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Estimating the Cost of Unreliability in Tea Plantation Factory for Sustainable Production

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Abstract. Company X is a company engaged in the field of agro-industries that produce various kinds of tea. To meet the market demand requires a company to produce large quantities of tea. Continuous production results in a decrease in machine reliability so that machines are often damaged which results in production being hampered and at the end the company suffered losses. This paper analyzes the costs borne by the company due to the unreliability of the engine using Cost of Unreliabilty method for a Double Indian Ball Breaker Net Sorter as the most critical machine in production department. This method was chosen because it related to the unreliability of the engine. From the calculation results, obtained the costs of corrective COUR due to unreliability in the amount of $ 74,806.8 and of downtime COUR $ 108.080. To minimize losses is recommended to improve scheduled preventive maintenance of machine.
Keywords: Tea plantation, cost of unreliability, lost of revenue

1. Introduction

Company X is a tea plantation company that produces various teas for domestic and foreign consumption, including black tea produced for foreign markets. With the high market demand for black tea then to oblige companies are required to produce tea continuously. The production machinery used include machine Double Indian Ball Breaker Net Sorter (DIBN). Due to the continuous production that resulted in the engine being tired and decreasing the reliability of the machine so that there were frequent damages which resulted in high corrective cost and loss of potential revenue, according to [1] In a production business, one of factors that affect the profits and losses of the company is due to the unreliability of machines, if the reliability of the machine decreases then will interfere to the production targets that has been determined, this will certainly impact on loss revenue that should be Obtained. To find out the losses or costs resulting from the engine unreliability was calculated using the method of Cost of Unreliability (COUR), this method is selected because it can determine the amount of lost of revenue and costs resulting from corrective remedial actions and also the cost due to length of downtime.[1] said, to estimate the potential losses of the caused by unreliability in printing machine it will be calculated by COUR method. [2] In calculating the costs caused by unreliability and unavailability in waiting for repairs, the COUR method was used. By knowing the magnitude of the losses caused by the unreliability of this machine and to minimize it, it is expected that the company can determine scheduled preventive maintenance actions so that downtime will be reduced.

2. Methods

2.1. Understanding maintenance

Maintenance an activity to ensure that physical assets continue to perform its functions as required by the user [3], The main purpose of the maintenance activity is to extend the life of the assets, ensuring optimum availability of equipment for production or service and to invest as much profit as possible, ensuring the readiness of all equipments needed in emergency activities and ensuring the safety of everyone who uses the facility[4],

2.2. Cost of unreliability (COUR)

The cost of unreliability is a calculation to get results from the amount of costs lost due to a machine's inability [1]. There have been many papers discussing the losses caused by machine failure using the COUR method, including by[5] For the business in gas plant, the financial issue of reliability is controlling the COUR from equipment and process failures which waste money. Based on [6] to

calculate the cost of unreliability in Electric Power System, the Reliability Network Equivalent approach is used. This paper explains the COUR method for analyzing the cost of losses due to unreliability in machines in tea plantation plants. To calculate the cost of unreliability, there are three main steps that should be done, is to calculate the failure rate of machines based on failure data, calculate the time lost due to downtime then calculate the lost cost because of unreliability of the engine [7]. The formula of COUR are:

$$\text{COUR} = \text{Direct Cost} + \text{Indirect Cost} \quad (1)$$

$$\text{Direct Cost} = \text{EC} + \text{LC} + \text{PC} \quad (2)$$

Where :

EC: Equipment or spare parts costs is cost used for replacement of machinery or engine components, such as spare part purchases.

LC: Labor Cost that the cost used to pay for labor in maintenance and repair activities.

PC : Production Cost is the cost of the lost because the machine is not production, consisting of LPC (Loss Production Cost) and OPC (Off-Spec Productions)

Indirect costs Cost is not directly related to the unreliability of the engine, comprising:

The Cost of being conducting reactive maintenance activities, such as predictive maintenance and preventive maintenance.

The Cost of sloppiness: poor reliability is usually associated with other elements of production, such as health & safety, quality and environmental performance.

