Application of Preventive Maintenance in Planning Maintenance of Tablet Printing Machines in Drug Companies

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Abstract. Companies that implement the production process will always be faced with market competition. The process is done on the floor of the production required to produce a quality product and is able to win the competition. Machine condition greatly affects the results of the production process. A good machine will produce a quality product, otherwise the machine that his condition is not good will result in products that are not qualified. Companies engaged in the manufacture of the drug often have damage to the machine where the damage is mostly caused by engine component of a machine failure function so that the machine could not start the process when the operating damage to one of the machines at work, then the machine production process will be interrupted because it takes time to replace components of the machine. For that to be done, a step to improve the system of corrective maintenance which currently used the company so that the damage to the engine at the time of the working hours of the machine can be avoided. The purpose of this research is to get the engine maintenance schedule intervals by performing a critical component replacement tablet printing machine based on data obtained by the drug companies. Determining the schedule engine maintenance done by using Reliability Engineering. Of research results in retrieved that components are frequently damaged components namely Punch and Dies and the Pulley with the value of the respective machine reliability of 0.3429 and 0.4183. While the time Interval component replacement punch and dies the optimum is 791 hours per cycle of usage which means that the components of the punch and dies must be replaced at a time when the machine operates 791 hours. Whereas in the pulley component the optimum replacement time interval is 1695 hours per cycle of damage where the pulley component must be replaced when the engine is operating 1695 hours.

1. Introduction
The growing manufacturing industry has triggered companies to always strive to remain able to survive in the market competition that can arise between companies and similar products. The process carried out on the production floor is required to produce quality products and be able to win the competition. To produce a quality product, the company must be able to carry out every process so that high quality output can be produced [1]. The condition of the machine greatly affects the results of the production process. A good machine will produce a quality product, on the other hand a machine that is not in good condition will produce a quality product too. A good machine can be seen based on
the level of reliability of the engine. Reliability is the possibility that a part of a machine or product can function properly in a certain time related to the level of confidence that an equipment or component will perform its function without experiencing problems or damage at the time of operating conditions that are still implemented in the time period [2, 3].

The level of machine reliability in producing a product depends on the maintenance carried out on the machine. Maintenance is a collection of actions executed on assets with the aim of retaining assets, or specified, a specified condition. The maintenance function is an essential part of any asset intensive organization, and needs to support the organization's business objectives [4]. Maintenance is an activity to maintain or maintain factory facilities or equipment and make repairs or adjustments or replacements needed so that there is a satisfactory state of production operations in accordance with what is planned [5]. Machine maintenance has an important role in determining the company's production activities with regard to the smooth and congestion of production, slowness, and production volume and production efficiency. The cessation of the operation of the engine will result in a constrained production process. Apart from that, the products produced will not reach the quality that has been targeted by the company [6, 7].

Companies engaged in the pharmaceutical industry produce a variety of drugs ranging from tablets, syrups, ointments, oral powders, external medicine powders, capsules where each of these products has different departments in the manufacturing process. This company is very dependent on the reliability of its production machinery to run the production process. This is because industries that produce drugs must have a high level of precision in producing drugs. If the engine is damaged or its reliability in carrying out the production process decreases, the drugs produced will not match the prepared composition. This can cause a loss because the medicinal products cannot be sold on the market. The company is currently implementing a machine maintenance system in the form of preventive maintenance and corrective maintenance to support the smooth production process. Preventive maintenance is a treatment that is carried out in a scheduled, generally periodic manner where a set of maintenance tasks such as inspection and repair, replacement, cleaning, lubrication, adjustment, and equalization is carried out. Preventive maintenance aims to prevent sudden damage to the engine, increase reliability, and reduce downtime [8]. The implementation of a preventive maintenance system is carried out by cleaning engine parts and lubricating the production machine. While the engine maintenance system in the form of corrective maintenance is carried out by the company by replacing and repairing engine components after damage to the component concerned. If an engine failure occurs during engine working hours, the production process will be disrupted, because time is needed for replacement of engine components. For this reason, planning for maintenance of machine components is carried out in the production process of medicines so that machine damage can be avoided.

Care planning has been carried out in many previous studies. One study was conducted at a company that produces corrugated carton boxes located in Gresik. The study was conducted to design a maintenance schedule with preventive maintenance on corrugating machines and flexo machines. The results of this study indicate that the cost of care before and after scheduling resulted in savings of 22.16% when compared to the company's corrective schedule [5]. Other research was also carried out on shoe sole companies that suffered sudden engine damage so that the planned production schedule was disrupted. The research was carried out by implementing a preventive maintenance system. The results obtained showed that with the implementation of the preventive maintenance system, downtime was reduced by 2.85% and a savings of 38% occurred. [9]. Based on previous studies, this study aims to obtain a machine maintenance schedule by performing critical component replacement of tablet printing machines and increasing the efficiency of engine components.

2. Methodology
The study was conducted at a drug company where the object under study was a tablet printing machine. This type of research is descriptive research that is a type of research that aims to describe systematically, factually and accurately about the facts and characteristics of an object or a particular
The study was conducted for 10 months with several stages. The research began by conducting observations to observe the state of the drug company directly. Based on the results of observations, the problem formulation will be determined in accordance with the condition of the company, namely how the company carries out maintenance on the production machine. In this stage, various types of machine maintenance can be identified which can be corrective or preventive. With the formulation of this problem, the objectives of the research will be applied as a solution to the problems that occur. Problem solving can be done based on supporting data as input for this research process. The data used to solve the problem of engine damage is the damage to the engine production data and damage data components of the critical engine.

