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Maintenance policy of Jet Dyeing machine using Life Cycle Cost (LCC) and Overall Equipment Effectiveness (OEE) in PT.XYZ

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***Abstract*— PT. XYZ is one of the textile companies located in Majalaya, Bandung Region, West Java Province established since 1976. In the production process, one of the important roles is the process of dyeing. The dyeing machine K has the highest frequency of damage compared to other jet dyeing machine in the dyeing unit. In this case required Life Cycle Cost (LCC) method to determine the number of maintenance set crew and the optimal retirement age of a machine. Another method used is the Overall Equipment Effectiveness (OEE) method to determine the performance and the level of effectiveness of a machine. Another thing done on the method of OEE is the determination of six big losses to determine what factors caused the value of OEE is low. Based on the LCC method obtained the lowest total LCC which is IDR 12.675.632.621 with a five years retirement age of the machine and the amount of the maintenance crews as much as 4 peoples. Based on the calculation of OEE method obtained OEE value Jet Dyeing K machine of 84.59%. These results are still less in order to meet the standards set by JIPM amounted to 85%.**

Keywords—*Life Cycle Cost, Overall Equipment Effectiveness, Six Big Losses*

I. INTRODUCTION

In production activities, PT. XYZ has several units of production namely texture unit, weaving unit, dyeing unit, and finishing unit. To support the dyeing process, there are 17 jet dyeing machines that operate for 24 hours in a day. The dyeing process is dyeing the fabric evenly by immersion. Dyeing machine that cannot operate will disrupt production processes and cause losses. To reduce losses due to the length of downtime experienced by machines in the dyeing unit, then the company performs preventive maintenance and corrective maintenance activities. Although, maintenance activities are currently considered not effective because the maintenance of the company does not calculate the age of the machine that can be seen from the record failure of jet dyeing machine. Figure 1 is a breakdown of the total number of downtime hours in the dyeing unit that occurred in January 2010 until November 2016. A non-operating Jet Dyeing machine will disrupt production processes and cause losses. To reduce losses due to the length of downtime experienced by machines in the dyeing unit, the company performs preventive maintenance and corrective maintenance activities.

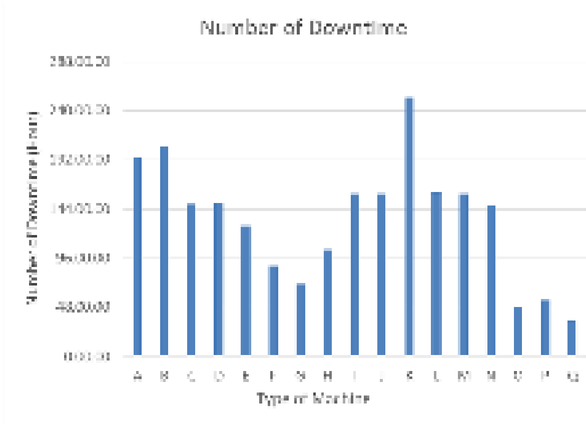

Figure 1. Downtime data of Jet Dyeing Machine in hours

In Figure 2 it can be concluded that the Jet Dyeing k machine has the highest frequency of damage when compared with other Jet Dyeing machines which are 125 times, and then Jet Dyeing machine K was selected as research object to be given solution regarding maintenance policy. However, maintenance activities are currently considered not effective because the maintenance of the company does not calculate the age of the machine that can be seen from the record failure of Jet Dyeing machine.

