Research Article

The Calculation Analysis of Total Productive Maintenance (TPM) on the Plumatex FFS894 Machine Using the Overall Equipment Effectiveness (OEE) Method at PT.XYZ Pharmaceutical Company

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Abstract: PT.XYZ is a company engaged in the pharmaceutical sector which is inseparable from problems related to the effectiveness of machines or equipment causes by the effect of Six Big Losses. Therefore, we need effective and efficient steps in the maintenance of machines or equipment to overcome and prevent these problems. Total Productive Maintenance (TPM) is a management principle to increase the productivity and efficiency of the Company's production by using machines effectively. Incorrect handling and maintenance of machines will result in losses which are called Six Big Losses. The first step in the effort to increase production efficiency at PT. XYZ Company is to measure the effectiveness of the Plumatex FFS894 machine using the Overall Equipment Effectiveness (OEE) method which then measures Six Big Losses to find out the amount of efficiency lost in the Six Big Losses factor. With a cause and effect diagram can analyze the actual problem which is the main cause of the high losses resulting in the low effectiveness of the Plumatex FFS894 machine. The conclusion on the Plumatex FFS894 machine is that the OEE value for the period of August 2020 to January 2021 range from 77.76% to 86.82%, with an average OEE value of 82.73%. So, the Plumatex FFS894 machine has not reached the ideal conditions (≥85%). The factor that made the biggest contribution which result in the low effectiveness of using the Plumatex FFS894 machine which is the main priority for improvement is Reduced Speed Losses with a percentage of 25.76% and Idling and Minor Stoppage Losses with a percentage of 21.09%.

Keywords: Total Productive Maintenance (TPM), Overall Equipment Effectiveness (OEE)

INTRODUCTION

PT. XYZ is a pharmaceutical company which production is divided into two departments, namely Small Volume Parenteral (SVP) and Large Volume Parenteral (LVP). Data retrieval for this paper will be carried out at the LVP Production department. The product produced by the LVP department is an infusion which the production process is carried out on the Flip-Off (FO) infusion type. In this process, it is expected that there will be no reject infusions because the input from the machine is an infusion of good quality that has passed the particle and fiber free inspection, as well as passed the leak test. However, in reality, reject infusion products are still frequently produced in the production process. For this reason, an improvement is needed in order to increase the effectiveness and efficiency of the Plumatex FFS894 machine, so that what is expected by the company, namely the there is no reject in the infusion production process can be realized.

This paper aims to find out the value of Overall Equipment Effectiveness (OEE) on the Plumatex FFS894 machine at PT. XYZ. The next aim is to find out the value of Six Big Losses which affects the performance of the Plumatex FFS894 machine. Furthermore, after finding out the value of Overall Equipment Effectiveness (OEE) and the value of Six Big Losses, it will provide recommendations for improvements to overcome the problem of the Six Big Losses factor at PT. XYZ the Pharmaceutical Company. The existence of competitive price requires the pharmaceutical industry to run factory operations as efficiently as possible in order to produce drugs at the lowest possible cost and still maintain the quality (Mubarok, 2019).

To maintain the condition of the Plumatex FFS894 machine so that it does not suffer damage or reduce the type of damage time, and so that the production process does not stop too long, then a good machine care and maintenance system is needed. If there is no machine care and maintenance system in the company, it will cause losses to the company, which can directly reduce the effectiveness of the machine or equipment, and result in costs that must be incurred due to damage to machines or equipment that can also affect the level of consumer confidence. The losses experiences by this company are better known as Six Big Losses (Nakajima, 1988).

Implement the TPM method allows companies to find waste that arises and occurs in the production process, then the TPM method also allows companies to find and eliminate the main factors that hinder the production process. The calculation of Overall Equipment Effectiveness (OEE) on this production machine can be used as the basis for the implementation of this Total Productive Maintenance method, where then the calculation of the

Six Big Losses factor value and the elimination of the biggest factor value of Six Big Losses is the final stage of the Total Productive Maintenance method is used. (Stephens, Matthew, 2004).

