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Implementation of Total Productive Maintenance (Tpm) in the Application of Overall Equipment (Oee) in Pt.Xyz

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Abstract:- PT. XYZ is engaged in the zipper making industry, the company will identify factors affecting machine effectiveness and analysis of maintenance activities for input materials in Total productive maintenance (TPM) implementation. This study aims to measure the effectiveness of the total equipment of the production process, especially on the old Y-Bar Press machine, determine the factors causing the low Overall Equipment Effectiveness (OEE) value and identify the losses / losses, suggest the improvement of TPM implementation. The Overall Equipment Effectiveness (OEE) value of Press Machine Y-Bar for April-May 2018 between 32.95% - 76.08% is still below the Overall Equipment Effectiveness (OEE) rating standard with low performance ratio of 32.95% - 76.08%. Companies can know the effectiveness of older machines by calculating the effectiveness level of equipment using Total Productive Maintenance (TPM) based on Overall Equipment Effectiveness (OEE) value, so as to increase equipment effectiveness and eliminate big losses for companies known as Six Big losses.

Keywords:- *Maintenance, Total Productive Maintenance, Equipment Effectiveness (OEE), Six Big Losses.*

I. INTRODUCTION

Due to the age of the machine that has been aged the company applied the machine maintenance policy is corrective maintenance system. It causes the company to only repair damaged machines or breakdowns. At PT. XYZ has a problem in the Y-Bar Press machine, i.e. decreased production speed and often produce NG products that eventually become loss.
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. (Corder, Antony, K. Hadi, 1992). Therefore, much needed maintenance activities that include maintenance and maintenance of machinery used in the production process. Maintenance is all activities in which to keep the equipment system working properly (Jay Heizer and Barry Render, Operations Management, 2001) the main maintenance objectives can be defined as follows (Daryus A, Maintenance Management Machine, 2008).

- To extend the usefulness of assets,
- To ensure the optimum availability of equipment installed for production and to obtain the maximum possible investment return,
- To ensure the operational readiness of all necessary equipment in an emergency at all times,
- To ensure the safety of persons using such means.

The maintenance function is to extend the economic life of the existing machinery and production equipment and to make sure that the machines and production equipment are always in an optimal state and ready to use for the production process (Agus Ahyari, 2002).

Advantages to be gained by good maintenance of the machine are as follows:

- Machinery and production equipment in the company concerned will be able to be used in the long term,
- Implementation of production processes within the company concerned went smoothly,
- Can avoid or can minimize the possibility of possible severe damage from machinery and production equipment during the production process runs,
- The production equipment used can run stable and well, then process and process quality control must be implemented well also,
- Can be avoided the total damage of the machine and production equipment used,
- If the machine and production equipment is running well, then the absorption of raw materials can run normally,

Planned maintenance is divided into three forms of implementation, namely (Wijaya and Sensuse, 2011):

A. Preventive maintenance

Preventive maintenance is a periodical inspection of machinery and equipment in order to know the conditions that cause damage, and to keep the machinery and equipment damaged by repairing and resetting before it becomes more damaged.

B. Corrective maintenance (repair maintenance)

Corrective maintenance is an activity undertaken to overcome the failure or damage found during the preventive maintenance period. In general, corrective maintenance is not a scheduled maintenance activity, because it is done after a component is damaged and aims to restore the reliability of a machine or equipment. Corrective maintenance is usually known as breakdown or run to failure maintenance. Maintenance is only done after or broken machine. So if this strategy is used as the main strategy will cause a very high impact on a production.

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C. Predictive maintenance

Predictive maintenance is a maintenance activity performed on a predetermined date based on predictive analysis and evaluation of operational data taken to do predictive maintenance that can be data vibration, temperature, vibration flow rate and others. Total productive maintenance (TPM) is a basic maintenance development program that involves all human resources (HR), so that if implemented will improve quality, reduce costs and productivity, and reduce the cost. This maintenance system can be done by creating small groups in order to be well realized. (Nakajima, 1989). Total productive maintenance (TPM) began to be developed in the 1970s at a Japanese company which is a maintenance concept developer applied to a US manufacturing industry company called Preventive Maintenance. Like the period of PM development in Japan where the period of the 1950s can also be categorized as a period of "breakdown maintenance". Maintaining the condition of machines / equipment that support the implementation of the production process is an important component in the implementation of maintenance of production units. The purpose of productive maintenance is to achieve what is called profitable PM.