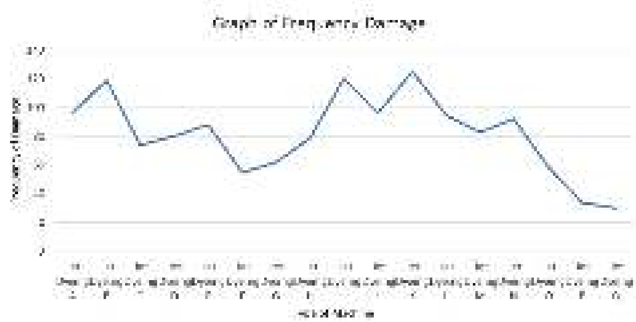

Figure 2. Frequency Graph of Jet Dyeing Machine Damage

Based on the problems which existing in PT. XYZ, then the steps to prevent and overcome the problems is focus on the dyeing unit, Then an analysis will be conducted related to the cost approach, One of which is the Life Cycle Cost (LCC) method to determine the optimal machine life and the Overall Equipment Effectiveness (OEE) method to determine the level of effectiveness of the use of an equipment overall. Once machine effectiveness is known, the next step is to identify the problem causing the low productivity of equipment by looking at six big losses to find out what factors are most influential in decreasing the effectiveness of the machines that cause losses for the company.

II. LITERATURE REVIEW

A. Maintenance Management

Maintenance is defined as the activity that component or system defective will be returned/repaired under certain conditions at a certain period. In general, the maintenance system is classified as follow[1] :

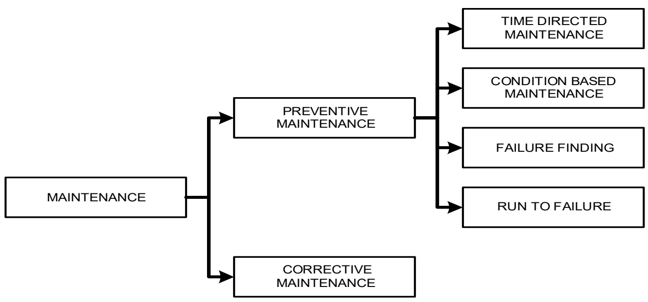

Figure 3. Classification of Maintenance activity[1]

B. Failure Rate Pattern

The basic pattern of decay rate function λ will change over time as a tool/machine operation. The curve rate of damage or called Bath tube-curve is a curve showing the rate of decay pattern that is common to a device. The rate of damage will follow a basic pattern as follows [2]:

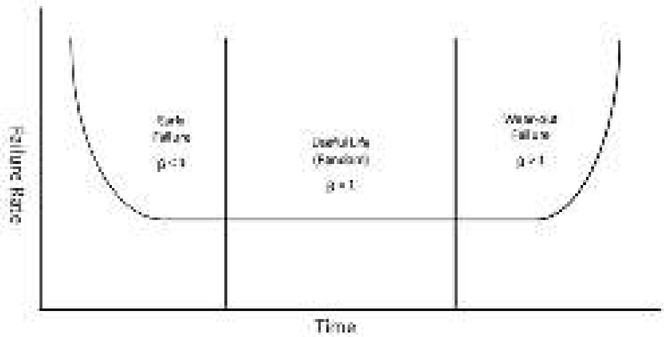

Figure 4. Reliability Bath Tub Curve[2]

From Figure 4 is known the pattern of damage can be divided into three phases, namely:

a. Phase Burn - In Period, at time T0 - T1: Describe the damage rate decreased with the addition of component operating time has Weibull probability density function with a value of $\beta < 1$

b. Phase Useful Life Period, at time T1 - T2:This phase illustrates the damage rate is constant over time with the addition of the component operations and have exponential probability density function with a value of $\beta = 1$.

c. Phase Wear - Out Period, at the time T2 - T∞:This phase depicts the rate of damage increases with the addition of components operating time. This phase has a probability density function of the Normal and Weibull with a value of $\beta > 1$.

