Analytical Insights for Yaw Gear Service Planning and Budgeting in Wind Farms

by Jahnvi Sikligar

1. Insights about Yaw Gear Failures

01.

Frequency of failures: The distribution shows a high frequency of failures occurring within a short period (around 0-50 months) after the previous failure. This suggests that a significant number of yaw gear components tend to fail relatively quickly after being replaced or repaired, indicating a potential issue with the reliability or durability of the components.

02.

Potential pattern or trend: While there are failures occurring at various intervals, the distribution appears to be skewed towards the left, with a gradual decline in the frequency of failures as the number of months since the previous failure increases. This pattern may indicate that the probability of failure decreases as the yaw gear component ages, potentially due to factors such as improved maintenance, component quality, or operational adjustments over time.

03.

The data shows that the most common reason for replacing yaw gear parts is wear and tear. This is evident by the fact that the highest frequency of parts replaced falls at the low end of the quantity scale (2), which likely represents parts that are routinely replaced due to standard wear and tear.
pen_spark

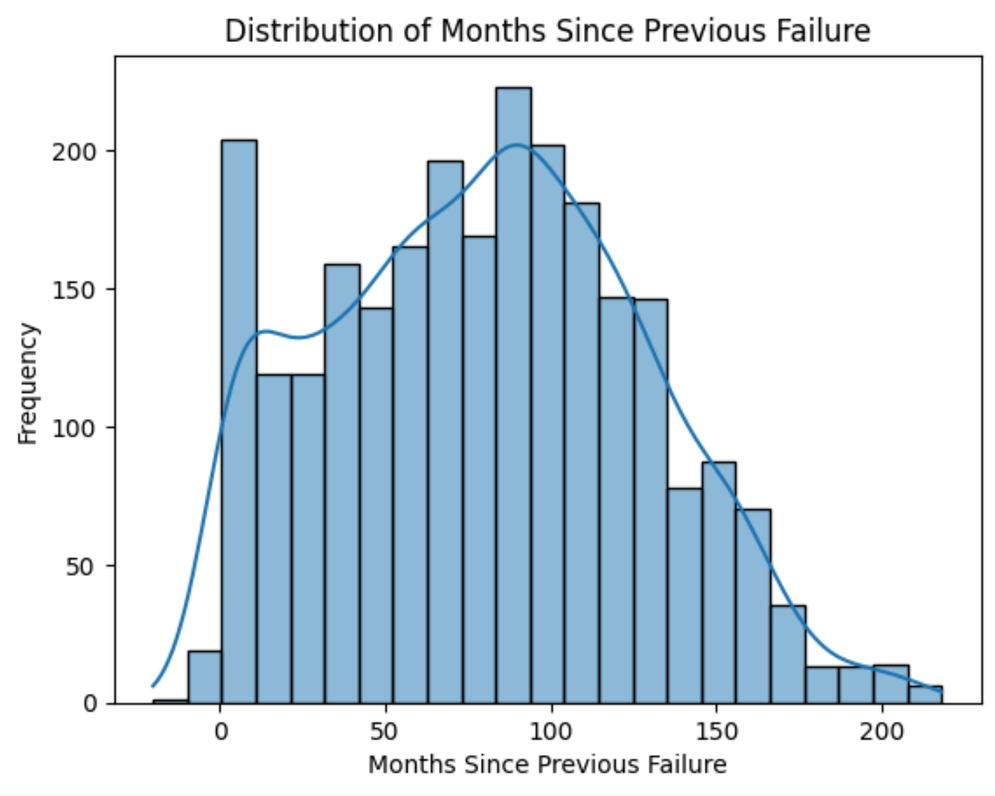
Distribution of Months Since Previous Failure
Frequency
Months Since Previous Failure
0
50
100
150
200

