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Determination of optimum time of replacement with age replacement model

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Abstract. Technological developments in the manufacturing industry aim to make the machine operate optimally supported by good engine maintenance activities. Products produced by this company are light bulbs for household needs and motorized vehicles. The company has been implementing corrective maintenance policies, where component replacement is carried out if the engine component is damaged. The purpose of this research is to obtain the optimum time of replacement components Engine Inflatable. The optimum replacement schedule with an Age Replacement model for Tail Pipe components is 45 days, 14 Hole Double Row Burner is 38 days and, Tipping Burner is 43 days.

1. Introduction

Development of technology on manufacturing industry aims to increase production capacity. The continuous operation of production machines must be supported by good engine maintenance activities[1]. The company engaged in the manufacture of light bulbs often have constraints resulting. The output of the engine is Blowing IE Glass Bulb. Damage to the Machine or Inflatable repair requires replacement of engine components[2]. The company has a corrective maintenance which is the treatment that is carried out when the engine is damaged. This results in the inefficiency of the treatment system being implemented which has an impact on the termination of the production process so that the company loses production time[3]. The first process in making light bulbs is printing glass bubbles (glass bulb). Inflatable machines are machines that print glass pipes into glass bubbles. Maintenance is a routine work, repetitive work, is needed to keep existing facilities in good condition, can be used according to original capacity and efficiency[4]. The facilities referred to above include; production machinery, building equipment, land, and others. Thus, companies avoid the occurrence of production losses and other losses[5].



The main maintenance objectives can be defined as follows[6,7,8].:

1. Extend the useful life of assets (means every part of a workplace, building and contents). This is especially important in developing countries due to lack of capital resources for replacement. In developed countries it is sometimes more profitable to 'replace' rather than maintain.
2. Ensure the optimum availability of the equipment that was installed for the production or service to get return of Investment as fully as possible.
3. Ensure the operational readiness of the whole necessary equipment in case of an emergency at any time, for example the spare unit, rescue and firefighting units, and so on.
4. Ensure the safety of people using the facility

Age Replacement Model is a replacement model where the component replacement time interval is carried out by taking into account the usage age of the component, so as to avoid replacing the newly installed equipment which will be replaced in a relatively short time[9,10,11].

2. Research Methods

The type of research is action research because this research only proposes a maintenance schedule that has not been applied by the company. Action Research is a research that conducted to obtain practical findings in decision-making purposes operations of flow charts and reduces engine maintenance activities that do not add value (non-value added activities) as well as the calculation of the cost for minimizing expenditure in particular parts of the company maintenance[12]. The object is observed in research stations making the light bulb that is blowing machine.

1. The Dependent Variable is influenced or determined by the value of another variable. The dependent variable in this study is the schedule replacement of components [13].
2. The Independent Variable are variables that affect the dependent variable both positively and negatively. The independent variables in this research are *Component Failure Frequency*. Corrective and Preventive Maintenance Time a variable that state the time to replace components with corrective maintenance policies and preventive maintenance policies.

3. Results and Discussion

3.1. Data Collection

Data collection is done by interviewing workers in the maintenance section. Data obtained include a list of engine components, damage data for Inflatable Engine components. Frequency of Damage can be seen in Table 1.

Table 1. Frequency of Inflatable Machine Components damage

No	Component Name	Number of Units	Inflatable Machine Name								Damage
			IM-1	IM-2	IM-3	IM-4	IM-5	IM-6	IM-7	IM-8	Frequency
1	<i>Valve Core PH16</i>	2	1	1	2	1	2	1	2	1	22
2	<i>Tipping Burner</i>	1	3	5	3	6	3	5	5	2	32
3	<i>Rotary Barrel</i>	1	2	3	2	3	1	2	1	1	15
4	<i>Flare Fittings 41 FL</i>	1	2	4	3	4	5	3	4	3	28
5	<i>Verical Gear 80mm</i>	1		1		1	1		2		5
6	<i>Gas Hoses d 6mm 1.2m</i>	1	2	1	1	3	1	1		2	11
7	<i>Link Belt</i>	1	1	2	1	1		2	1	1	9
8	<i>Flare Pin</i>	1	3	2	2	3	1	3	3	2	19
9	<i>Glass Tube Clamp</i>	1	1		2		2	2		2	9
10	<i>Inner Cutter Holder</i>	1	2	1		1		1	2	3	10
11	<i>Twizer-SS</i>	2	1	2	3	2	1	2	1	1	26
12	<i>Gas Balancing</i>	1		1	1	2	3	2	2	1	12
13	<i>A-60 Mould</i>	1	4	3	2	3	2		2	3	19
14	<i>14 Hole Double Row Burner</i>	1	5	3	5	2	4	5	3	4	31
15	<i>Tail Pipe</i>	1	2	2	4	5	3	5	4	3	28

3.2. Processing

In dealing with the company's current strategy required an efficient treatment. Treatment strategy with preventive replacement need replacement interval of time in determining the schedule replacement of components engine. The concept of reliability is used to determine the optimum replacement intervals. The pattern of distribution for each critical component already obtained based on the current Index of the biggest Fit[14]. Recapitulation of the calculation of the Index of Fit to the distribution patterns over time damage to Critical components can be seen in table 2.