C. Life Cycle Cost

According to Blanchard and Fabricky et all [3], Life cycle cost is the sum of cost estimates from start to finish, both equipment and projects as determined by the analysis study and total expenditure estimates experienced during operated [5]. The purpose of the LCC analysis is to choose the most cost-effective approach for a series of alternatives that term cost of ownership (ownership) the shortest achieved. In this study, the problem is modeled through LCC approach, which is illustrated as follows:

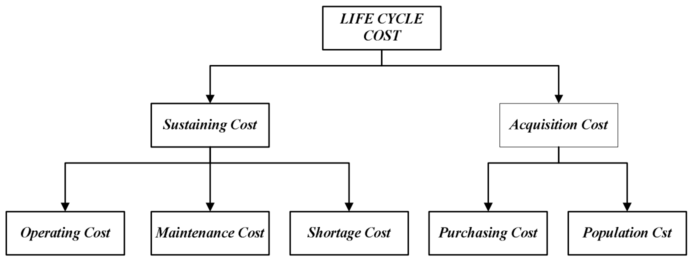

Figure 5. Life Cycle Cost Model [3]

D. Six big losses

Six Big Losses is the most common causes of equipment-based productivity loss in manufacturing. Measurements of machine/equipment effectiveness can be identified through the six big losses as follows[4]:

a. Equipment failures
Equipment failures are caused by equipment defects that require repair. Big losses include product opportunity loss, spare part loss, sporadic losses.

b. Set-up and Adjustments
Set-up and adjustments are caused by changes in operating conditions, such as product type turnover, change of working hours, adjustment of operating conditions.

c. Idling and Minor Stoppages
Idling and minor stoppages, due to sensor error or waiting for material/parts to come or be processed. Idling and minor stoppages are caused because the incident of the machine is stalled for a moment and idle.

d. Reduced Speed Losses

Reduced Speed Losses due to decreased engine speed, the engine does not work at its normal speed.

e. Scrap and Re-work
   Scrap is caused because the resulting product is out of specification or defect during a normal production process, and the quality is bad.
f. Start-up Losses
   Start-up Losses are caused by the length of time to adjust to normal conditions causing many rejects and scraps.

E. Overall equipment effectiveness (OEE)

Overall equipment effectiveness (OEE) is a product of six big losses in machinery / equipment [5]. The six factors in the six big losses as described above can be grouped into three main components in OEE to be used in measuring machine/equipment performance as follows, downtime losses, speed losses, and defect losses. OEE measures the overall effectiveness of the equipment by multiplying availability, performance rate, and rate of the quality product. The relationship between equipment, six big losses, and OEE calculations can be described as follows :

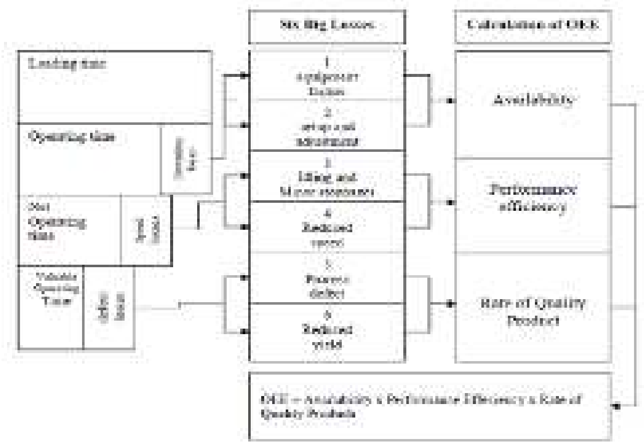

Figure 6. Equipment Relationships, Six Big Losses and OEE[5]

III. RESEARCH METHODOLOGY

Beginning with failure analysis of jet dyeing machine in dyeing unit, researching to get data time to repair (TTR) and time to failure (TTF). The next step is to determine the distribution parameters of the data and test the suitability of the distribution. After that, do the calculations to get Mean Time To Repair (MTTR) and Mean Time To Failure (MTTF). Calculate the total life-cycle cost so that obtained the proposed retirement age of the selected machine and maintenance crew optimal for doing maintenance. Overall Equipment Effectiveness (OEE) measures the overall effectiveness of the equipment by multiplying availability, performance rate, and rate of the quality product. After getting the value of OEE will then do an analysis of six big losses for the company to know what factors of the six factors that have the greatest impact that resulted in a low level of effectiveness of the use of equipment or machine[6].