Fig 1.1

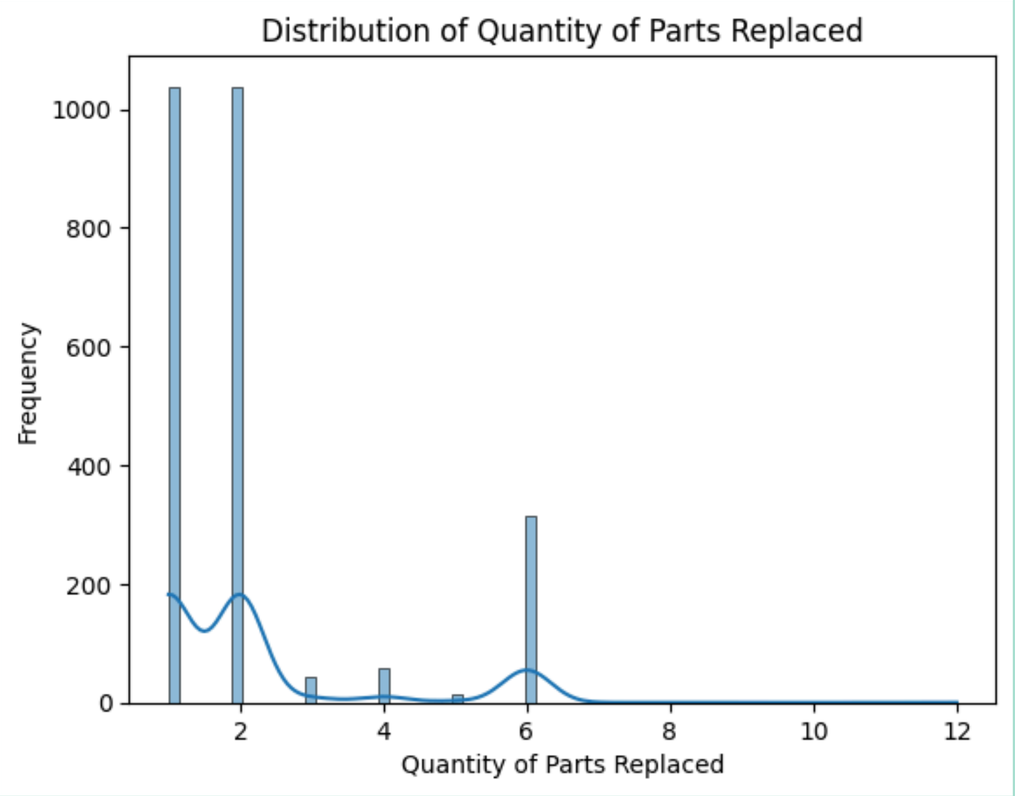
Distribution of Quantity of Parts Replaced
Frequency
Quantity of Parts Replaced
0
200
400
600
800
1000
2
4
6
8
10
12

Fig 1.2

2. Major Drivers of Yaw Gear Lifetime and Failure Frequency

Strong Positive Correlations

- TurbineNumber and ServiceReportID: These variables increase proportionally.
- QuantityofPartsReplaced and MonthsSincePreviousFailure: These variables tend to move in the same direction.

Strong Negative Correlations

- TurbineNumber and TotalEmployeesInTurbineForRepairJob: As the turbine number increases, the number of employees involved in repairs decreases.
- CurrentAge_years and HoursUnderNormalOperation: There is an inverse relationship between these variables.

Weak or No Correlations

- TerrainElevation and WindTurbulenceEstimate: These variables show very weak or no correlation with most other variables, suggesting they may not be strong predictors for certain targets.

