the influential factors of the six big losses. By doing OEE calculations, companies will know where they are and where weaknesses are and how to make improvements (Almeanazel, 2010).

This study purpose is to analyze the application of TPM at World Class Automotive Company, knows the great value of Overall Equipment Effectiveness (OEE) which is based on availability, performance and rate of quality factors. Second, knowing the factors that cause the decline in effectiveness through the measurement of six big losses and identifying the dominant factors of the six factors of the six big losses and analyzing the factors that contribute the most using the fishbone diagram. Then provide recommendations to overcome the main problems from the six big losses.

II. LITERATURE REVIEW

A. Kaizen

"Kaizen" literally means "change for the betterment". Kaizen involves small improvements and is carried out on a continual basis and involving people of all level in the organization. The principle behind Kaizen is that "a very large number of small improvements are more effective in an organizational environment than a few improvements of large value". This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. Objective of Kaizen is achieve and sustain zero loses with respect to minor stops, measurement and adjustments, defects and unavoidable downtime (R.Singh et.al, 2013).

B. Total Productive Maintenance (TPM)

Total Productive Maintenance is a program to determine the basis of improvements in plant productivity and performance, machinery and processes involved in the overall strength of work (Nakajima, 1988). Total Productive Maintenance (TPM) refers to the key words: Total, Productive, and Maintenance, as follows:

- Total
- All employees and management are involved.
- Covers the total life cycle of the production system.
- Productive
- Creating maximum productivity through zero defects, zero accidents, and zero damage.
- Minimize problems in the production system.

- *Maintenance*

Maintain good production system, which includes: individual process, factory, and whole production management system. (Gasperz, 2012).Total Productive Maintenance (TPM) covers several things such as total commitment to the program by top management, wider empowerment of workers to perform 14 corrective actions, and is an activity that takes a relatively long time to implement and the process is continuous. TPM makes maintenance activities an important focus in the business world and is no longer considered an unfavorable activity. In TPM, downtime for maintenance is scheduled as part of the daily production process and is even an integral part of the production process (A.A.U. Nugeroho, et. al. 2018).

C. Overall Equipment Effectiveness (OEE)

In evaluating and measuring the extent of the successful implementation of TPM, the measurement tool used is "Overall Equipment Effectiveness (OEE)". OEE is a comprehensive measure that identifies the level of machine / equipment productivity and its performance in theory. This measurement is very important to find out which areas need to be increased in productivity or efficiency of the machine / equipment and also can show the bottleneck area found on the production line. OEE is also a measuring tool for evaluating and correcting appropriate ways to ensure increased productivity in the use of machinery / equipment. By knowing the value of OEE (A. Wulandari, et.al.2018),

Mathematically from Overall Equipment Effectiveness (OEE) is formulated as equation 1:

OEE = *Availability* x *Performance Efficiency* x *Rate of Quality*

Where.

Availability (AV) formula as equation 2:

$$Availability = \frac{Operation\ Time}{Loading\ Time} x\ 100\%$$
$$Operation\ Time = Loading\ Time - Down\ Time\ Losses$$

Performance Efficiency (PE) formula as equation 3:
PerformanceEfficiency =

$$\frac{Processed\ amount\ x\ Ideal\ cycle\ time}{Operation\ Time} x\ 100\%$$

Rate of Quality (RQ) formula as equation4:
Rate of quality =

$$\frac{Processed\ amount - Deffect\ amount}{Processed\ amount} x\ 100\%$$

World Class Manufacturing OEE's Standard and this three factors shown by table 1 below:

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

Table 1:- World Class Manufacturing OEE's Standard

D. Six Major Losses

The six major losses are as follows:

- Downtime Losses, there are two kind losses:
- Equipment failure / breakdown (loss due to damage to equipment)
- Set-up and adjustment, (Losses due to installation and adjustment)
- Speed Losses, there are two kind losses:
- Idling and minor stoppages (Losses due to operating without a load or for stopping for a moment),
- Reduced Speed (Loss due to decreased operating speed).
- Defect Losses, there are two kind losses:
- Rework loss (losses due to defective products or because the product works are reprocessed)
- Reduced Yield Losses (Losses at the beginning of production time to achieve stable production conditions)