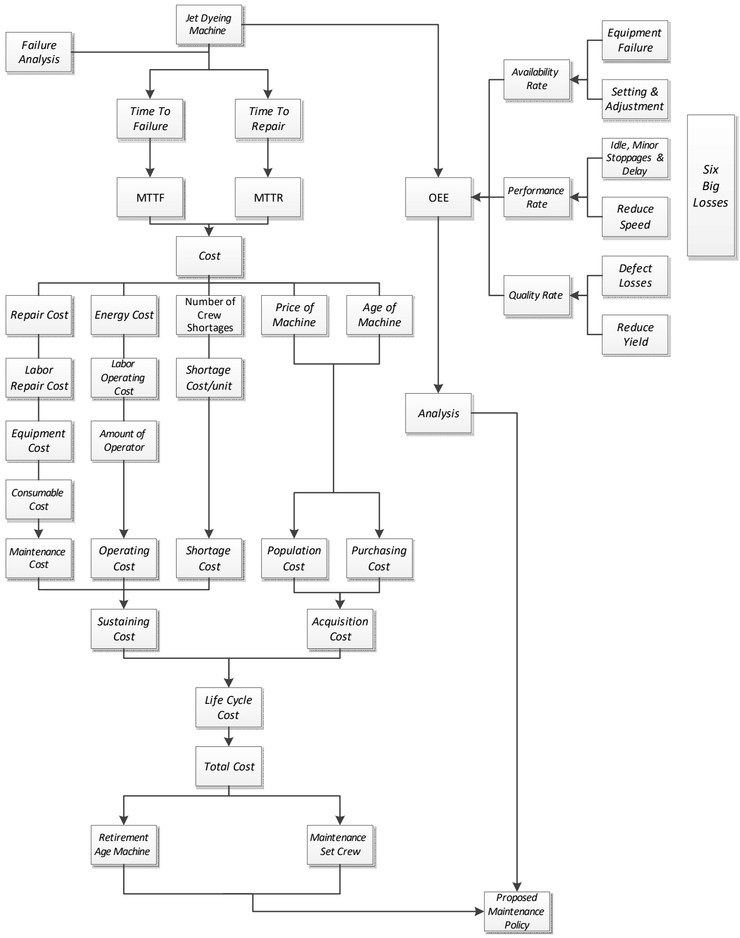

Figure 7. Conceptual Model

IV. RESULTS AND DISCUSSION

A. Life Cycle Cost

Life Cycle Cost calculation aims to determine the optimal maintenance crew and retirement age Jet dyeing machine that can be seen from the influence of the most cost-sensitive variables[7]. After performing calculations consisting of annual operating cost, annual maintenance cost, probability calculation of queue on each maintenance crew, determining the number of units less, annual shortage cost, annual sustaining cost, annual purchasing cost, book value, annual population cost, and annual acquisition cost then got the total life-cycle cost from Jet Dyeing K machine at PT. XYZ with the lowest cost is IDR.12.675.632.621. In addition, the optimal retirement age for the Jet Dyeing K machine is 5 years, and the optimal number of crew maintenance sets is 1 set. Details 1 set of maintenance crew there is 4 people mechanical staff.

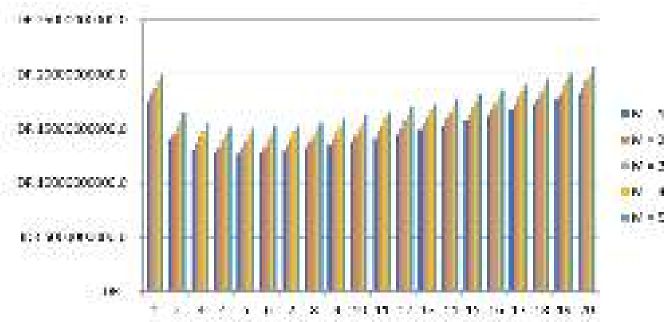

Figure 8. Life Cycle Cost

B. Overall Equipment Effectiveness (OEE)

Based on OEE calculation of Jet Dyeing K machine in 2016, OEE value is 84,6%. The result is still less than 0.40% to meet the standard set by JIPM that is 85%. Details of the multiplication of the availability, performance rate, and rate of quality are as follows :