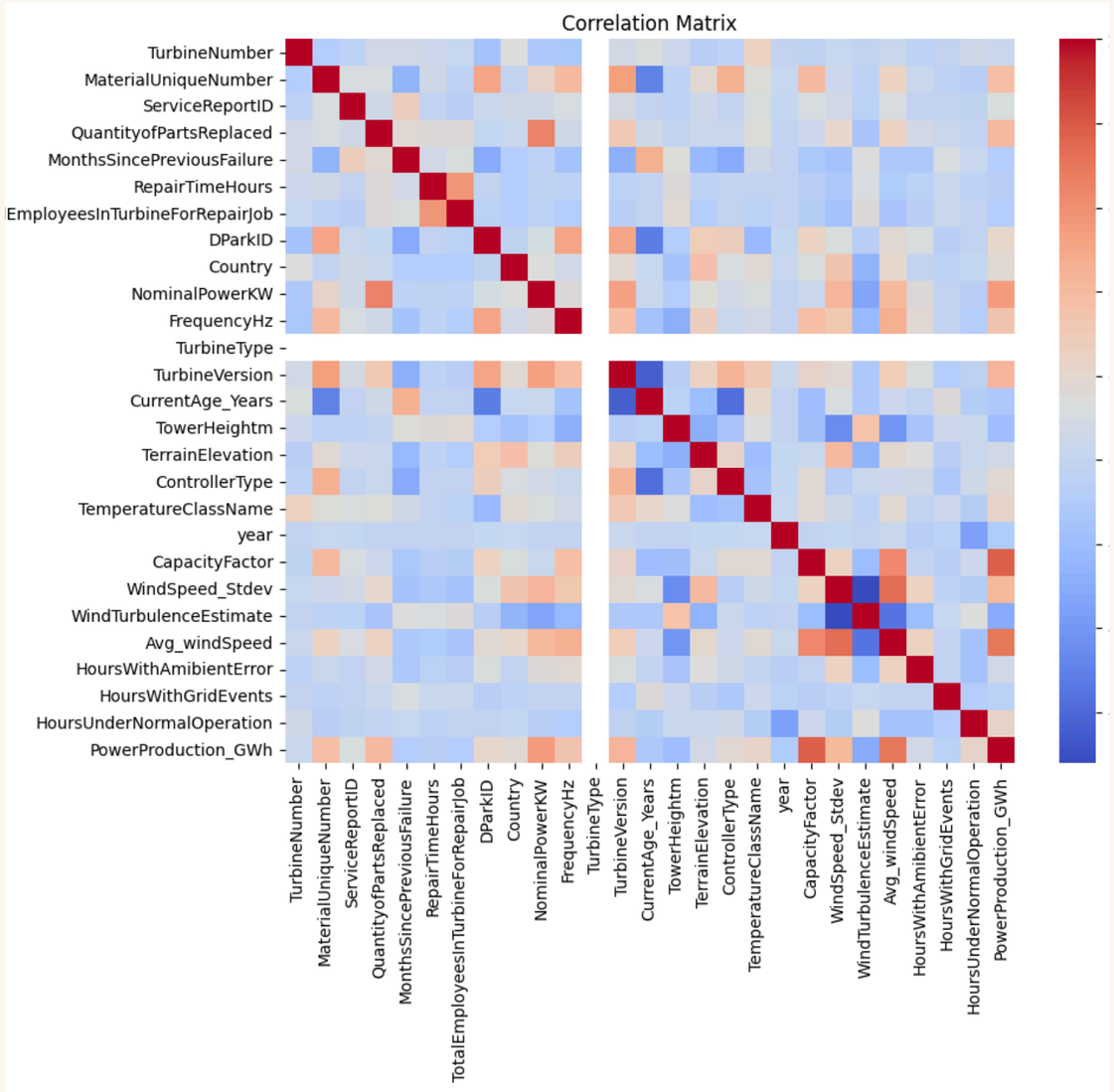

Fig 2.1

3. Forecasting Yaw Gear Demand for 2021

Mean Squared Error (MSE): 13596.745354882585
Mean Absolute Error (MAE): 116.60508288613573
Forecast: 2021 2027.394917

- The forecast for 2021 is 2027.394917, which suggests a potential decrease in yaw gear failures compared to the last historical year in the dataset.
- Specifically, the forecast is 116.61 lower than the actual value (test data), representing a 5.44% decrease in failures.
- This forecast implies that the demand for yaw gear replacements and associated resources (labour hours, technicians) might be lower in 2021 compared to the previous year, assuming the forecasting model's predictions are reliable.

