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Cost of unreliability method to estimate loss of revenue based on unreliability data: Case study of Printing Company

Judi alhilman

Industrial and System Engineering School Telkom University
Jl.Telekomunikasi Terusan Buah Batu, Bandung, West Java, 40257, Indonesia
alhilman@telkomuniversity.ac.id

Abstract. In the production line process of the printing office, the reliability of the printing machine plays a very important role, if the machine fail it can disrupt production target so that the company will suffer huge financial loss. One method to calculate the financial loss cause by machine failure is use the Cost of Unreliability(COUR) method. COUR method works based on down time machine and costs associated with unreliability data. Based on the calculation of COUR method, so the sum of cost due to unreliability printing machine during active repair time and downtime is $ 1003,747.00.
Keywords: Unreliability, COUR, Financial loss.

1. Introduction

In a production business, a lot of factors that affect the profits and losses of the company, one of them is due to the unreliability of machines in the production line. If the reliability of the machine decreases then the production will stop and will interfere to the production target that has been determined, this will certainly impact on loss revenue that should be obtained. To estimate the potential losses caused by unreliability machine it will be calculated by COUR method. This method is chosen because the calculation based on downtime data history from printing machine and based on costs that relation to down time printing machine, so the results of this calculation is expected close to real conditions. All manufacture industries must ensure that their production is accordance with demands, one of them is that the machine must reliable enough. [1]. The manufacturing industry strives to find ways to reduce the cost of production and materials in order to always be competitive and sustainable in the business world. It is very difficult to produce with good quality, low production cost regardless of engine reliability. As long as machine condition becomes a good element and source for the company in reducing cost, evaluation and selection of machine conditions become an important component in the production line. [1]. There have been many studies of potential loss calculations using the COUR method but it is still rare to examine to the printing press. In the printing industry, the problem also still occurs where the machine suddenly breakdown while the production running. If the printing machine fail to operate, it will disrupt the newspaper production activity which will impact to unstable demand fulfilment [2]. Based on previous research using COUR method in industry area, the research on printing machine using COUR method is very useful because from the results of the research we can know the loss of revenue caused by unreliability machine.

2. Methods

2.1. COUR Model

Calculation by COUR method will get the result of loss potential revenue due to the inability of a machine in production line. Unreliable systems will show a high COUR value [2]. Here is a model that explains the costs used in COUR calculations.

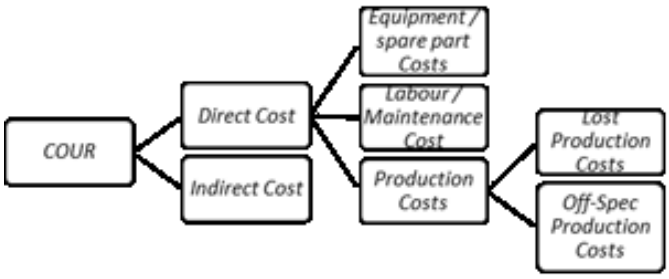

Figure 1. Cost of Unreliability Model

$$COUR = DC + IC \quad (1)$$

DC: Direct Cost
IC: Indirect Cost

2.2. Direct Cost

Direct cost is all costs that have a direct cause and effect relationship with reliability events. Direct cost is influenced by following aspects:

- Equipment / spare parts costs (EC): costs used for replacement of machinery or engine components, such as spare part purchases.
- Labor Maintenance cost (LC): the cost used to pay for labor in maintenance and repair activities.
- Production cost (PC): costs incurred due to loss of production, consisting of:
  - Loss Production costs (LPC): revenue that should be earned if production activity is not disrupted by production failure.
  - Off-Spec Productions costs (OPC): costs incurred because the resulting product is incompatible with product specifications, which may mean that it cannot be sold because of reject.

$$DC = EC + LC + PC \quad (2)$$

2.3. Indirect Cost

According to (Daley, 2009), indirect cost of COUR is a cost charge that does not have a direct causal relationship with reliability events. Costs included in the indirect cost are as follows.

- The Cost of being a reactive organization: organization or company 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, resulting in dissatisfaction and loss of customers that can result in loss of profits that should be obtained.

3. Result

3.1. Data Collection and Processing

Data collection is taken from a large printing company in Bandung that has distribution of its printing products throughout West Java, data used in 2016. Data collected are damage duration time, time to repair, wage and cost data related to unreliability machine. Maintenance activities on the printing machine is done by maintenance crews with details as follows: team maintenance consists of 4 people crews, each get a wage of IDR. 5000,000,00 / month. The total wage for 4 maintenance crews is IDR. 240,000,000,00 / year. Loss profit (LP) calculation is: LP = total production / hour x production price = 40,000.00 exp. x IDR 3000.00 = IDR. 120,000,000.00/hour, it is mean that if the printing machine down then the company will loss revenue of IDR. 120,000,000.00 / hour for one machine.