Troubleshooting machine maintenance is done in several stages. The first stage of identifying the components on the critical engine is to find out the types of components that are often damaged so that component replacement must be done. Identification of this critical component is done by using the Pareto diagram with the 80/20 rule. Pareto diagram is an image that sorts the clarification of data from left to right according to the highest to lowest ranking so that important problems are found to be resolved immediately. This diagram helps management to quickly identify the most critical areas that require special and fast attention [11]. The next step is to do a distribution pattern maintenance test to avoid the engine from damage. So that it can be known the appropriate engine maintenance interval. The type of distribution used in order to find out the pattern of data formed is a normal, lognormal, exponential and Weibull distribution. The selection of distribution patterns is using the Least Square Curve Fitting method, which is based on the largest Index of Fit (correlation coefficient) value. Testing the distribution of critical component patterns is done using data time intervals between component damage (MTTF). Mean time to failure (MTTF) is the average time interval of damage that occurs when the engine or component is damaged again [9]. The next stage of this research is to calculate the reliability of critical engine components. The calculation of the reliability of critical engine components on the proposed replacement schedule is used to determine the value of the reliability of engine components when the proposed replacement of the proposed component is made. Calculations are carried out based on the distribution pattern that has been selected for each component. After that, a time interval was calculated so that the machine maintenance schedule was obtained by performing critical component replacement of the tablet printing machine. The maintenance time interval is calculated for each critical component of the tablet printing machine.

3. Result and Discussion

3.1. Identification of Damage to Tablet Printing Components

The selection of critical components that will be the focus of the study was carried out with Pareto 80/20 rules using Minitab software. The results of component identification using the Minitab software can be seen in Figure 1.
The diagram above shows 80% loss of production time due to 20% of the damaged components. Thus, there are 2 types of critical components that can cause damage to tablet printing machines namely punch and dies, and pulley.

3.2. Testing the Critical Component Distribution Pattern
Testing the distribution of critical component patterns is done using data time intervals between component damage (MTTF). The distribution used is normal, lognormal, exponential and weibull distribution. The selection of distribution patterns is using the Least Square Curve Fitting method, which is based on the largest Index of Fit (correlation coefficient) value. The recapitulation of the calculation of the Index of Fit for interval distribution patterns of damage to punch and dies and pulley components can be seen in Table 1.

| Components      | Normal  | Lognormal | Exponential | Weibull |
|-----------------|---------|-----------|-------------|---------|
| Punch and Dies  | 0.8939  | 0.9878    | 0.9699      | 0.9660  |
| Pulley          | 0.9824  | 0.9428    | 0.8751      | 0.9842  |

From the table, it is obtained that the chosen distribution for punch and dies component is lognormal distribution with index of fit value of 0.9878 while pulley component is weibull distribution with index of fit value of 0.9842.

3.3. Calculation of Mean Time to Failure (MTTF) and Reliability
After the distribution pattern selection is performed for each component based on the largest Index of Fit value then the next stage is calculating the parameters and values Mean Time To Failure (MTTF). The recapitulation of critical component MTTF tablet printing machines can be seen in Table 2 below.

| No. | Component         | MTTF (hour) | MTTF (days) |
|-----|-------------------|-------------|-------------|
| 1   | Punch and Dies    | 791.41      | 33          |
| 2   | Pulley            | 1694.93     | 71          |

Based on the table, it was found that the average time of damage to the punch and dies component was 791.41 hours (33 days) while the pulley component was 1694.93 hours (71 days).

3.4. Determination of Reliability Value
The calculation of the reliability of critical engine components on the proposed replacement schedule is used to determine the value of the reliability of engine components when the proposed replacement of the proposed component is made. Calculations are carried out based on the distribution pattern that has been selected for each component. The recapitulation of reliability value to the use of components can be seen in Table 3.

| No. | Component   | MTTF (days) | Value of Reliability |
|-----|-------------|-------------|----------------------|
| 1   | Punch and Dies | 33          | 0.3429               |
| 2   | Pulley      | 71          | 0.4183               |
Based on the table, it obtained that after 791.41 hours (33 days) the use of punch and dies components has a reliability value of 0.3429 and after 1694.93 hours (71 days) the use of pulley components has a reliability value of 0.4183.

3.5. Determination of Schedule for Maintenance of Tablet Printing Machine Components
The maintenance time interval is calculated for each critical component of the tablet printing machine. The maintenance time projection is carried out in the range of the 35th tp hour to 1211 hours along the reliability value (0-1) for the punch and Dies component. While pulley components, the maintenance time projection is carried out in the range of tp 20 hour to 4515 hours along the reliability value (0-1). The maintenance projection results show that the optimum punch and dies component replacement interval is 791 hours per cycle of use. This means that the components of punch and dies must be replaced when the engine operates 791 hours. In pulley components the optimum replacement time interval is 1695 hours per cycle of damage. This means that the pulley component must be replaced when the engine is operating 1695 hours.

4. Conclusion
There are two components that are often damaged IE components Punch and Dies and the Pulley where the value of the components obtained for reliability machine Punch and dies amounted 0.3429, whereas the value of reliability of components engine Pulley is 0.4183. With the application of reliability engineering in determining the treatment interval components engine, obtained that time Interval component replacement punch and dies the optimum is 791 hours per cycle of usage which means that the components of the punch and dies already should be replaced at the time of the engine operating hours, 791. While on the component pulley obtained optimum replacement, intervals are 1695 hours per cycle of damage where the components of the pulley must be replaced at the time of the engine operating hours, 1695.

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