LITERATURE REVIEW

A. Total Productive Maintenance (TPM)

Based on the Japanese Institute of Plant Maintenance (JIPM), the definition of TPM is a team-based maintenance strategy to maximize equipment effectiveness by implementing a productive maintenance system as a whole covering all equipment used, extending the life of the equipment associated with, usage, maintenance and planning and involvement of all employees, from top management executives to production operators (Sharma et al., 2006).

According to Borris, the definition of TPM is a simple and good engineering practice. TPM demands a root-cause analysis solution. In both the equipment field service environment and the hospital environment, both require ensuring failure events do not happen again. As well as the expected results are an impact on customers and benefits for the Company (Borris, 2006;4).

B. Overall Equipment Effectiveness (OEE)

Overall Equipment Effectiveness (OEE) is useful so that the condition of the equipment or machine is always in an ideal state by eliminating 6 Big Losses on the equipment or machine. Based on Denso (2006) in the journal (Sunaryo & Eko, 2015) states that 6 Big Losses are the cause of production equipment not operating normally. Using OEE analysis will obtain a level of reliability from production equipment.

Based on Nakajima (1998) in the journal (Sunaryo & Eko, 2015) states that the Overall Equipment Effectiveness (OEE) value can be said to meet the JIPM standard if, the Availability ratio value of 90%, the Performance ratio value of 95%, the Quality ratio value of 99% and the Overall Equipment Effectiveness (OEE) value of 85%. The Overall Equipment Effectiveness (OEE) value is obtained from multiplying three parameters, namely as follows:

$$OEE\ (\%) = Availability\ Rate\ \times Performance\ Rate\ \times Quality\ Rate$$

1. Availability Ratio is a ratio that describes the benefits of operating time for available equipment or machines with the following formula:

$$Availability\ Ratio = \frac{Operation\ Time}{Loading\ Time} \times 100\%$$

2. Performance Efficiency is a ratio that describes the ability of the equipment or machine to produce goods with the following formula:

$$Performance\ Efficiency\ = \frac{(Processed\ Amount\ \times Ideal\ Cycle\ Time)}{Operation\ Time} \times 100\%$$

3. Quality Rate is a ratio that describes the ability of an equipment or machine to produce products according to standards with the following formula:

$$Quality\ Rate = \frac{(Processed\ Amount - Defect\ Amount)}{Processed\ Amount} \times 100\%$$

C. Six Big Losses

According to Chen et al. (2005) in the journal (Erna & Hafid, 2017) The decrease in the level of performance of a machine or equipment which results in the machine or equipment not operating ideally, efficiently and effectively, namely as follows:

1. Breakdown Losses namely wasted idle time resulting in a reduction in the amount of production.
2. Set-up and adjustment losses (make-ready) namely the losses resulting from the set-up time and adjustment is the entire set-up time including the setting time.
3. Idling and Minor Stoppage namely a loss due to minor disturbances and idle time due to external factors so that the machine stops production.
4. Reduced Speed Losses namely the losses when the speed of the equipment or machine decreases so that it does not operate optimally.

5. Defect and Rework Losses namely a product that does not comply with the specified quality specifications, even though the product can still be reworked.
6. Yield or scrap losses namely losses appear at the beginning of the production time that has not been able to achieve stable production conditions.

METHOD

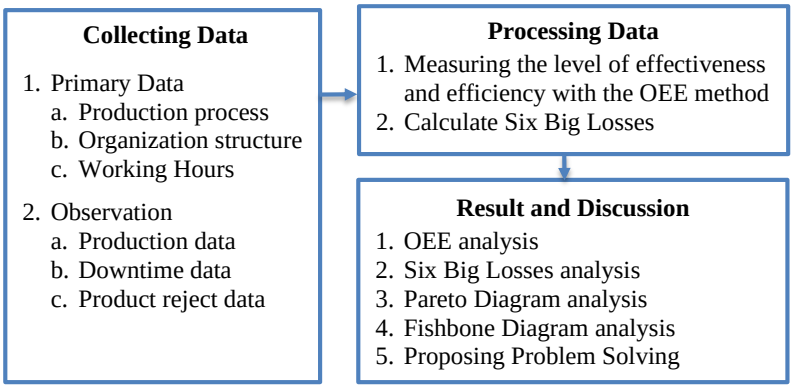

Figure 1. Research Methodology Diagram

1. Collecting Data

Collecting primary and secondary data is by observing, observing and recording at PT. XYZ. The aim of this observation is that researchers to obtain valid data for materials to compile paper. Researchers uses the data in this paper, including:

a. Infusion production result data in August 2020 – January 2021;
b. Plumatex FFS894 machine downtime data in August 2020 – January 2021;
c. Reject data for infusion production in August 2020 – January 2021.