The Cost of Loss Business: poor reliability can Affect production targets and production quantities, so customer needs are not met, the resulting in dissatisfaction and loss of customers that can result in loss of profits that should be Obtained.

3. Result and discussion

3.1. Distribution determination

Tests conducted to find the data distribution data represents distribution of time to repair, time to failure and downtime. Testing distribution this data using Minitab applications with distributed test Anderson Darling. The value of the confidence level that is used on the test was 95%. Data destruction is tested against a normal distribution, exponential and Weibull. The results of the test, namely distribution in Figures 1 and 2.

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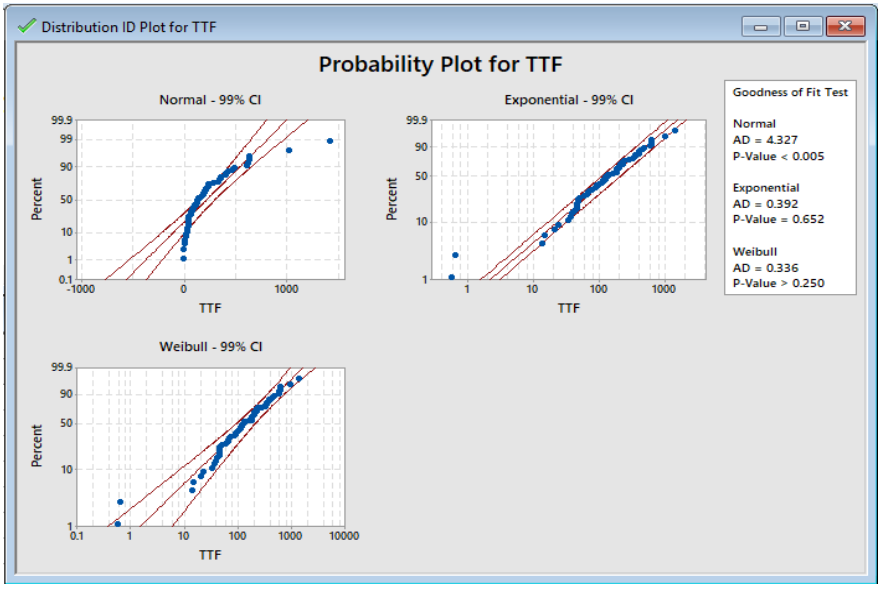

Figure 1, TTF Distribution Determination

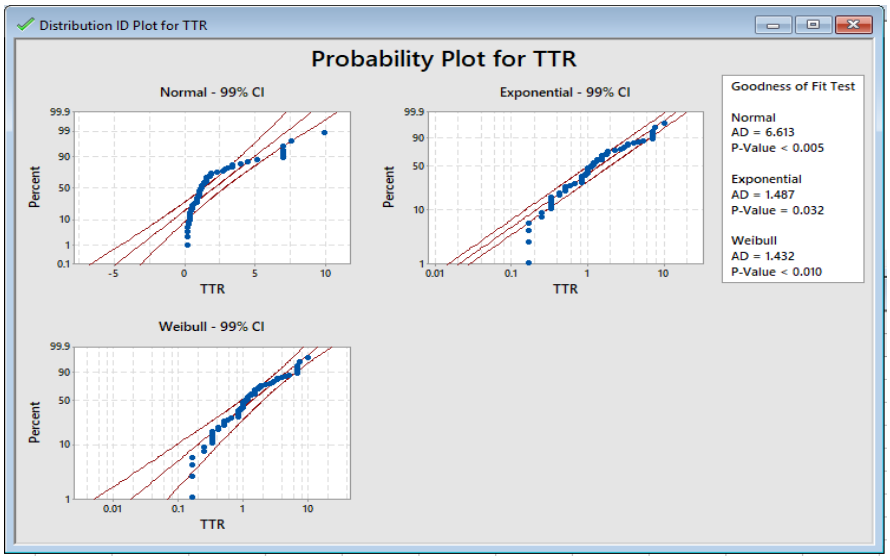

Figure 2. TTR Distribution Determination

From Figure 1 and 2 can be seen that the selected distribution of TTF and TTR are the Weibull distribution.