(Mc. Kellen, 2005), The six major losses include equipment failure/breakdown losses, setup and adjustment losses, idling and minor stoppage losses, defect and rework losses, and start-up losses. TPM endeavors to increase efficiency by rooting out losses that sap efficiency. The calculation of OEE by considering the impact of the six

major losses on the production system with Availability, Performance Efficiency, and Rate of Quality is indicated in Figure 1

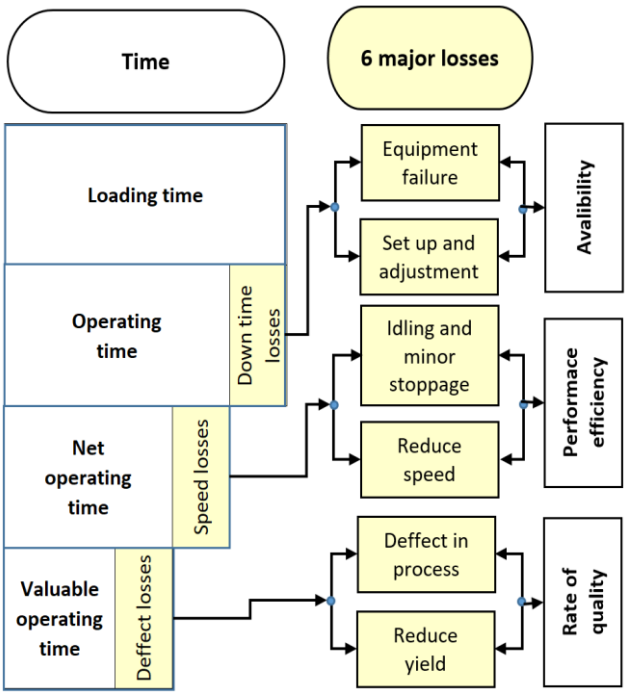

Fig 1:- Six Big Losses Image

E. Fishbone Diagram

Fish bone diagram was introduced for the first time in 1943 by Prof. Kaoru Ishikawa. This diagram is useful for analyzing and finding root cause from initial problem by asking why until found the root cause.

Mentioning one by one the causes and effect only shows all possible causes of certain problems which are grouped according to rational categories. This type of cause and effect diagram is ready to give the possibility to approach the contradictory suggestions that are being used.

III. METHODOLOGY

A. Data Collection

This research uses secondary data that is collected from production side such as machine breakdown, machine stand-by, operating time, production amount and number of defects. Data taken from September 2018 to November 2018. Data collected will be input at the data processing stage.

B. Framework

This research process the data quantitatively, the data obtained in the study will be processed and analyzed so that it can provide a clear work system. The research stages can be seen in Figure 2.

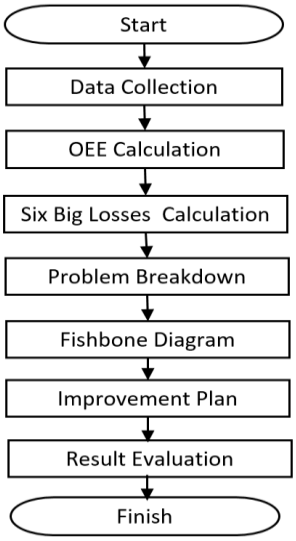

Fig 2:- Research Stages

IV. RESULTS AND DISCUSSION

The production process flow at the Engine Shop in the one of Indonesian big automotive company is shown in figure 3. The initial process starts from the reception of engine components resulting from casting plant such as: Crank Shaft, Cylinder Head, CAM and Cylinder Block. Then, the componentsare machined. The results of the machining process are sent to the Engine Assembly Line to be assembled with other components until it becomes an Engine Assy.

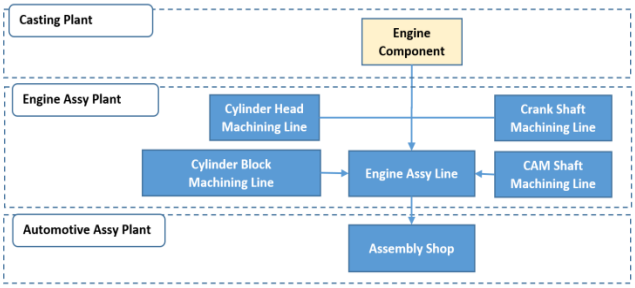

Fig 3:- Engine Flow Process

Engine Machining Process is more complex than Engine Assembly Process due to they involve many big machines for machining process and these machines have been 15 years old. We can see the impact to the OEE achievement each line as shown at figure 4.