2. Processing Data

Processing data uses the Overall Equipment Effectiveness method, with the assistance of the Microsoft Excel 2010 software application

a. Calculating the Availability Value
b. Calculating the Performance Efficiency Value
c. Calculating the Rate of Quality Product Value
d. Calculating the Overall Equipment Effectiveness (OEE) Value
e. Calculating the OEE Six Big Losses Value

3. Results and Discussion

Carry out analysis to find out the results of the continuation of the data processing stage. At this stage the researchers analyze all the results of calculations, namely the value of Availability, Performance Efficiency, Rate of Product Quality, Overall Equipment Effectiveness, and OEE Six Big Losses which then determines the dominant problem using the Pareto diagram. In addition, the researchers carry out an analysis to obtain the root of the problem that occurs by using a cause and effect diagram in order to determine the proposed troubleshooting.

RESULTS AND DISCUSSION

A. OEE Value

Data for data processing that can measure the effectiveness of the object of this paper is the Plumatex FFS894 machine because it has a quite high level of damage. Measurement of effectiveness uses the Overall Equipment Effectiveness (OEE) method from reports on production and maintenance activities at the production unit at PT. XYZ. Plumatex FFS894 machine data for the period of August 2020 to January 2021 are the data use in this paper.

All data information uses historical data from the Company, interviews and brainstorming. Furthermore, the data processing is processed. The initial stage, it is necessary to carry out three measurement ratios, namely Availability, Performance Efficiency Ratio, Rate of Quality on the Plumatex FFS894 machine with data processing using Microsoft Excel 2010 software. The results of OEE calculations on the Plumatex FFS894 machine are as follows.

Table 1. Availability Plumatex FFS894

Period	Loading time (hours)	Downtime (hours)	Operating time (hours)	Availability (%)	Availability Standard (%)
August-20	405	43	362	89.38	90
September-20	504	46	458	90.87	90
October-20	455	53	402	88.35	90
November-20	475	49	426	89.68	90
December-20	433	54	379	87.53	90
January-21	455	59	396	87.03	90

Table 2. Performance Efficiency Ratio Plumatex FFS894

Period	Total Good Products (pcs)	Ideal Cycle Time (hours)	Operating Time (hours)	Performance Efficiency %	Performance Efficiency Standard (%)
August-20	10194	0.035	362	97.68	95
September-20	10201	0.044	458	98.00	95
October-20	10442	0.037	402	96.88	95
November-20	10450	0.040	426	97.76	95
December-20	10534	0.034	379	94.78	95
January-21	10573	0.036	396	96.29	95

Table 3. Rate of Quality Plumatex FFS894

Period	Total Good Products (pcs)	Total Reject Product (pcs)	Rate of Quality Product (%)	Rate of Quality Product Standard (%)
August-20	10194	320	96.86	99.9
September-20	10201	256	97.49	99.9
October-20	10442	410	96.07	99.9
November-20	10450	310	97.03	99.9
December-20	10534	660	93.73	99.9
January-21	10573	493	95.34	99.9

Table 4. OEE Plumatex FFS894

Period	Aviability (%)	Performance Efficiency (%)	Rate of Quality Product (%)	OEE (%)	OEE Ideal (%)
August-20	89.38	97.68	96.86	84.57	85
September-20	90.87	98.00	97.49	86.82	85
October-20	88.35	96.88	96.07	82.24	85
November-20	89.68	97.76	97.03	85.08	85
December-20	87.53	94.78	93.73	77.76	85
January-21	87.03	96.29	95.34	79.89	85
Average	88.81	96.90	96.09	82.73	85