The objective of TPM (Total Productive Maintenance) is to increase productivity on equipment and production equipment by investing the necessary maintenance so as to prevent 6 big losses, namely:

- ✓ Breakdown
  Losses due to Damage to Machinery (Equipment and Work Equipment).
- ✓ Setup and Adjustments
  Losses resulting from the need to re-prepare equipment and equipment.
- ✓ Small Stops
  Loss due to the interference that causes the machine cannot operate optimally.
- ✓ Slow Running
  Losses incurred due to slow running engine do not match the desired speed.
- ✓ Startup Defect
  Loss caused by product defect at Startup (when machine start).
- ✓ Production Defect
  Losses that occur due to the number of defective products in the production process.

In addition to the six disadvantages mentioned above, other advantages of Total Productive Maintenance (TPM) implementation are to avoid the occurrence of work accidents and create a safe working environment for its employees.

OEE is a tool for measuring the existence of hidden costs. The most effective use of OEE is during the process with the use of basic quality control equipment, such as praetor diagrams. Use can be important for the existence of a company's performance measurement system. (Nakajima, 1988) Performance Measurement with OEE (Overall Equipment Effectiveness) consists of 3 main components of production machine Availability, Engine Performance, Performance and Quality.

OEE objectives can be used in several types of levels in an enterprise environment. First, OEE can be used as a "benchmark" to measure the company's performance plans. Second, the OEE value, the approximation of a production flow, can be used to compare the cross-performance line of the firm, it will look unimportant flow. Third, if the machinery process is done individually, OEE can identify which machines have poor performance, and even indicate the focus of TPM resources (Dal, 1999: 1490).

The OEE (overall equipment effectiveness) formula is as follows (Wireman, 2004):

OEE = Availability x Performance x Quality x 100%..... .(2.1)

$$\text{Availability} = \frac{operation\ time}{loading\ time} = \frac{loading\ time - (\sum downtime)}{loading\ time} \quad \text{.....(2.2)}$$

Loading time is the time available (availability) per day or per month reduced by the time machine downtime planned (schedule downtime) maintenance schedule (Schedule maintenance).

Loading Time = Machine Working time – (schedule downtime + schedule maintenance)……..(2.3)

Operation speed rate is the ratio between ideal engine speed based on actual engine capacity (theoretical / ideal cycle time) with actual engine speed (actual cycle time). The mathematical equation is shown as follows (Wireman, 2004):

$$\textit{Operation speed rate} = \frac{theorical\ cycle\ time}{actual\ cycle\ time} \quad \text{..... (2.4)}$$

Net operation rate is the ratio between the number of processed products (events amount) multiplied by actual cycle time with the operation time. Net operation time is useful to calculate the losses caused by minor stoppages and decreased production speed (reduced speed).

$$\textit{Net operation rate} = \frac{procesed\ ammount\ x\ actual\ cycle\ time}{operation\ time} \quad \text{.... .....(2.5)}$$

Performance ratio can be calculated as follows (Wireman, 2004):

Performance Ratio

Net Operating x Operating Cycle Time..... …….(2.6)

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II. ANALYSIS AND DISCUSSION

Period	Machine Working Time	Setup and Adjustment	Down Time	Defect Amount	Processed Amount	Work	Schedule Downtime	Schedule Maintenance
1/4 - 7/4	48,21	1,60	1,50	215	3.316.743	62,00	5,00	3,00
9/4 - 14/4	47,50	1,83	1,25	175	2.514.637	62,00	5,00	3,00
16/4 - 21/4	55,21	1,92	2,00	148	3.645.621	64,00	5,00	3,00
23/4 - 28/4	58,41	1,42	1,00	380	2.364.516	64,00	3,00	3,00
30/4 - 4/5	49,51	1,68	1,25	356	3.116.479	62,00	3,00	3,00
6/5 - 11/5	53,47	1,55	1,75	173	3.645.996	62,00	2,00	3,00
13/5 - 18/5	45,21	1,25	2,75	151	1.997.845	64,00	2,00	3,00
20/5 - 25/5	56,89	1,45	2,50	146	2.236.479	62,00	2,00	3,00
27/5 - 31/5	46,21	1,64	2,25	175	2.378.942	64,00	2,00	3,00