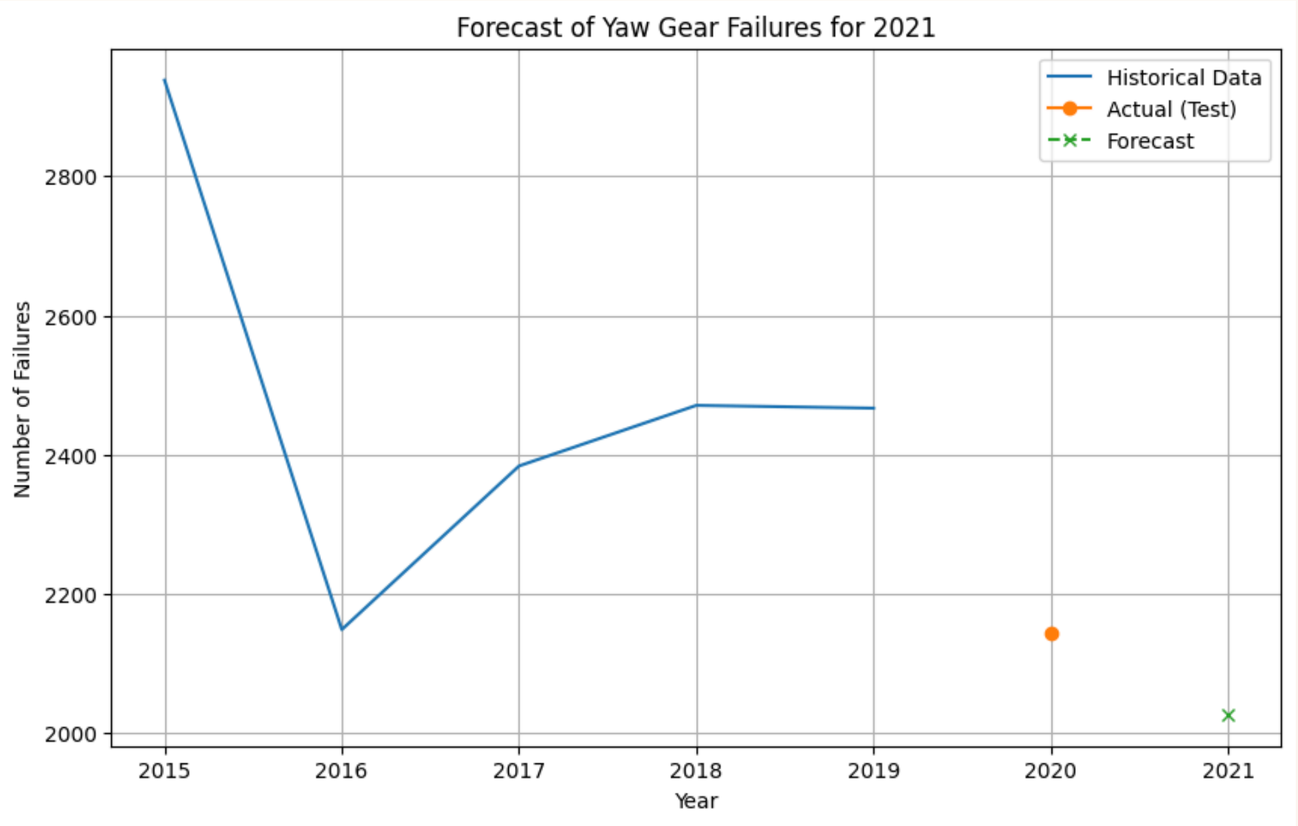

Fig 3.1

4. Capacity Planning for Labour Hours and Number of Resources

Analysis

Fig 4.1: The distribution is positively skewed, with a large number of repair jobs requiring fewer labour hours (around 200-400 hours). However, there is also a considerable number of repair jobs that require a higher number of labour hours, as indicated by the tail of the distribution extending towards higher values.

Fig 4.2: The distribution appears to be right-skewed, with the majority of repair jobs requiring fewer resources (around 5-10 employees). There is a significant number of repair jobs requiring between 5 and 10 employees, while fewer repair jobs require more than 10 employees.