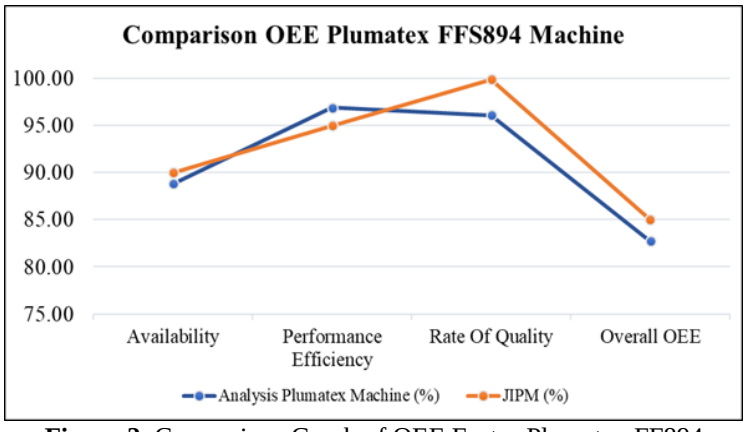

Figure 2. Comparison Graph of OEE Factor Plumatex FF894

Based on the graph of OEE data processing results on the Plumatex FFS894 machine, the Availability of 88.81% is still below the JIPM standard, which is 90%, the Performance Efficiency of 96.90% is above the JIPM standard, which is 95%, the Rate of Quality of 96.09% is still below the JIPM standard, which is 99.9% and Overall OEE of 82.73% is still below the JIPM standard, which is 85%. Overall, the Plumatex FF894 machine is not operating effectively according to the JIPM standard, but still can make improvements to achieve the ideal value. The results are quite good on the Performance Efficiency ratio because the value of the analysis results show that it had a value above the JIPM standard.

B. Six Big Losses

The OEE value on Plumatex FFS894 has obtained results, then the next step is to process data on each of the Six Big Losses factors to find out the biggest factor that affects OEE. In order to see more clearly the effect of Six Big Losses on the effectiveness of the Plumatex FFS894 machine, the calculation of Time Losses, the Cumulative percentage of Six Big Losses, and the Pareto Diagram is as follows.

Table 5. Cumulative Percentage on Plumatex FFS894 Machine

No	Six Big Losses	Total Time Losses (hours)	Percentage (%)	Cumulative Percentage (%)
1	Reduced Speed Losses	136.85	25.76	25.76
2	Idling & Minor Stoppage Losses	112.00	21.09	46.85
3	Setup and Adjusment Losses	97.00	18.26	65.11
4	Breakdown Losses	95.00	17.89	83.00
5	Deffect Losses	90.30	17.00	100.00
6	Yield or Scrap Losses	0.00	0.00	100.00
	Total	531.14		

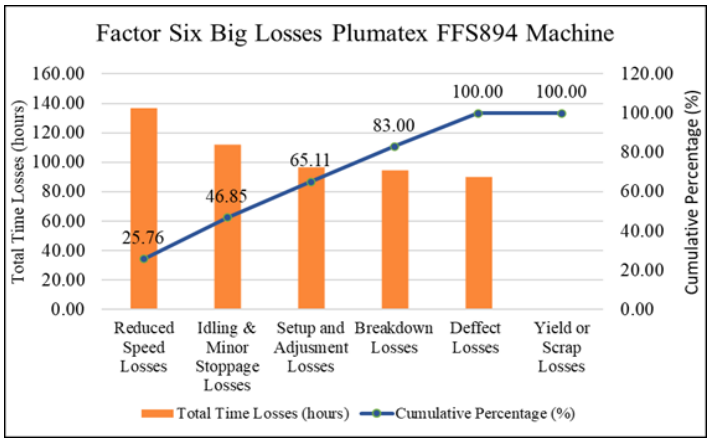

Figure 3. Pareto Diagram of Six Big Losses on Plumatex FFS894 Machine

Based on the analysis of the Six Big Losses factor, it will obtain the factors that become the top priority to make improvements in increasing effectiveness. By making a Pareto diagram of each factor in Six Big Losses to Total Time Losses based on Table 5 and Figure 2, the factors that contribute most to the low effectiveness of the Plumatex FFS894 machine are Reduced Speed Losses of 136.85 hours of time losses and a Percentage of 25.76% as well as Idling & Minor Stoppage Losses of 112 hours of time losses and a Percentage of 21.09% which causes the time to be ineffective.