Table 1 Data of Press Machine Y- Bar on April- May 2018

Period	Machine Working time	Schedule Downtime	Schedule Maintenance	Loading Time
1/4 - 7/4	48,21	5,00	3,00	40,21
9/4 - 14/4	47,50	5,00	3,00	39,50
16/4 - 21/4	55,21	5,00	3,00	47,21
23/4 - 28/4	58,41	3,00	3,00	52,41
30/4 - 4/5	49,51	3,00	3,00	43,51
6/5 - 11/5	53,47	2,00	3,00	48,47
13/5 - 18/5	45,21	2,00	3,00	40,21
20/5 - 25/5	56,89	2,00	3,00	51,89
27/5 - 31/5	46,21	2,00	3,00	41,21

Table 2. Data of Press Cycle Machine Y- Bar antara bulan April- May 2018 (jam)

The Overall Equipment Effectiveness rating can be obtained by performing calculations according to Equations 2.1 to Equation 2.6. For example calculation on Y-Bar Press Press machine.

A. Calculation of Loading Time

The value of loading time required machine working time data, schedule downtime and operation time. The equations used to calculate loading time are:

Loading Time = Machine Working time – (schedule downtime + schedule maintenance)
Loading time = 48,21 – (5 + 3)
= 38,08 hour

ISSN No:-2456-2165

Period	Machine Working time	Schedule Downtime	Schedule Maintenance	Loading Time
1/4 - 7/4	48,21	5,00	3,00	40,21
9/4 - 14/4	47,50	5,00	3,00	39,50
16/4 - 21/4	55,21	5,00	3,00	47,21
23/4 - 28/4	58,41	3,00	3,00	52,41
30/4 - 4/5	49,51	3,00	3,00	43,51
6/5 - 11/5	53,47	2,00	3,00	48,47
13/5 - 18/5	45,21	2,00	3,00	40,21
20/5 - 25/5	56,89	2,00	3,00	51,89
27/5 - 31/5	46,21	2,00	3,00	41,21

Table 3. Data of loading time Press Machine Y- Bar antara bulan April- May 2018 (jam)

B. Calculation of Total Downtime and Operation Time.

The value of the total Downtime required Setup and Adjustment and Downtime data. The equations used to calculate the total downtime are:

Total Downtime = Setup and adjustment + Downtime Total Downtime

= 1,60 + 1,50 = 3,10 hour

The value of Operation time required data Loading time and Downtime. The equations used to calculate Operation time are:

Operation time = Loading time – Downtime

= 40,21 – 1,50 = 38.71 jam

Analogi with the above calculation, the Total Downtime and Operation time on April – May 2018 is shown in Table 3.4 below:

Period	Setup and Adjustment	Down Time	Loading Time	Total Downtime	Operation Time
1/4 - 7/4	1,60	1,50	40,21	3,10	38,71
9/4 - 14/4	1,83	1,25	39,50	3,08	38,25
16/4 - 21/4	1,92	2,00	47,21	3,92	45,21
23/4 - 28/4	1,42	1,00	52,41	2,42	51,41
30/4 - 4/5	1,68	1,25	43,51	2,93	42,26
6/5 - 11/5	1,55	1,75	48,47	3,30	46,72
13/5 - 18/5	1,25	2,75	40,21	4,00	37,46
20/5 - 25/5	1,45	2,50	51,89	3,95	49,39
27/5 - 31/5	1,64	2,25	41,21	3,89	38,96

Table 4. Data total downtime dan operation time bulan April - May 2018 (jam)

C. Availability Ratio Calculation And Operating Speed Rate

Value of Availability ratio required data Operation time and Loading time. The equations used to calculate the Availability ratio are:

Avaibility ratio $= \frac{operation\ time}{loading\ time} = \frac{38,71}{40,21} = 0,96$

The value of Operating speed rate required data Theoricritical cycle time and Actual Cycle time. The equations used to calculate the operating speed rate are:

Operation speed rate $= \frac{ideal\ cycle\ time}{actual\ cycle\ time} = \frac{0,03}{0,04} = 0,60$

Analog with the above calculation then Availability ratio and Operating speed rate period March-April is shown in Table 5 below:

ISSN No:-2456-2165

Period	Operation Time	Loading Time	Availability ratio (%)	Ideal Cycle Time (hour/pcs)	Actual Cycle Time (hour/pcs)	Operating speed rate (hour/pcs)
1/4 - 7/4	38,71	40,21	0,96	0,03	0,05	0,60
9/4 - 14/4	38,25	39,50	0,97	0,03	0,05	0,60
16/4 - 21/4	45,21	47,21	0,96	0,03	0,04	0,75
23/4 - 28/4	51,41	52,41	0,98	0,03	0,05	0,60
30/4 - 4/5	42,26	43,51	0,97	0,03	0,05	0,60
6/5 - 11/5	46,72	48,47	0,96	0,03	0,05	0,60
13/5 - 18/5	37,46	40,21	0,93	0,03	0,11	0,27
20/5 - 25/5	49,39	51,89	0,95	0,03	0,05	0,60
27/5 - 31/5	38,96	41,21	0,95	0,03	0,05	0,60

