Determination of Maintenance Schedule of Loading and Unloading Pump Machine Using Genetic Algorithm Method

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ABSTRACT

This paper discusses the application of genetic algorithm methods in solving engine maintenance problems in an industry, from processing data that has been obtained by taking the case of engine pump maintenance where the level of damage that occurs is more than 50%. Within genetic algorithm method, we can get the optimal solution and generated in scheduling engine maintenance

Key word: Maintenance schedule, Pump Machine, Genetic Algorithm

1. Introduction

Maintenance is the concepts of all activities needed to be maintain or maintain the quality of facilities or machines to function properly as in reach the desire condition. Care is also a supportive activity that ensures the continuity of machinery and equipment of the machine so that when needed can be used as expected.

There have been many studies on engine maintenance scheduling, among others, using the Reliability Centered Maintenance (RCM) approach [1][2], where the results using this method are only limited to the physical aspects of engine maintenance by taking into account the desires of machine operators, besides the Overall Equipment Effectiveness (OEE) method used in engine maintenance scheduling, but in the use of this method only limited as a measuring instrument in measuring total productive maintenance where by paying attention to the six big loss of the engine [3][4][5].

In this study the method used is Genetic Algorithm. GA or Genetic Algorithm is a search technique in computer science engineering to solve problems in forecasting optimization [6][7][8][9][10]. Genetic algorithms are a special class of evolutionary algorithms using techniques inspired by evolutionary biology such as in heritance, mutations, natural selection and recombination (or crossover). The advantages of this method where results in scheduling treatments become more optimal.

2. Literature Review

Maintenance planning contributes significantly for every company to production [11][12][13]. Maintenance activities are very important operations for restoring equipment of the machine to a specific state [14][15]. Maintenance is an activity to maintain and make repairs to machinery or plant equipment in order to create a production operating condition that is in accordance with what is expected. Maintenance categorized into two main classes: Corrective Maintenance and Preventive Maintenance [16][17][18][19]. Corrective Maintenance is unscheduled maintenance or repair required to return items/equipment to a defined state, which is carried out because of perceived
deficiencies or failures. Preventive Maintenance is planned, periodic and specific schedule to keep equipment in a working condition [12][20][21][22].

Genetic Algorithm

Genetic Algorithm is a searching method that is based on the natural evolution process [23][24][25], which is the formation of a random initial population consisting of individuals with properties that depend on genes in their chromosomes. Individuals carry out the process reproduction to give birth to offspring, the offspring's nature is formed from a combination of the characteristics of the two parents or inherited from the parent traits.

A framework commonly used in the application of genetic algorithms to solve an optimization problem [26][27][28][29]. According to [8], the success of using genetic algorithms is largely determined by determining the statement of the problem in the form of search points called chromosomes, and the selection of operators used.

The things that must be done in using genetic algorithms are [6][30]:

1. Defining individuals, where individuals state one possible solution of the problem at hand.
2. Defining fitness values, is a measure of whether an individual is good or not or not the solution is obtained.
3. Determine the initial population generation process, usually carried out by generating random numbers.
4. Determine the selection process to be used
5. Determine the cross over process and the mutation of the gene to be used

In genetic algorithms, chromosome processing as a population by genetic operators occurs repeatedly (Cole). At first it is generated randomly in accordance with the repression of the problem to be developed. Furthermore, genetic operators will combine genetic information from population elements to form the next generation population[31][32].

3. Methodology

Variables of this research are:
- Dependent variable (Dependent), a variable that is strongly influenced by independent variables. In this research is the optimization of machine maintenance planned.
- Independent variable (Independent), that is variable affecting the dependent variable. In this case it is:
  a) Time of Machine Damage
  b) Machine Maintenance Time Data
  c) Machine setup data
  d) Machine Downtime Data

4. Result and Discussion

Data in Company

The data obtained include data on the history of engine failure, data on downtime, engine maintenance time data, machine set-up time data.