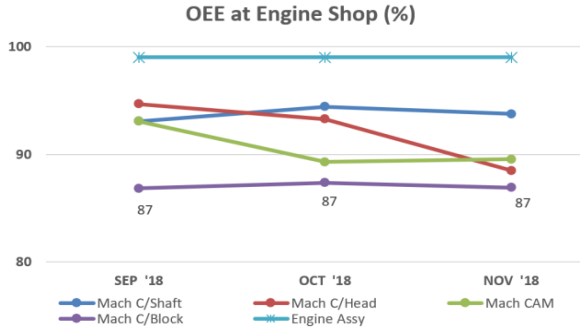

Fig 4:- OEE each Line

ISSN No:-2456-2165

Base on OEE achievement above, researcher decided to research at Cylinder Block Machining line because of the lowest OEE achievement and involve the most machine quantity for processing as mentioned at figure 5.

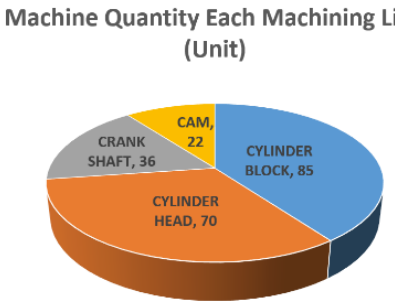

Fig 5:- Machine Quantity

Base on September till November 2018 data for Cylinder Block Machining Line's, we calculated the OEE and three factors as equation 1, 2, 3 and 4. The result calculation as mention at figure 6.

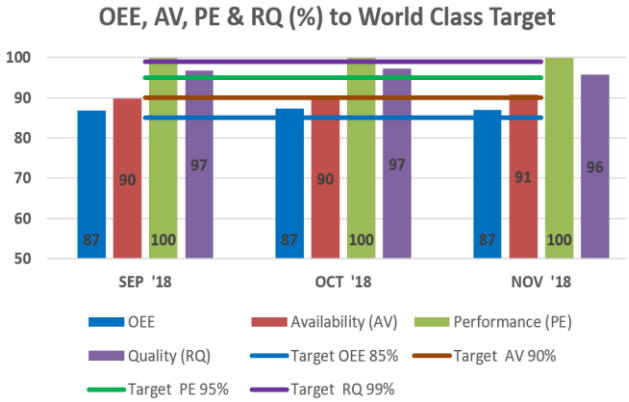

Fig 6:- OEE achievment Vs Worl Class Target

At Figure 6, if we compare the OEE achievement to the World Class Manufacturing OEE's standard, this Cylinder block machining line can achieved the target of OEE, AV and PE, but RQ still below the target. But if compare to company target as mention at figure 4. The OEE, AV and RQ haven't achieved it, just PE have achieved it.

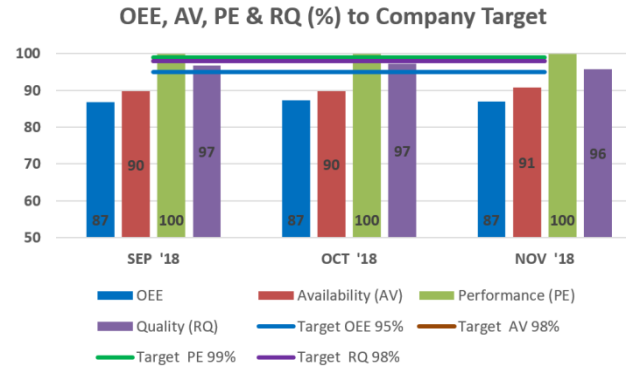

Fig 7:- OEE achievment Vs Company Target

Due to Kaizen spirit, we must do continuous improvement to increase OEE value by increasing the priority factor. From figure 8, to increase the OEE value, we must increase AV value because of have the biggest gap to the company target.

