Southern Water Corp – Technical Presentation

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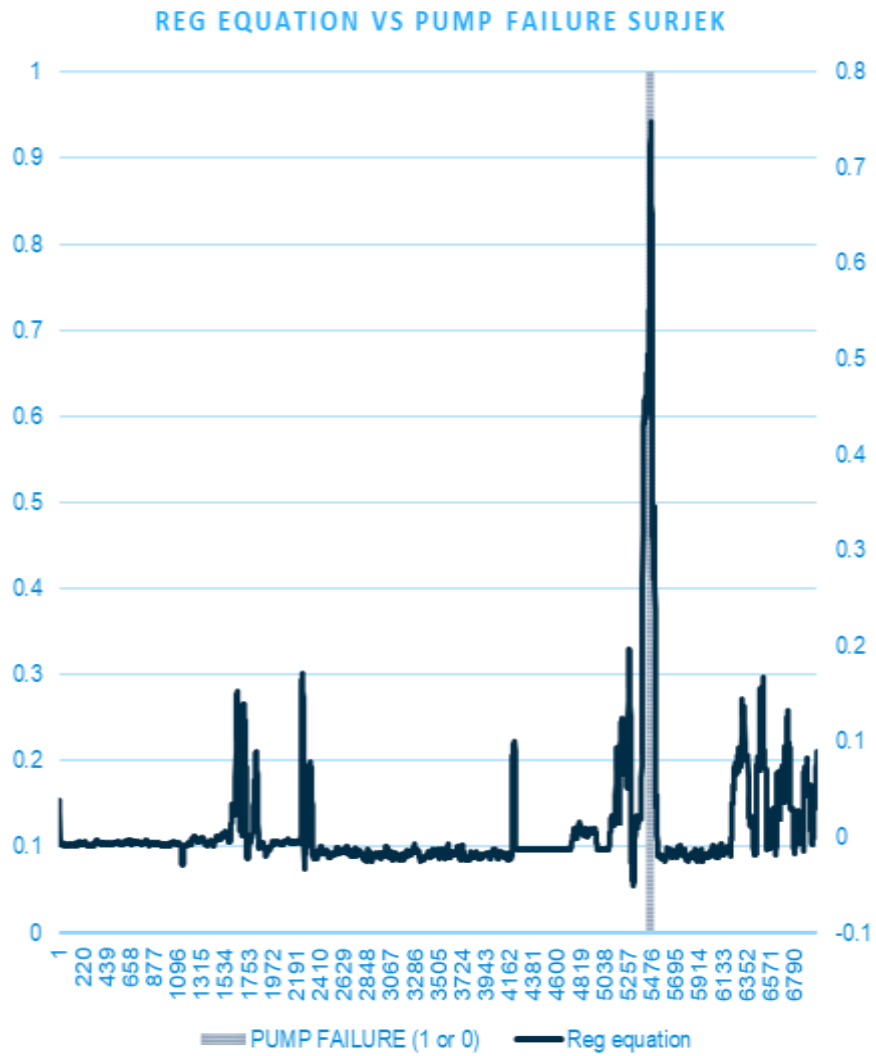
Maximising plant availability to meet increased demand may lead to pump failure, thereby loss of revenue and increased operational costs

! Increased demand leading to increased pump wear	Though the increase in demand has led to an increase in revenue, there are concerns as the plants will have to run harder to meet the demand. This could lead to a spike in production cost, which could significantly impact profit in the future.
! To meet the spike in demand, availability of plants have to be maximised	Maximising plant availability may lead to reliability issues. This could lead to pump failure.
! Asset failure will not bring in any revenue	Several pumps at Surjek have provided abnormally high-pressure readings, indicative of system failure. Failed assets lead to increased operational costs and a loss of revenue.