Fig 4.3: The data points show a positive correlation, indicating that as the number of employees increases, the repair time tends to increase as well. However, there is also considerable variation in the data, suggesting that other factors besides the number of employees may influence the repair time

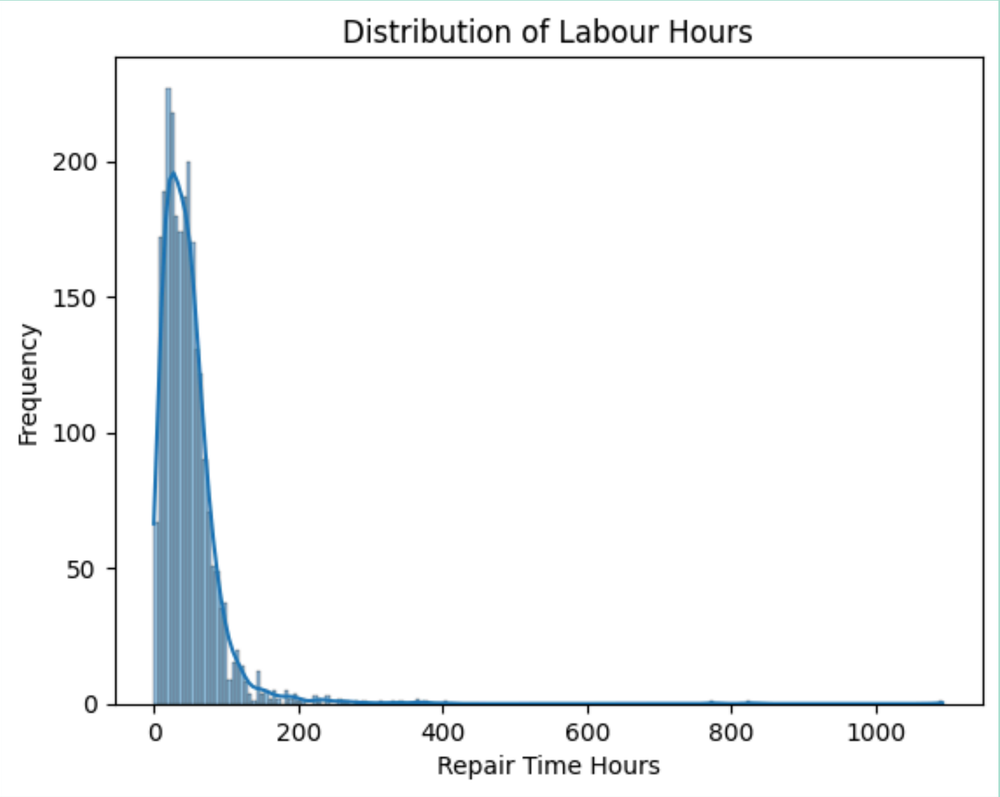
Distribution of Labour Hours
Frequency
Repair Time Hours
0
50
100
150
200
0
200
400
600
800
1000

Fig 4.1

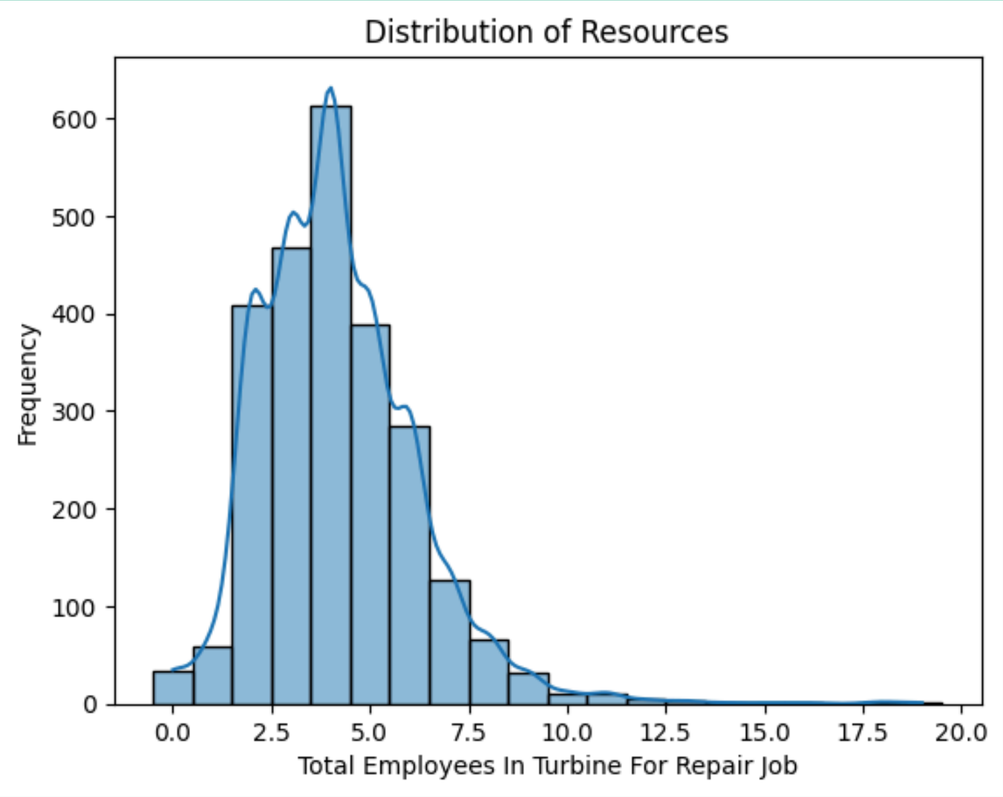
Distribution of Resources
Frequency
Total Employees In Turbine For Repair Job
0
100
200
300
400
500
600
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