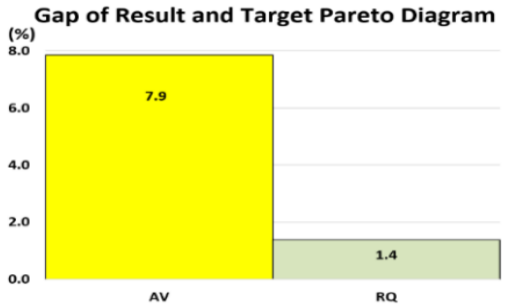

Fig 8:- Gap of OEE Factors Vs Target

A. Calculation of Six Big Losses

Base on Figure 8 Gap of Result and target Pareto Diagram, we focus for six big losses those related to Availability as follows:

- Equipment failure - breakdown (loss due to damage to equipment) = Total Equipment Breakdown (hour) / Loading Time (hour)
- Set-up and adjustment(Losses due to installation and adjustment) = Total Set-up and adjustment (hour) / Loading Time (hour)

Base on above formula of losses, we can see the result of losses for availability from September till November 2018 as mention at table 2 just for equipment failure, but for set up and adjustment losses are zero due to it being done at out of working time.

in Min

Month	Loading Time	Machine Breakdown	BD Loses (%)
September	24,810	2,539	**10.23**
October	25,115	2,548	**10.14**
November	23,535	2,167	**9.21**

Table 2:- Equipment Failure Losses

B. Problem Breakdown

From the losses analysis that have been calculated above, known that equipment failure is the high losses as mention at Table 2. So we will focus at machine breakdownfor OEE improvement to achieve company's target 95%.

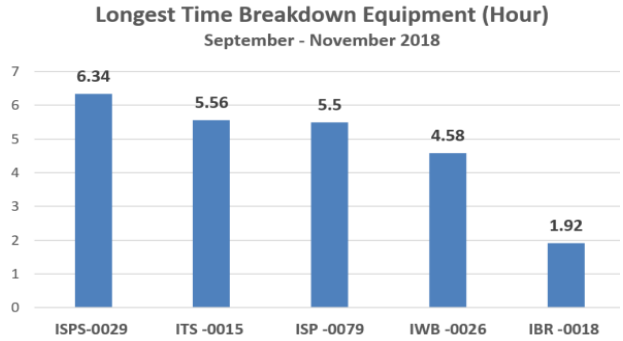

Fig 9:- Five Longest Time Breakdown Equipment

Priority improvement that must be done from machine breakdown is base on the long line stop machine and most frequent line stop machine from September till November 2018 that shown at graph figure 9 and figure 10. Base on five longest line stop machine as mention at figure 9 are as follows: ISPS-0029, ITS-0015, ISP-0079, IWB-0026 and IBR-0018.

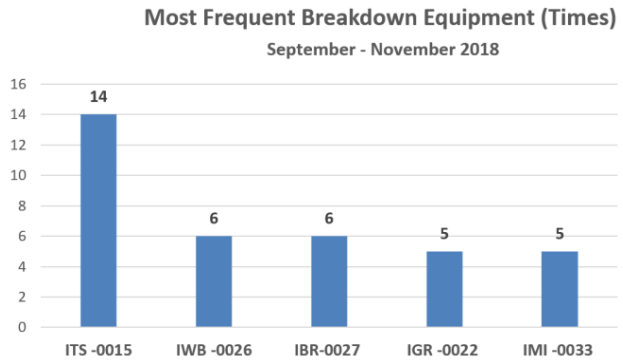

Fig 10:- Five Most FrequentBreak Down Machine

Base on fivemost frequent line stop machine as mention at figure 10 are as follows: ITS-0015, IWB-0026, IBR-0027, IGR-0022 and IMI-0033. Base on figure 9 and 10, We will focus for next improvement base on overlapping information of 5 longest line stop machine and 5 most frequent line stop machine are as follows: ITS-0015 and IWB-0026.

ITS-0015 machine failure from September till November 2018 as mention at figure 11, and IWB-0026machine failure from September till November 2018 as mention at figure 12.