Surjek Flow Meter 2 is the variable that we need to watch out to avoid a ‘Failure Event’



Source: Southern Water Corp Statistical Records

Key Insights

Abnormalities in readings of variable Surjek Pump Torque seems to be triggering the 'Failure Event’

1. As we approach the First Pump Failure Period (14:40 hours to 14:45 hours of 10/12/2014), there is a sudden spurt in Surjek Pump Torque readings which triggers abnormalities first in Max Daily Pump Torque and then in Rotational Pump RPM

2. This further triggers abnormal readings in Surjek Flow Meter 1 and Surjek Flow Meter 2

3. This leads to a ‘Failure Event’

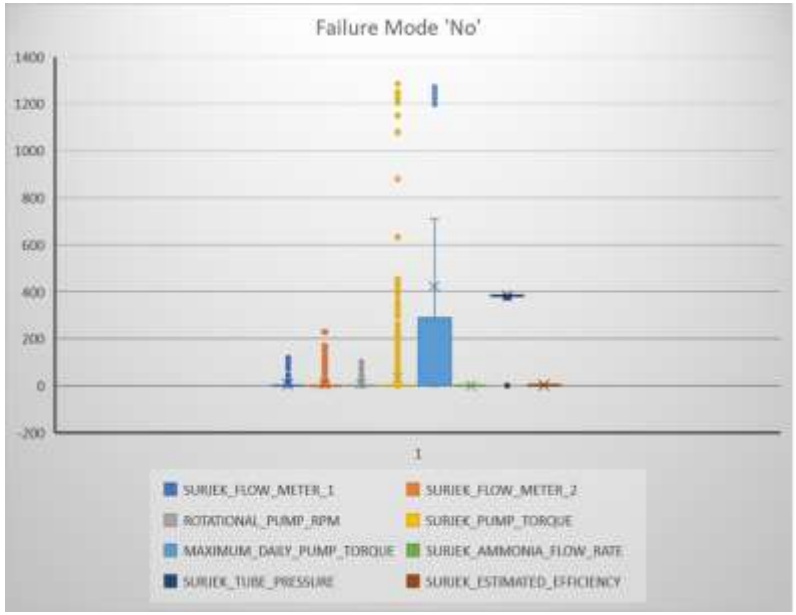
We use Descriptive and Inferential Statistical approaches to solve the problem confronting us

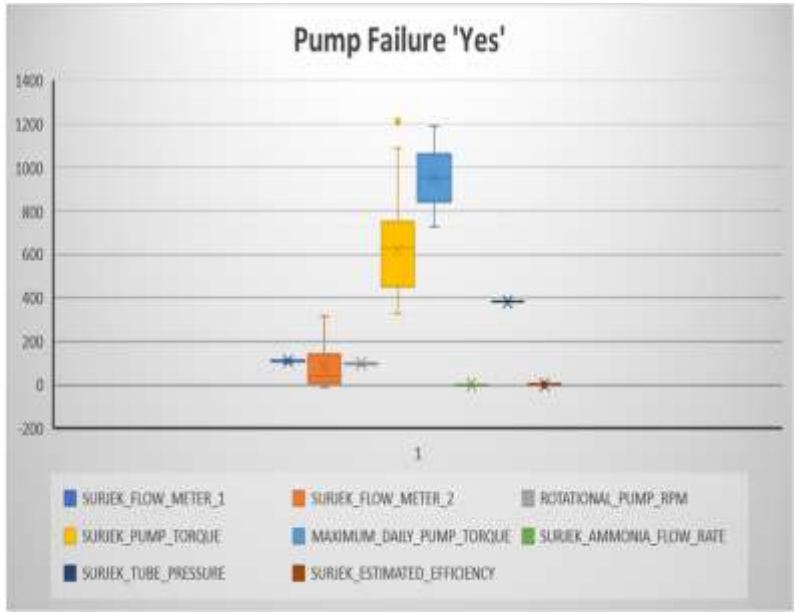
Identify variables that lead to pump failure to avoid an increase in the annual maintenance operation costs

Descriptive Statistics:
Box Plots to identify outliers and variables that are active during Failure Event

Inferential Statistics:
1) **Pearson Correlation** to ascertain which variables are closely related to Failure Event.
2) **Multivariate Regression** Analysis to predict pump failure. Raw vs Rolling Std Deviation with 30 sec intervals

The variables that show readings during failure are Surjek Flow Meter 2, Surjek Pump Torque and Max Daily Pump Torque