C. Fishbone

After calculating the six big losses, resulting graph looks like the six big losses. The factors that most influence the value of machine effectiveness are the Reduce speed and idling minor and stoppage factors, then carry out a cause and effect analysis of these two factors using a fishbone diagram as shown below.

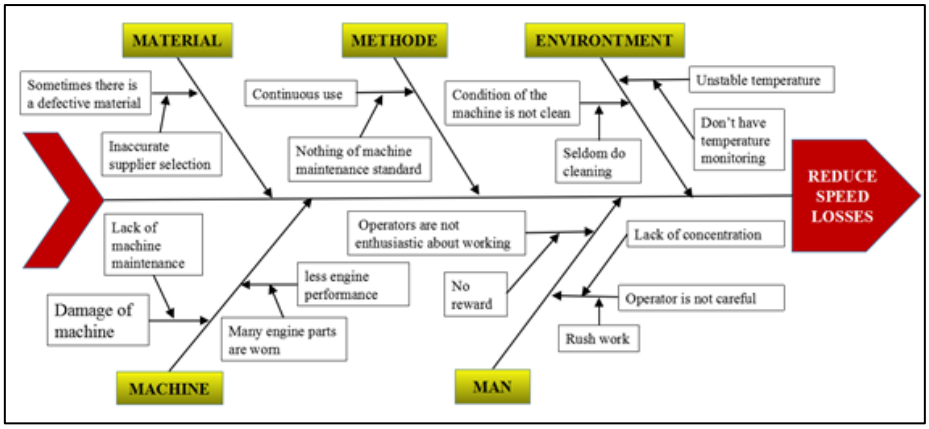

Figure 4. Fishbone Diagram of Reduce Speed Loss Global

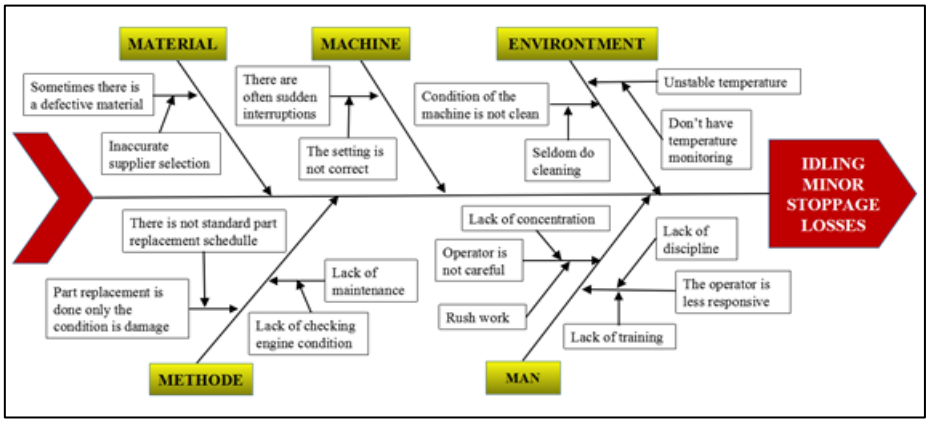

Figure 5. Fishbone Diagram of Idling Minor and Stoppage Losses Global

These results are still too widespread after reducing the cause and effect of the problem as shown below.