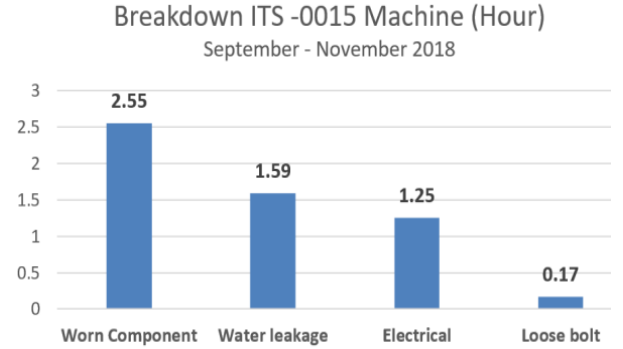

Fig 11:- ITS-0015 Machine Break Down detail

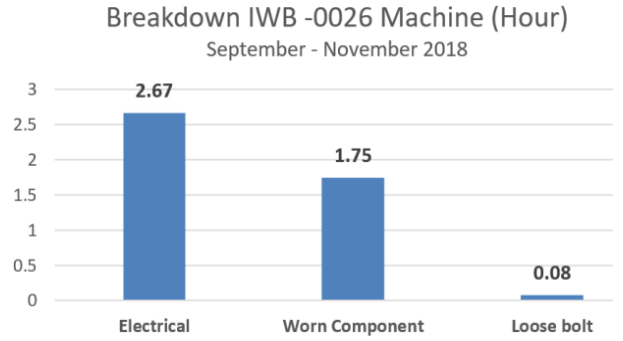

Fig 12:- IWB-0026 Machine Break Down detail

Then we will make grouping the above problem of ITS-0015 machine and IWB-0026 machine become TPM PM and TPM AM as mention at figure 13.

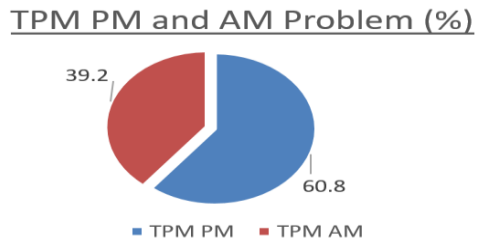

Fig 13:- Percentage of TPM PM and AM problem

From figure 13, we can see that 60.8% problem relate to TPM PM and 39.2% relate to TPM AM activities.

C. Fishbone Diagram

To look for the root cause of long time breakdown of machines, we focus for 3 observation items as follows: TPM PM, TPM AM and Method.We will use fishbone diagram as mention at figure 14 for it.

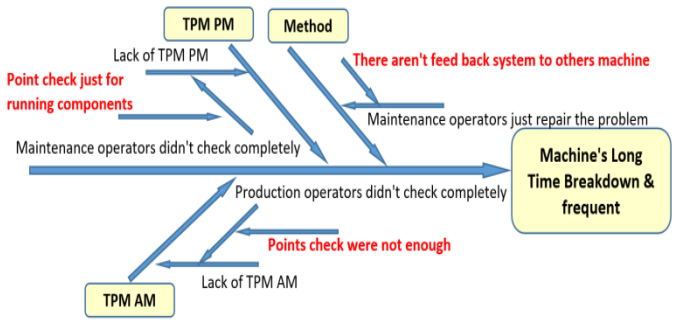

Fig 14:- Fishbone Diagram

Base on above fishbone diagram, we can find out the root cause of long time breakdown of machines as follows:

- TPM PM Point check just for running components
- TPM AM Point check were not enough
- There aren't feed back system to others machine.

D. Improvement / Kaizen Plan

We propose improvement planin December 2018 base on 3 root cause above as follows:

- Additional TPM PM Point check not just for running components but also for static components that impact for long time and frequent machine breakdown.

- Additional TPM AM Point check fro Production operators that impact for long time and frequent machine breakdown.
- Dofeedback system to others component in same amchine and to others similar machine.

E. Result Evaluation after Kaizen

After implementing above improvement plan in December 2018, then we measure the impact of OEE achievement become 92% as mention at figure 15.

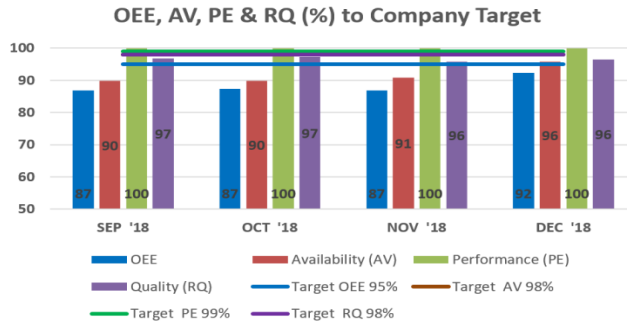

Fig 14:- OEE achievment after Kaizen Vs Company Target

Then we evaluate the longest line stop machine before and after kaizen as mention at figure 15. and most frequent line stop machine as mention at figure 16.