| Date     | ITEM Checked               | Information | Time of Machine Damage (minutes) |
|----------|-----------------------------|-------------|----------------------------------|
| 03/08/07 | REPLACE MECHANICAL SEAL     | 036         | 60                               |
| 09/11/07 | REPAIR LINE STEAM           | 028         | 45                               |
| 02/02/08 | CLEANING INLET FILTER       | 067         | 30                               |
| 15/05/08 | CLEANING INLET FILTER       | 087         | 30                               |
| 18/09/08 | REPLACE CARBON PLAT PUMP    | 095         | 30                               |
| 20/12/08 | REPLACE MECHANICAL SEAL     | 110         | 60                               |
Table 2. Machine maintenance data time

| No | Part of being examined | Machine Maintenance Activity | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun |
|----|------------------------|-----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1  | Loading Pump           | Oil Gear Check              | 8   | 9   | 7   | 10  | 9   | 7   | 7   | 8   | 10  | 8   | 9   | 10  |
|    |                        | Oil Pump Check              | 12  | 11  | 13  | 10  | 11  | 13  | 13  | 12  | 10  | 12  | 11  | 13  |
|    |                        | Cleaning Inlet Filter       | 20  | 22  | 21  | 23  | 22  | 25  | 20  | 23  | 21  | 21  | 25  | 22  |
|    |                        | Mechanical Seal Check       | 9   | 8   | 9   | 9   | 9   | 7   | 8   | 9   | 7   | 9   | 9   | 9   |
|    |                        | Carbon Plat 1 Check         | 10  | 9   | 9   | 8   | 7   | 7   | 8   | 9   | 9   | 8   | 10  |     |
|    |                        | Carbon Plat 2 Check         | 9   | 8   | 8   | 9   | 10  | 10  | 9   | 9   | 10  | 8   | 7   | 10  |
| 2  | Unloading Pump         | Alignment Check             | 10  | 9   | 8   | 10  | 9   | 10  | 8   | 9   | 10  | 9   | 10  | 8   |
|    |                        | Bearing Check               | 9   | 9   | 10  | 8   | 10  | 9   | 9   | 9   | 10  | 9   | 10  | 9   |

4.2 Data Processing

Initialization of random numbers in the population

Initiation with random numbers becomes a population for July 2017 until June 2018:

| Value of x | Value of f |
|------------|------------|
| 7          | 0.6174     |
| 5          | 0.5187     |


| Value of x | Value of f |
|-----------|-----------|
| 30        | 3.0511    |
| 12        | 1.0104    |
| 11        | 1.0253    |
| 29        | 1.5257    |
| 13        | 1.0203    |
| 4         | 0.3984    |
| 13        | 1.0189    |

Test the fitness value of the population
fitness of data test is done to measure the level of goodness. This fitness calculation is done using the software:
BestX = 128.9877 228.1580

Make crossover
At this stage crossovers are carried out to determine the parent and produce offspring from crossovers. Based on the results of crossovers using the Matlab software, the results are obtained father = 12 mother = 4 children X1 = 196.5136 and 164.6524 then X2 = 180.5622 and 172.6307.

Make a selection
At this stage the selection is to determine the next step of the crossover :

| cumF   | ncumF   |
|--------|---------|
| 0.0016 | 0.0704  |
| 0.0035 | 0.1542  |
| 0.0039 | 0.1684  |
| 0.0049 | 0.2114  |
| 0.0185 | 0.8057  |
| 0.0195 | 0.8483  |
| 0.0220 | 0.9573  |
| 0.0230 | 1.0000  |

Mutation in the population

kk =12
Populasi_s(kk, : )
ans =
199.2236 173.6501

Evaluation of mutase results
Based on the evaluation of mutase results obtained minf = 220.5946 and the best best repair is 2 which means 2 times in one month.

5. Conclusion
Based on the evaluation of the mutase results for the loading pump, the minf is 220.5946 and the best repair for treatment is 2, which means 2 times in 1 month. And the evaluation of the mutase results for the unloading pump obtained is 344.5943 and the best repair for treatment is 2, which means it is 2 times in 1 month Where previously the treatment was done 1 month only once and the treatment was less optimal.
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