Table 5. Data Availability ratio dan Operating speed rate bulan April - May 2018

D. Calculation of Net Operation Time and Net Operation Rate

Value of Net operation time required data Loading time, idle and minor stoppages and downtime. The equations used to calculate the Net operation time are:

Net Operation time = Loading time – (idle and minor stoppages + downtime)

= 40,21 – (4,91 + 1,50)

= 33,80 jam

The value of Net Operation rate required data processed amount, actual cycle time and Operation time. The equations used to calculate the Net Operation rate are:

$$\textit{Net Operation rate} = \frac{\textit{procesed ammount x actual cycle time}}{\textit{operation time}} = 1.17$$

Analog with the above calculation then Availability ratio and Operating speed rate period April - May 2018 is shown in Table 3.6 below:

Period	Loading Time	Idle and Minor Stoppages	Down Time	Net operation time	Net operation rate
1/4 - 7/4	40,21	4,91	1,50	33,80	1,17
9/4 - 14/4	39,50	2,15	1,25	36,10	1,01
16/4 - 21/4	47,21	0,94	2,00	44,27	1,07
23/4 - 28/4	52,41	1,75	1,00	49,66	1,01
30/4 - 4/5	43,51	1,75	1,25	40,51	1,04
6/5 - 11/5	48,47	1,49	1,75	45,23	1,09
13/5 - 18/5	40,21	5,67	2,75	31,79	1,31
20/5 - 25/5	51,89	2,41	2,50	46,98	1,04
27/5 - 31/5	41,21	2,34	2,25	36,62	1,02

Table 6. Data of operation time and Net operation rate of April – May 2018

E. Calculation of Performance Ratio and Quality Ratio

Value of Performance ratio required data Operating speed rate and Net operating rate. The equations used to calculate the Performance ratio are:

Performance Ratio = Operating speed rate x Net operating rate x 100%

= 0.60 x 1.17 x 100%

= 70%

Value of Quality ratio required data processed amount and defect amount. The equations used to calculate the Quality Ratio are:

Quality Ratio = Processed Amount - Defect Amount/Processed Amount

= 3316743 – 215 / 3316743

= 99.99 %

Analog with the above calculation then Performance ratio and Quality ratio period April - May 2018 is shown in Table 3.7 below:

ISSN No:-2456-2165

Period	Operating speed rate (hour/pcs)	Net operation rate	Performance ratio (hour)	Defect Amount	Processed Amount	Quality ratio (%)
1/4 - 7/4	0,60	1,17	0,70	215	3.316.743	99
9/4 - 14/4	0,60	1,01	0,61	175	2.514.637	99
16/4 - 21/4	0,75	1,07	0,80	148	3.645.621	99
23/4 - 28/4	0,60	1,01	0,61	380	2.364.516	99
30/4 - 4/5	0,60	1,04	0,62	356	3.116.479	99
6/5 - 11/5	0,60	1,09	0,65	173	3.645.996	99
13/5 - 18/5	0,27	1,31	0,36	151	1.997.845	99
20/5 - 25/5	0,60	1,04	0,62	146	2.236.479	99
27/5 - 31/5	0,60	1,02	0,61	175	2.378.942	99

Table 7. Data Performance ratio dan Quality ratio bulan April - May 2018

F. Calculation of Overall Equipment Effectiveness (Oee)

Value of Overall Equipment Effectiveness (OEE) required Data Availability, Performance Rate and Quality Rate. The equations used to calculate the Overall Equipment Effectiveness are:

OEE (%) = Availability x Performance Rate x Quality Rate
= (0,96 x 100%) x 0,70 x 0,99
= 66,91 %

Analog with the above calculation then Overall Equipment Effectiveness period April - May 2018 is shown in Table 3.8 below:

Period	Availability ratio (%)	Performance ratio (%)	Quality ratio (%)	OEE (%)
1/4 - 7/4	96,27	70,20	99	66,91
9/4 - 14/4	96,84	60,60	99	58,10
16/4 - 21/4	95,76	80,25	99	76,08
23/4 - 28/4	98,09	60,60	99	58,85
30/4 - 4/5	97,13	62,40	99	60,00
6/5 - 11/5	96,39	65,40	99	62,41
13/5 - 18/5	93,16	35,73	99	32,95
20/5 - 25/5	95,18	62,40	99	58,80
27/5 - 31/5	94,54	61,20	99	57,28

