Mandrel machine scheduling determination based on damage intervals

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Abstract. The sudden breakdown of engine components makes the production cost even higher. This study aims to evaluate the planned care system that has been carried out based on the damage that occurred. This study uses a distribution pattern in determining the right time to carry out planned care. Based on the schedule changes by the damage interval obtained the planned care system by the company is right. The addition of checks on the gripper bar and spring in the maintenance process is expected to detect early damage of the mandrel machine. The integration of production, maintenance, and inventory in planning planned maintenance is scheduled to minimize downtime and improvements can be made to the maximum with the readiness of components from the inventory.

1. Introduction
Based on previous research, the most significant cause of subsystem downtime in the Tension Rell area is the mandrel component [1]. Mandrel component damage causes the rill tension engine stop operating for 12 times in the 2012-2016 period. The damage interval can be used as a basic for a planned maintenance schedule.

Downtime is a time when a system cannot be used, so the system function does not work. Downtime is one of the biggest factors for inefficiencies in the manufacturing industry process [2]. Extended duration downtime with little variation has a more significant effect on system performance than short downtime with many variations [3]. The effort to minimize the downtime is an essential step in the industrial world to improve machine reliability in supporting the production process. Planned changes and planned maintenance can minimize the downtime [4]. Planned turnover is preferred because it can reduce unexpected costs.

The schedule of planned turnover has been developed to reduce unexpected system failures long time a go [5–7]. But in the industrial world, maintenance is required to keep a system running like it should be. If it is done only planned changes without thinking about optimizing engine performance, it will make the operating costs of the system more expensive. Poor maintenance systems are also one of the most significant contributors to downtime [8]. The integration of the maintenance system that involves maintenance, production, and inventory can increase machine productivity and save annual maintenance costs [9–11]. This study aims to evaluate the existing treatment system based on the
interval of damage that occurs. The integration of planned treatment methods and proposed changes is expected to reduce downtime.

2. Method
This research was conducted in the Mandrel subsystem Tension Reel (TR) Area in steel companies in Banten, Indonesia. It use the mandrel engine damage interval data during the period 2012-2016. Damage interval data is processed using four distribution patterns, namely Weibull, normal, lognormal, and exponential distributions. The method is the least square in getting the index of fit value. With this test can be determined the tendency of damage data to follow specific distribution patterns. The appropriate distribution pattern is the most extensive index of fit value.

Calculation of the Replacement Time Interval is done by calculating the total minimum downtime (TMD). The minimum total downtime is the time needed for a component to be replaced by another component that requires the minimum downtime [12]. Calculation of distribution patterns and total minimum downtime using Minitab 16 software.

3. Results and Discussion
Based on mandrel engine damage data during the period 2012-2016, damage occurred for 12 times (table 1). In February there was damage to the mandrel, which was quite close, i.e., eight days and four days. This caused significant maintenance costs and a disrupted production schedule.

Table 1. Damage time interval for critical components of the mandrel

| No | Date       | Time Interval (day) |
|----|------------|---------------------|
| 1  | 03/20/12   | *                   |
| 2  | 06/01/12   | 73                  |
| 3  | 08/03/12   | 65                  |
| 4  | 08/16/12   | 12                  |
| 5  | 02/02/13   | 168                 |
| 6  | 02/10/13   | 8                   |
| 7  | 02/15/13   | 4                   |
| 8  | 12/30/13   | 317                 |
| 9  | 10/30/14   | 306                 |
| 10 | 11/14/14   | 15                  |
| 11 | 07/02/15   | 229                 |
| 12 | 09/30/16   | 456                 |

Table 1 data is used to determine the distribution pattern. This distribution plot aims to determine what distribution matches for the existing data. Four distributions are used to identify data patterns that are formed from the damage time obtained from observations of the Subsystem Mandrel Tension Reel (TR) area. These distributions include Weibull Distribution, Lognormal Distribution, Exponential Distribution, and Normal Distribution.

The distribution that corresponds to the damage time data obtained is the distribution with the smallest AD value. Plotting Distribution Results Using Minitab 16 namely Weibull Distribution value 0.452, Lognormal Distribution 0.457, 1.011 Exponential Distribution, and Normal Distribution 0.609. The distribution with the smallest AD value is in the Weibull distribution so that the data is suitable for the Weibull distribution (Fig. 1).
After determining the right distribution then determine the parameter estimation. Parameter estimation results show that the value of the shape or value \( \sigma = 0.689028 \) and the scale value or value \( \beta = 131.793 \) (figure 2). From this parameter value, \( \sigma \) and \( \beta \) can be calculated critical component replacement time intervals.

Calculation of critical component replacement time intervals requires \( T_f \) and \( T_p \) values to determine the total minimum downtime (TMD). The time needed to replace the component due to damage is symbolized by \( T_f \), and the time necessary to replace the part based on the time interval (preventive action) is symbolized as \( T_p \). \( T_f \) and \( T_p \) values are obtained from the results of interviews with the production and service mechanics of the Shearing Line & HSPM. The \( T_f \) value is 960 minutes while the \( T_p \) value is 660 minutes. To determine the total minimum downtime (TMD), the calculation of the cumulative distribution function of the subsystem is used using the parameters: \( \sigma = \)

![Figure 1. Plotting distribution](image1)

![Figure 2. Parameter Estimation Results](image2)
0.689028; \beta = 131,793. Then calculate the amount of damage in the time interval and Minimum Downtime (TMD) Calculation. Based on the calculation of the Total Minimum Downtime (TMD), the smallest downtime was obtained on the 25th day of 0.054042045. So that the optimal replacement time interval of the critical component subsystem Mandrel Tension Reel (TR) is 25 days = 600 hours of machine operation.

Overall during the period of damage occurs, the ideal change interval is 25 days so that the inventory can prepare the spare parts stock first. When viewed from a planned maintenance schedule that is for 14 days, the company are correct by taken the preventive maintenance measures. From the results of discussions with maintenance, the maintenance schedule was still maintained by adding some component checking items that had not been done so far. The addition of this item is expected to detect the possibility of potential mandrel components experiencing sudden damage. Additional checks are performed on the gripper bar and spring components. The addition of maintenance can be done on the gripper bar component is checking the gripper bar step by trying to clamp the plate with a size of 0.8 mm, checking and cleaning the clamp, giving the lubricant to the sliding mandrel fan gripper bar and cleaning the gripper area from dirt and dust. The addition maintenance to the spring component can be done by checking the mandrel at the expand and collapsed position, adjusting the diameter of the mandrel at the expand and collapse post and performing the lockout spring if the collapsing and expand position is not maximal.

Planned maintenance is carried out before the estimated time of changing maintenance can reduce the potential damage. Estimation of turnover scheduling as a basic for the inventory to prepare the required components so that the component turnover time can be maximized. The integration of making planned maintenance by the conditions of the production floor will minimize the downtime that occurs, and the inventory is ready when component changes occur by the downtime interval which arises.

4. Conclusion
The planned maintenance time settings can be implemented using a planned turnover analysis. Planned maintenance should be done before the component replacement schedule. The integration of planned care and proposed changes by integrating maintenance, production, and inventory is expected to minimize the possibility of downtime and downtime can be corrected as soon as possible with the readiness of components from the inventory. Planned maintenance about damage intervals can improve a more detailed planning system so that the possibility of downtime can be detected as early as possible. This research can be continued to the application of maintenance autonomy so that the engine maintenance process is more optimal.

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