3.2. Distribution and Calculation of MTTR, MTTF and MDT Parameters

After doing the test of TTR and TTF data distribution by Minitab, then determine the distribution parameters that have been using software Avsim +9.0. Output of Avsim + 9.0 can be used to perform calculations of MTTR and MTTF.

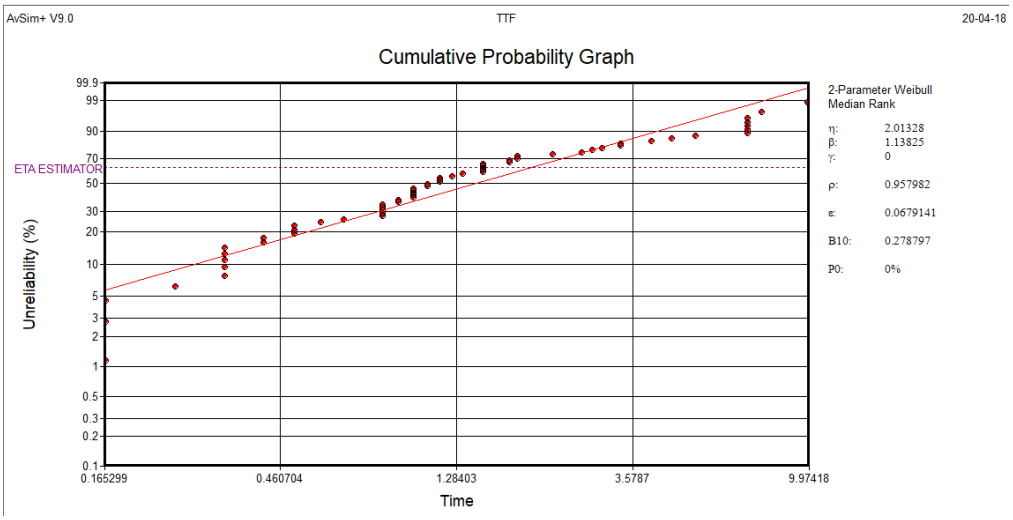

Figure 3. Distribution of Weibull TTF Test Results

From Figures 3 and 4 can be seen the value of the Weibull distribution parameter for TTF and TTR and for more detail can be seen in table 1 and 2.

Table 1. Distribution of Weibull parameters TTF

Distribution	Parameter	Value
Weibull	η	201 328
	β	113 825
	Y	0
	ρ	0.957982
	ε	0.0679141

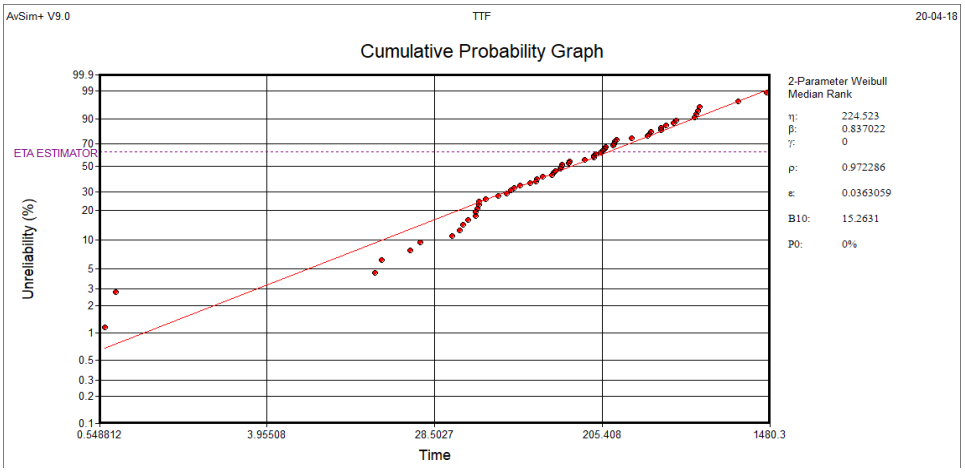

Figure 4. Distribution of Weibull TTR Test Results

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Table 2. Parameters Weibull Distribution TTR

Distribution	Parameter	Machine DIBN
Weilbull	η	224 523
	β	0.837022
	Y	0
	ρ	0.972286
	ε	0.0363059

The parameters used for the Weibull distribution is η and β. After determining the parameters based on the distribution selected, then do the calculations of MTTR and MTTF.