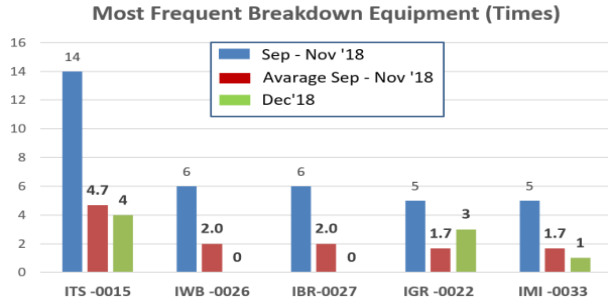

Fig 15:- Machine Break Down Frequent Evaluation

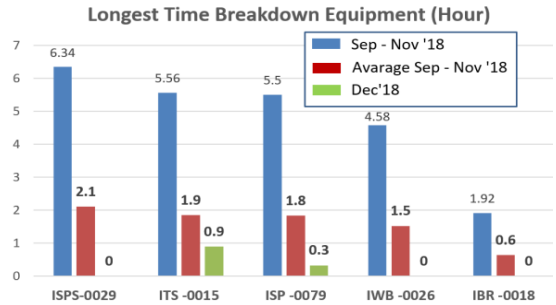

Fig 16:- Longest Time Breakdown Equipment Evaluation

Base on above evaluation, breakdown time of ITS-0015 machine reduce from avarage 1.9 become 0.9 hours in December 2018 and IWB-0026 machinereduce from avarage 1.5 become 0 hour in December 2018. And breakdown frequent of ITS-0015 machine reduce from avarage 4.7 become 4times in December 2018 and IWB-0026 machine reduce from avarage 2 become 0 tinme in December 2018.

V. CONCLUSION

Based on the results obtained can be concluded as follows:

- Based on the data of Overall Equipment Effectiveness (OEE) on the Cylinder Block machining Line for the period September 2018 - November 2018 the Overall Equipment Effectiveness (OEE) value is found at87% that over then the World Class Manufacturing OEE's standard 85%, but if compare to Company's OEE target 95% still have gap 8% for improvement/kaizen.
- From the data analysis, we found the gap of OEE factors to the target are AV = 7.9% and RQ = 1.4%, then we focus to increase AV.
- Due to there are 85 machines, we choose the machine that have long time and more frequent breakdown, then we chose to observe oITS-0015 and IWB-0026 machine.
- Improvement plan were proposed base on fishbone analysis as follows:

- Additional TPM PM Point check
- Additional TPM AM Point check
- Do feedback system.

- After implementing improvement/kaizen in December 2018, we can increase AV from 91% to 96% then impacted to OEE achievement from 87% become 92%.

REFERENCES

[1]. I.P.S. Ahuja, J.S. Khamba, (2008),"Total productive maintenance: literature review and directions", International Journal of Quality & Reliability Management, Vol. 25 Iss: 7 pp. 709 – 756

[2]. Ranteshwar Singh, Ashish M Gohil, Dhaval B Shah, Sanjay Desai, "Total Productive Maintenance (TPM) Implementation in a Machine Shop: A Case Study" Procedia Engineering 51 (2013) 592 – 599

[3]. Adik Ahmad Unggul Nugeroho, Gayuh Raditya Prabandanu, Rusmin Nuryadin, Erry Rimawan. "Effectiveness Analysis of Soehnel L1 Machine using Overall Equipment Effectiveness (OEE) Method in PT PQR" International Journal of Innovative Science and Research Technology, Volume 3, Issue 9, September– 2018

[4]. Nakajima, S. (1988). Introduction to TPM (Total Productive Maintenance). Productivity Press, Inc.

[5]. Mai, M. (1988). Genba Kaizen: Pendekatan Akal Sehat, Berbiaya Rendah Pada Manajemen. Pustaka Brinaman Pressindo.

[6]. [6] Annisaa Wulandari, Sampik Krisning Tyas, Erry Rimawan. "Implementation of Total Productive Maintenance (TPM) With Measurement of Overall Equipment Effectiveness (OEE) and Six Big Losses in International Journal of Innovative Science and Research Technology, Volume 3, Issue 12, December – 2018

[7]. Antony, C., & Hadi, K. (1992). Teknik Manajemen Pemeliharaan. Erlangga, JAKARTA

[8]. Almeanazel, O. T. R. (2010). Total productive maintenance review and overall equipment effectiveness measurement. Jordan Journal of Mechanical and Industrial Engineering, 4(4).