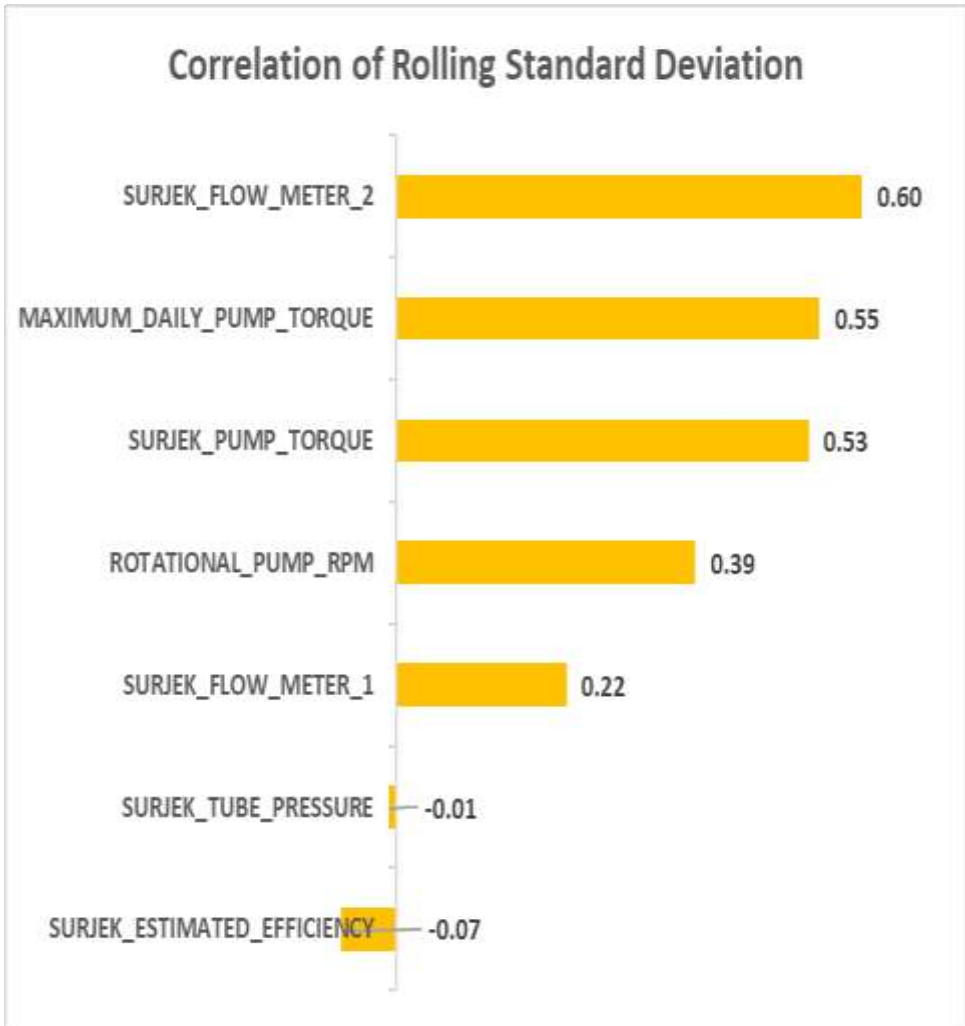




Key Insights

- By comparing the Pump Failure 'Yes' and 'No' modes, we observe that Surjek Pump Torque, Max Daily Pump Torque and Surjek Flow Meter 2 show large readings
- In Failure ‘No’ mode, some outlier values are missing. This indicates that values recorded during Failure Event are outliers
- When outliers are removed and Box Plots are used in Failure Mode ‘Yes’, no values are recorded by any variables. This emphasizes the fact that the values recorded during Failure Event are all outliers.

Surjek Flow Meter 2 is the variable that has highest correlation with Failure Event



Key Insights

- Watch out for abnormalities in Surjek Flow Meter 2 readings to predict Failure Event
- The next group of variables to closely monitor are Max Daily Pump Torque, Surjek Pump Torque, Rotational Pump RPM and Surjek Flow Meter 1
- Surjek Estimated Efficiency and Surjek Tube Pressure have negligible impact on Failure Event

The Regression Model can account for 53.59% variation

Regression Statistics	
Multiple R	0.732461567
R Square	0.536499947
Adjusted R Square	0.535969323
Standard Error	0.065354947
Observations	6997

Key Insights

- The regression equation is Y={(Flow_Meter_1_value*-0.0014+Flow_Meter_2_value*.0028+Pump_RPM_value*0.0046+Pump_Torque_value*0.00055+Daily_Pump_Torque*0.0016+Ammonia_Flow_value*0+Tube_Pressure_value*0.00047+Estimated_efficiency_value*-0.019)+(-0.013)}

- Regression coefficients indicate change in Dependant Variable for one unit change in Independent Variable