3.2. Determination of Representative Distribution

To find out the most representative distribution of Time to Failure (TTF) and Time to Repair (TTR) data for each machine, a data distribution match against the Weibull, Exponential and Normal distributions . Determination the distribution representing TTF and TTR distribution of printing machine can be seen in figure 2.

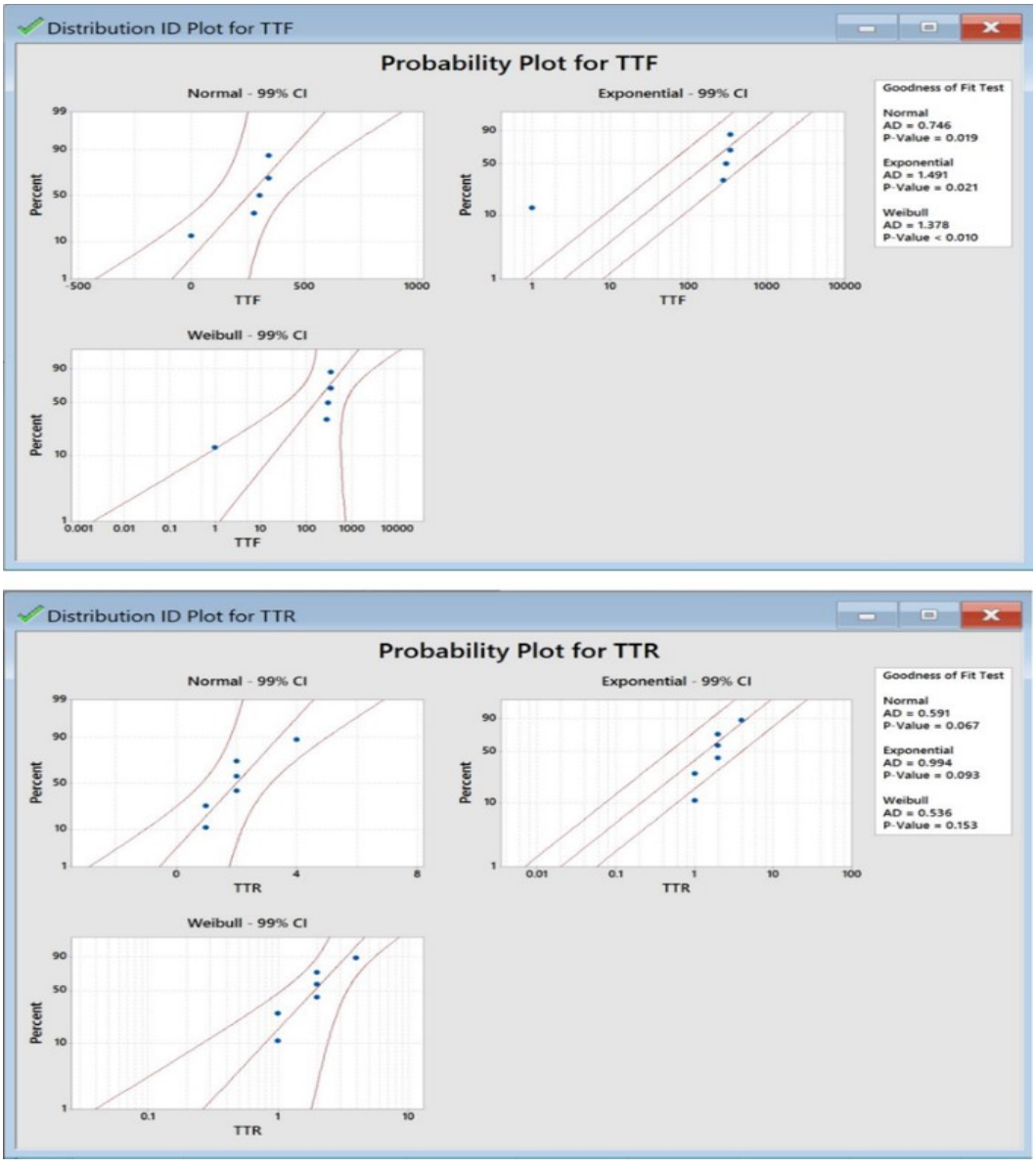

Figure 2. Distribution of TTF and TTR data

The selected distribution is Normal distribution. From each distribution it is found that Mean Time To Failure (MTTF) and Mean Time To Repair (MTTR) for normal distribution with parameter value equal to 192.85 and 2.075 respectively

3.3. Cost of Unreliability Calculation

Failure Rate Calculation, the data used for COUR calculations are machine failure data from January to December 2016. The first stage of COUR calculation is to calculate the failure rate of the unit.

$$\text{Failure rate} = 1/\text{MTTF} \tag{3}$$

In this study, interval study was determined during the observation time as long as 8640 hours. Details of failures number during the observation period, study interval and calculation of the failure rate can be seen in Table 1.