Table 3. Value MTTF and MTTR

Machine DBIN	1+ (1 / β + 1)	r (1 / β + 1)	η	Mean (Hours)
TTF	2.20	1.09	2.01328	358.50
TTR	1.88	0.96	224.523	1.96

After calculated based on the Weibull distribution, the MTTF value is 258.50 hours and MTTR is 2.01 hours.

3.3. Calculation of cost of unreliability

In calculating with COUR analysis the necessary variable are failure rate, time loss and money loss.

3.3.1. Failure Rate

Failure rate is the rate of subsystem failure in a certain period. This failure rate is obtained from the quotient between the number of failures and MTTF.

Table 4. Calculation of Failure Rate

	DIBN
Study Interval (hrs)	8640
Number of Failures	5
MTTF	358.50
Failure Rate	0.01395

3.3.2. Time lost

Time lost is the time lost due to subsystem failure. There are two types of lost time that are calculated, namely lost time due to corrective maintenance and lost time due to downtime. The general formula is as follows:

$$\text{CLT / Years} = \text{Corrective Time / Failure} \times S \quad (3)$$

$$\text{DTL Hours / Years} = \text{Downtime Time} \times S \quad (4)$$

$$S : \text{number of failures} \quad (5)$$

Details of Loss Time calculations results can be seen in Table 5.

3.3.2.1. Corrective lost time

Corrective lost time is time lost for their improvement.

Table 5. Corrective Lost

	DIBN
Failure Rate	0.01395
Number of Failures	5
Corrective Time / Failures	1.93
Corrective Lost Time Hrs / Years	9.65

The calculation uses data failure rate and number of failures, where the corrective time failures value is the MTTR value.

3.3.3. Downtime Lost Time

Downtime lost time is time lost from damaged machine until the machine was repaired.

Table 6. Down Time Lost

	DIBN
Failure Rate	0.01395
Number of Failures	5
Downtime Time Failures	2.80
DT Lost Time Hrs / 5years	14

The value used to calculate lost time downtime is the failure rate and number of failures. Value of downtime time failures is MDT data.

3.3.3. Money Lost

Money Lost is a loss that is lost due to unreliability of the machine and can cause losses to the company, consisting of losses due to down time and corrective time, for calculating required data of DT lost time,loss production costs, equipment costs and labor maintenance costs, the formula is:

LPC = loss time x Production Loss / hour (5)
EC = loss time x maintenance cost / hour (6)
LC = loss time x Cost / hour (7)
Value of corrective COUR = LPC + EC + LC (8)

Assumption loss profit / hour IDR. 100,000,000.00, maintenance cost IDR. 800,000.00 / hour, labor maintenance cost is IDR. 15,000,000.00 / month. Details of COUR calculations for DIBN machine can be seen in Tables 7.

Money Lost of Down Time and Corrective Time

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Table 7. Money Lost Calculations

	Down Time	***Corrective Time***
Lost Time Hrs / Years	14	9.69
loss Profit	IDR 1,400,000,000	IDR 969,000,000
Equipment / Sparepart Cost	IDR 11,200,000	IDR 7,752,000
Maintenance Labor Cost	IDR 210,000,000	IDR 145,350,000
COUR	IDR 1,621,200,000 $ 108,080.00	IDR 1,122,102,000 $ 74,806.8

Once calculated can be seen in Table 7, COUR down time value of $ 108,080.00, while the value of the corrective COUR is $ 74,806.8.

4. Conclusion

Based on calculation of Cost of Unreliability, costs due to unreliability DIBN machinery amounted to $ 74,806.8 for corrective COUR and amounted to $ 108.080 for downtime COUR, for a total of $ 182,886.8 COUR in a period during 8640 hours of engine operation. To improve efficiency, the engine needs scheduled preventive maintenance actions.

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