OEE = 99,25% x 86,97% x 98,01% = 84,6%

C. Six Big Losses

In six big losses, calculations such as downtime losses, speed losses, and quality losses are obtained. The percentage of total six big losses based on figure 9 are as follows :

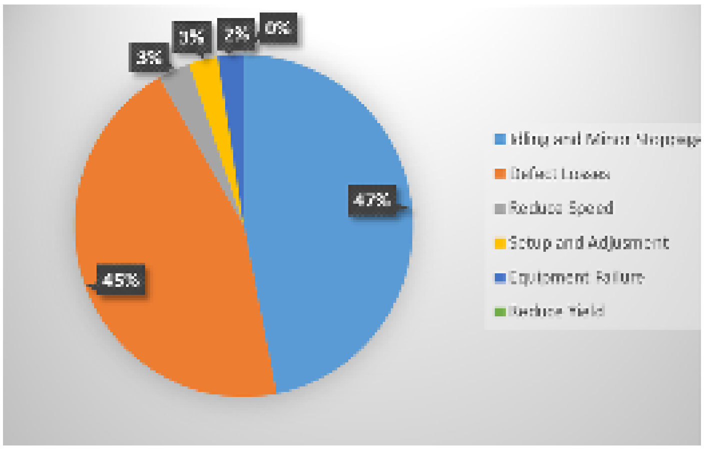

Figure 9. Six Big Losses

V. CONCLUSION

Based on the calculation, then get the total life-cycle cost from Jet Dyeing K machine at PT. XYZ with the lowest cost is Rp. 12.675.632.621. The calculation results using the life-cycle cost method, then the optimal retirement age of Jet Dyeing K machine is 5 years, and the number of optimal maintenance crew set as much as the 1 set. Detail 1 set of maintenance crew there is 4 people mechanical staff. Based on OEE calculation of Jet Dyeing K machine in 2016, the OEE value is 84.6%. The result is still less than 0.40% to meet the standard set by JIPM that is 85%. The cause of the problem of the dominant six big losses factor is that too many Jet Dyeing K machines stop repeatedly and too often the machines do not work due to idle and minor stoppages. In addition, the other cause has reduced speed, which means the actual production speed of the engine is reduced compared to the standard machine speed. Furthermore, in order to minimize losses, the company must perform more detailed and complete damage records for each component on the machine, Recording of costs associated with the repaired machine for more details, repair activities were undertaken and costs incurred and recording of machine history to be able to distinguish between downtime and repair time.

REFERENCES

[1] A. C. Márquez, *The Maintenance Management Framework: Models and Methods for Complex Systems Maintenance*. 2007.

[2] B. S. Dhillon, “Introduction to Engineering Reliability and Maintainability,” *Life Cycle Costing Eng.*, p. 224, 2009.

[3] B. S. Blanchard and W. J. Fabrycky, *Systems Engineering and Analysis*. 2006.

[4] M. Dogra, V. S. Sharma, A. Sachdeva, and J. S. Dureja, “TPM-A KEY STRATEGY FOR PRODUCTIVITY IMPROVEMENT IN PROCESS INDUSTRY,” *J. Eng. Sci. Technol.*, vol. 6, no. 1, pp. 1–16, 2011.

[5] S. Nakajima, “Introduction to Total Productive Maintenance (TPM),” *Cambrigde Product. Press. Inc.*, 1988.

[6] R. Raguram, “Implementation of Overall Equipment Effectiveness (OEE),” *Middle-East J. Sci. Res.*, vol. 20, no. 5, pp. 567–576, 2014.

[7] J. Alhilman, R. R. Saedudin, F. T. D. Atmaji, and A. G. Suryabrata, “LCC application for estimating total maintenance crew and optimal age of BTS component,” in *2015 3rd International Conference on Information and Communication Technology (ICoICT)*, 2015, pp. 543–547.