Table 1. Failure Rate Calculation Results

	MACHINE
Study Interval (hours)	8640
Number of Failures	27
MTTF	192.85
Failure Rate	0.0051854

3.4. Corrective Loss Time and Downtime Loss

The value of loss time is obtained from Corrective Loss Time (CLT) and Downtime Loss (DTL) calculations, as follow.

$$\text{CLT / Years} = \text{Corrective Time / Failure x S} \tag{4}$$

$$\text{DTL Hours / Years} = \text{Downtime Time x S} \tag{5}$$

Details results of Loss Time calculations can be seen in Table 2.

Table 2. Corrective Loss Time and Downtime Loss Calculations

	MACHINE
Failure Rate	0.0051854
Number of Failures	27
Correvtive Time/Failure (MTTR)	2.075907
Downtime Time Hours	2.5244
Corrective Loss Time Hours/Years	56.049489
DT Time Hours/Years	68.1588

3.5. Money Loss Calculation

The next stage of COUR calculation is to calculate the value of money loss. To obtain the calculation of money loss required data downtime loss, loss time, loss production cost, equipment / spare parts cost, and labour maintenance cost.

$$LPC = \text{loss time x Production Loss / hour} \quad (6)$$

$$EC = \text{loss time x maintenance cost / hour} \quad (7)$$

$$LC = \text{loss time x LC / hour} \quad (8)$$

$$\text{Value of corrective COUR} = LPC + EC + LC \quad (9)$$

Assumption loss profit / hour IDR. 120,000,000.00, maintenance cost IDR. 600,000.00/hour, labour maintenance cost is IDR. 20,000,000.00/month. Details of COUR calculations from one machine can be seen in Tables 3 and 4.

Table 3. Corrective COUR Calculation

	MACHINE
Corrective Loss Time Hours/Years	56.049489
Loss Product Cost	IDR. 6,725,938,680
Spare Part Cost	IDR. 33,629,693.4
Labour Maintenance Cost	IDR. 11,209,897.8
Corrective COUR	IDR. 6,770,778,271 = $451,385.00

Table 4. Downtime COUR Calculation

	MACHINE
DT Loss Time Hours/Years	68.1588
Loss Production Cost	IDR. 8,230,560,000
Spare Part Cost	IDR. 41,152,800
Labor Maintenance Cost	IDR. 13,717,600
DT COUR	IDR. 8,285,430,400 = $552,362.00

The formula to calculate Downtime COUR is use the same formula with corrective COUR but different in LPC calculation, for corrective COUR use Corrective loss time hours/year but for downtime (DT) COUR use DT lost time hours/year. The calculated costs converted into US Dollar ($) units, with exchange rate with rupiah is IDR 15,000/ 1 $.

4. Discussion

4.1. Failure Rate Analysis

The printing machine has a failure rate is 0.52% with MTTF of 192.85 hours. This indicates that the possible functional failure will occur in the unit is not too large because the value of failure rate close to zero, so the company is sufficient to apply preventive maintenance policies, such as inspection, or on-condition maintenance to prevent downtime that may occur due to machine failure.

4.2. Money Loss Analysis

Money loss calculations are used to help identify problems regarding loss income or expenditure incurred due to reliability issues. The analysis of money loss based on corrective time and downtime can be seen in Table 3 and 4 above. It is shows the relationship between cost elements that arise due to reliability issues. Between loss time and the cost are interconnected, the higher the loss hour per year, the cost of the company will be greater. Based on the money loss, which causes the money loss this printing machine unit is high due to high labour maintenance cost and high corrective loss time / year. This shows that the reliability problem will have a very bad impact on the cost that must be issued by the company. The high value of money loss in the printing machine is caused by the amount of loss time that resulting the production process will stop, so that income is not earned. Can be concluded that the amount of time loss is very influential on the amount of money loss that occurred.

5. Conclusion

The reliability of a machine is very influential to earn amount of company revenue, based on the cost calculation with Cost of Unreliability method, the cost caused by the system's inactivity based on active repair time is $ 451,385.00, and $ 552,362.00 based on downtime, so the total is $ 1003,747.0, its mean the company will suffer a loss of revenue due to the unreliability machine per year is $ 1,003,747.00.

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