Table 2. Recapitulation of Index of Fix Calculation

Component Name	Distribution	Index of Fit	Selected
<i>Tail Pipe</i>	Normal	0,98652	Lognormal
	Lognormal	0,98913	
	Exponensial	-0,93043	
	Weibull	0,97567	
14 Hole double	Normal	0,95362	Lognormal
	Lognormal	0,95794	
<i>row Burner</i>	Exponensial	-0,91355	

Table 2. Recapitulation of Index of Fix Calculation (Continued)

Component Name	Distribution	Index of Fit	Selected
<i>Tipping Burner</i>	Weibull	0,92486	Weibull
	Normal	0,97952	
	Lognormal	0,96296	
	Exponensial	-0,84800	
	Weibull	0,98850	

Processing Calculation of parameter values for critical component (Tail pipe) that is adjusted to the type of distribution pattern are as follows:

The distribution pattern of the Tail Pipe component is Lognormal, so the damage distribution parameters are as follows:

$$\begin{aligned}\mu &= x = \frac{\sum_{i=1}^n \ln t_i}{n} \\ \sigma &= \sqrt{\frac{\sum_{i=1}^n (\ln t_i - \mu)^2}{n}} \\ &= \sqrt{\frac{0,83840}{28}} \\ &= 0,17304\end{aligned}$$

MTTF value is calculated based on the pattern of damage distribution and distribution parameters of each critical component. The next step is to calculate the Mean Time To Failure (MTTF) parameters and values for each critical component of the Inflatable Machine.

1. The components of the Tail Pipe Lognormal distribution Parameters $\sigma = 0.17304$; $\mu = 3.81146$, then the calculation of the MTTF component is as follows:

$$\begin{aligned}\text{MTTF} &= \exp\left(\mu + \frac{\sigma^2}{2}\right) \\ &= \exp\left(3,81146 + \frac{0,17304^2}{2}\right) \\ &= 45,89829 = 45 \text{ days}\end{aligned}$$

2. The components of the 14 Hole double Row Parameter Lognormal distribution Burner is $\sigma = 0.31382$; $\mu = 3.59632$, then the calculation of the MTTF component is as follows:

$$\begin{aligned}
 \text{MTTF} &= \exp\left(\mu + \frac{\alpha^2}{2}\right) \\
 &= \exp\left(3,59362 + \frac{0,31382^2}{2}\right) \\
 &= 38,30440 = 38 \text{ days}
 \end{aligned}$$

3. Components of the Weibull distribution Parameters Burner Tipping is $\alpha = 46.30796$; $\beta = 7.25940$, then the calculation of the MTTF component is as follows:

$$\begin{aligned}
 \text{MTTF} &= \alpha \left(1 + \frac{1}{\beta}\right) \\
 &= 46,30796 \left(1 + \frac{1}{7,25940}\right) \\
 &= 46,30796 \times 0,93993 \\
 &= 43,52623 = 43 \text{ days}
 \end{aligned}$$

Based on the table above, the work plan can be changed as shown in Table 3 below:

Table 3. Component Replacement Schedule Plan

No	Component	MTTF day to-
1	<i>Tail Pipe</i>	45
2	<i>14 Hole double Row Burner</i>	38
3	<i>Tipping Burner</i>	43

Treatment strategies by means of preventive maintenance can schedule the replacement of critical components of the engine Instruments. Components that have reached proposed time interval should be replaced with new components. This treatment strategy can reduce the maintenance costs on Inflatable Machines and reduce production time loss when the Inflatable Engine is producing.

4. Conclusion

Based on the results of processing and problem solving analysis, the following conclusions can be drawn:

1. The critical components are the tail pipe, 14 hole Double Row Burner, and tipping burner.
2. The optimum replacement schedule with an Age Replacement model for Tail Pipe components is 45 days, 14 Hole Double Row Burner is 38 days and, Tipping Burner is 43 days.

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