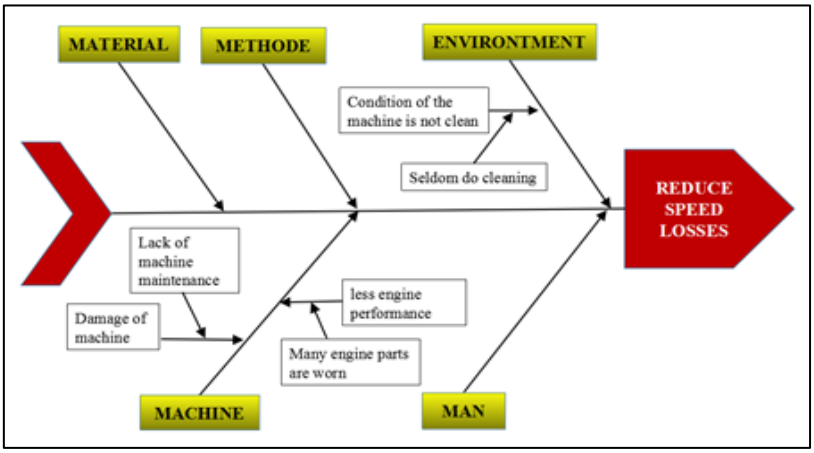

Figure 6. Fishbone Diagram of Special Reduce Speed Loss

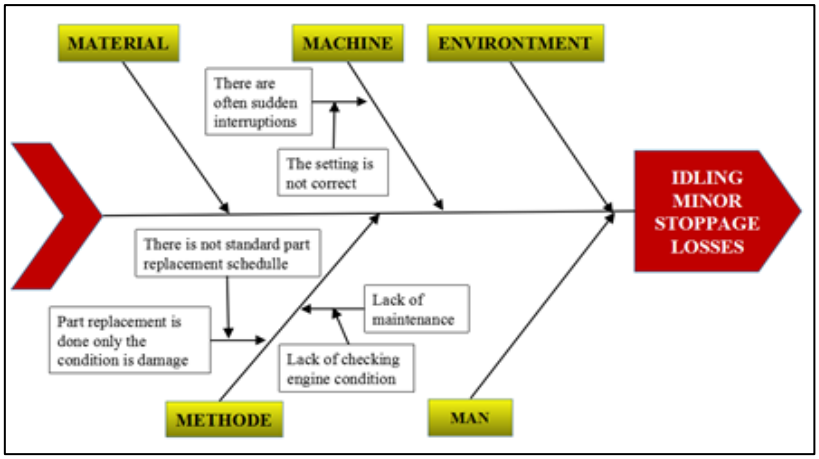

Figure 7. Fishbone Diagram of Special Idling Minor and Stoppage Losses

After finding out the cause of the problem from the reduce speed loss and idling minor stoppage factors using a fishbone diagram, carry out a proposed troubleshooting for each of the causes to increase machine productivity.

Table 6. Proposed Troubleshooting Most Affect Reduce Speed Losses

No	Factor	Problem	Problem Solving
1	Machine	Many parts are worn out, Lack of maintenance.	Do periodic checks, Perform replacement parts when it looks abnormal, Perform lubrication for dynamic parts.
2	Environment	Rarely Cleaning.	Perform regular cleaning either after the process is complete or shift changes.

Table 7. Proposed Troubleshooting Most Affect Idling Minor Stoppage Losses

No	Factor	Problem	Problem Solving
1	Machine	Incorrect machine settings	Train technicians, Provide work instruction manual.
2	Method	Lack of checking engine condition, There is no standard part replacement.	Do a daily check, Find out about the engine part life time, Make a preventive maintenance schedule according to the prevailing circumstances.

CONCLUSION

This paper aims to find out the Overall Equipment Effectiveness (OEE) value and find out the Six Big Losses value on the Plumatex FFS894 machine at PT. XYZ Pharmaceutical Company and determine recommendations for improvement in overcoming the problem of the Six Big Losses factors at PT. XYZ Pharmaceutical Company. The results of data processing in this paper show that the Availability value of 88.81% is still below the standard due to the large number of inappropriate installation activities that affect the readiness of the machine, while the Performance Efficiency value of 96.90% is above the applicable standard due to the reliability of technicians in troubleshooting, and The Rate of Quality value of 96.09% is still classified below the standard value, influences by incorrect initial installation, so that the Overall Equipment Effectiveness value of 82.73%, this value is still below the standard. The OEE value is quite good but still not optimal, so that in order to achieve the optimal value, we can make improvements to the machine maintenance strategy either periodically or based on life time part in order to increase the value of availability and Rate of Quality. The biggest factor causing the low effectiveness of the Plumatex FFS894 machine is Reduced Speed Losses of 136.85 hours of time losses and a Percentage of 25.76% as well as Idling & Minor Stoppage Losses of 112 hours of time losses and a Percentage of 21.09% which causes ineffective time. Furthermore, after finding out the results of data processing in this paper, PT. XYZ can carry out OEE calculations on all machines used in production aiming to obtain representative data and information to determine component prevention and periodic inspections in accordance with predetermined usage time interval calculations in order to reduce machine downtime during production.

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