Table 8. Overall Equipment Effectiveness (OEE) Data for April - May 2018

III. DISCUSSION

The value of OEE will be the reference in the research to conduct further analysis. The value of OEE achievement can be seen in table 8. In the table it is seen that the OEE value fluctuates from period to period. The lowest value of OEE achievement occurred in the period May 13 to May 18 with a value of 32.95% and the highest value in the period April 1 to April 7 with a value of 66.91%. The OEE value of the equipment / machine in ideal condition according to world class company standard is 85% (Vakantesh, 2000). The value can be obtained with the following composition: availability ratio 90% or more, performance ratio 95% or more, and quality ratio with 99% or more value.

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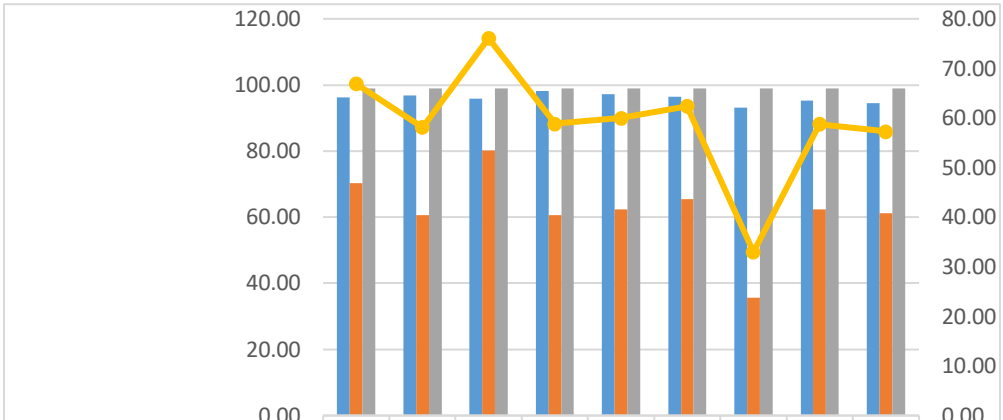

	1/4 - 7/4	9/4 - 14/4	16/4 - 21/4	23/4 - 28/4	30/4 - 4/5	6/5 - 11/5	13/5 - 18/5	20/5 - 25/5	27/5 - 31/5
Availibility ratio (%)	96.27	96.84	95.76	98.09	97.13	96.39	93.16	95.18	94.54
Performance ratio (%)	70.20	60.60	80.25	60.60	62.40	65.40	35.73	62.40	61.20
Quality ratio (%)	99	99	99	99	99	99	99	99	99
OEE (%)	66.91	58.10	76.08	58.85	60.00	62.41	32.95	58.80	57.28

Fig 1:- Achievement score Overall Equipment Effectiveness (OEE)

From Figure 1 it can be seen that only 1 time period of OEE value in accordance with the established standard that is reach 70% or more that is on 16 April to 21 April 2018 Besides at that time period the achievement of OEE value is still low. It also shows that the low value of OEE occurs due to the fluctuating performance ratio variable and still below the standard, especially in the period May 13 to May 18. Thus the main problem that occurs in the Y-Bar Press machine that results in low value achievement is due to fluctuating performance ratio factor and tend to be below standard, in other words, the ability of equipment or machines that have been very old that is not biased to run optimally.

IV. CONCLUSION

- Achievement of OEE value on average atom hydraulic press machine is 59,04%.
- Focus of improvement of the problem causing the loss factor Y-Bar Press Machine is the low average performance ratio of 62.09% because it is influenced by idle and minor stoppages and speed losses that occur in the machine.
- Total Productive Maintenance (TPM) can be implemented in PT XYZ through maintenance program by recognizing the Y-Bar Press machine breakdown symptoms, setup adjustment in Y-Bar Press machine, understanding the problems that happened in pressing and cutting.

V. SUGGESTION

- Companies need to evaluate the ability of machines that have very old and workload given to the equipment so that performance can be more optimal or start thinking about buying a new machine so as to return the oee to 85%.
- The need for additional maintenance personnel and the provision of spare parts and equipment inventory in maintenance and maintenance futures, must be available to see the condition of the machine is critical for maintenance activities are not disturbed that will harm the company.

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