Fig 4.2

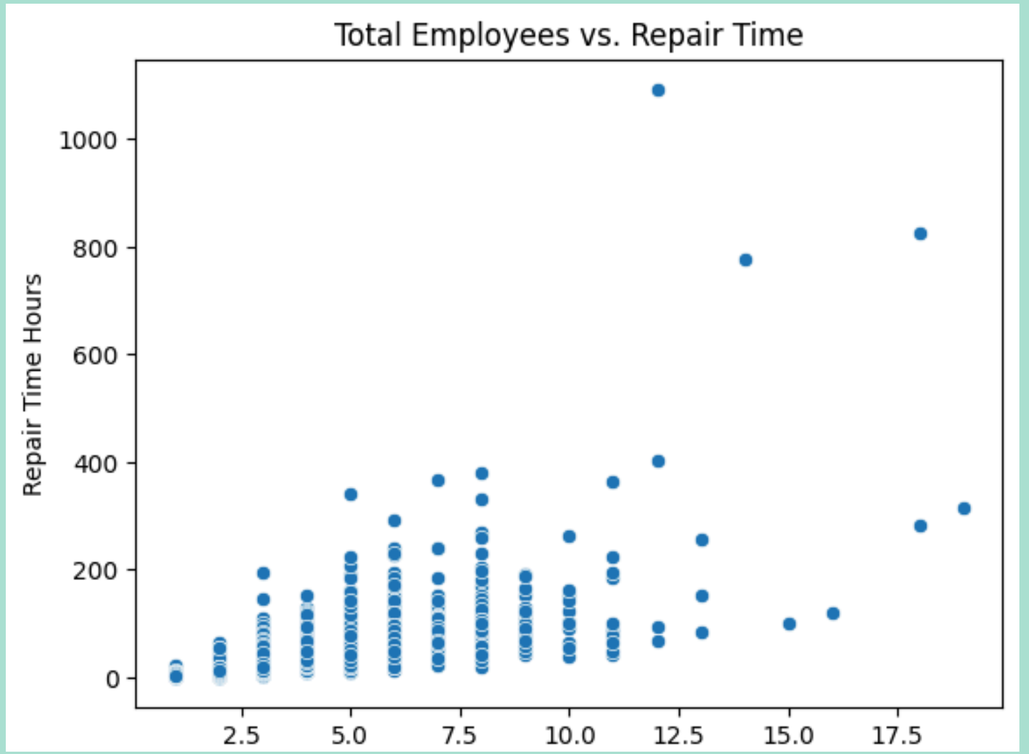
Total Employees vs. Repair Time
Repair Time Hours
0
200
400
600
800
1000
2.5
5.0
7.5
10.0
12.5
15.0
17.5

Fig 4.3

Thank you very much!