PIL Vessel Performance Monitoring and Analysis System

Department of Industrial Systems Engineering and Management
IE3100M Systems Design Project (AY2019/20)

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Background

Pacific International Lines (PIL) is a Singapore shipping company founded in 1967, currently operating around 150 vessels and offering reliable quality shipping services. PIL envisions itself as the global leader in the maritime industry.

Problem Description

1. The **Vessel Reporting Portal** is used by vessels at sea to submit daily noon reports. However, the portal has its limitations.
   - **x** Lacks logic validation
   - **x** Prone to Error
2. The **Vessel Monitoring & Analysis System** - PIL's analysis platform is hosted by an external vendor. However, the system has its limitations
   - **x** Incurs high recurring cost
   - **x** Not User-friendly

Objectives

To improve operational efficiency by:

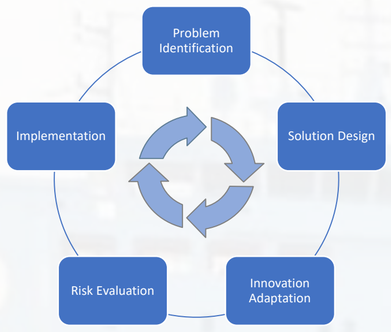
- ✓ Reducing man-hours in non-value adding work
- ✓ Building in-house analysis system for flexibility
- ✓ Enhancing accuracy of analysis

Key Skillsets

- Systems Thinking
- Quality Engineering
- Modelling and Analytics
- Human Factors Engineering

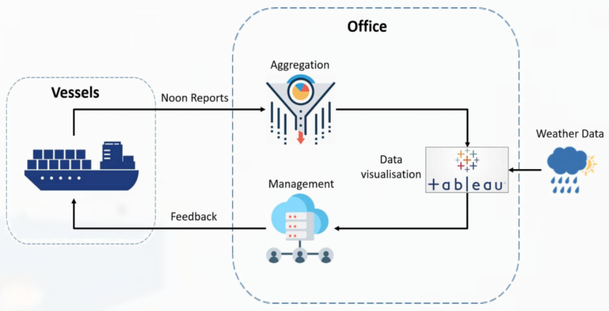
Project Overview

Project Methodology

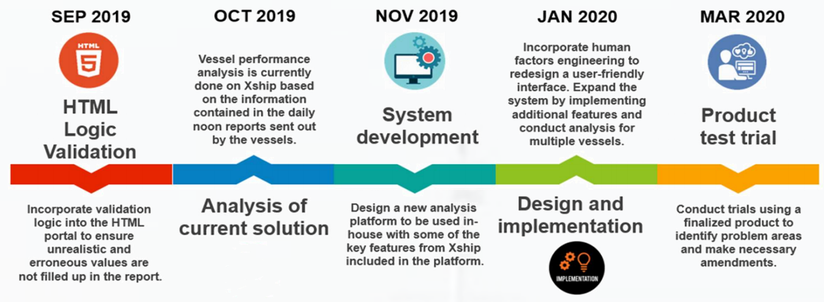


Using this methodology, we came up with the system architecture of PIL with our solutions and implemented them as shown in the timeline.

System Architecture

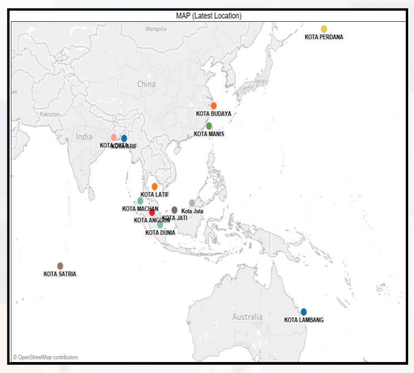


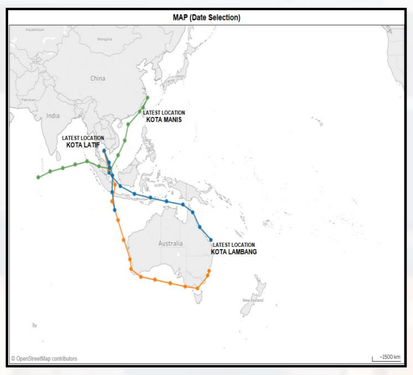
Project Timeline



Implementation of Solutions Approach

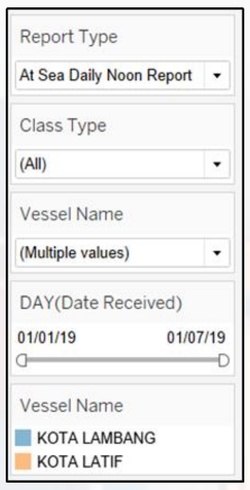
Map Feature





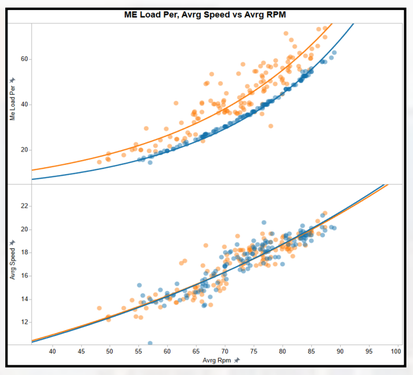
- ❖ Allows the user to **quickly see the current locations** of all the vessels based on the latest report received
- ❖ Hovering on the vessel points on the map allows the user to see the **more important parameter values** based on the report
- ❖ User can make use of the filter feature to **plot out the vessel's route** given the date range

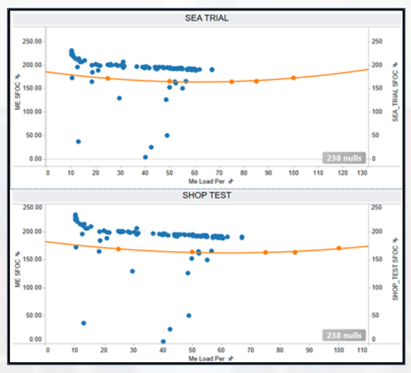
Filter Feature

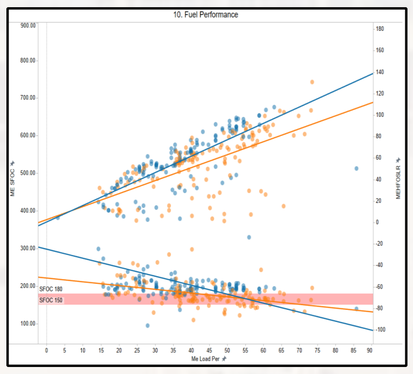


- ❖ **Allows the user to filter** by Date, Vessel Class, Vessel Name and Report Type for their analysis

Vessel Analysis







- ❖ Provides **visual analysis** of Vessel's Fuel & Hull performance and **allows comparison** across sister vessels based on selection in the filter feature
- ❖ Provides **comparison of the vessels' parameter values** against the Shop Test values

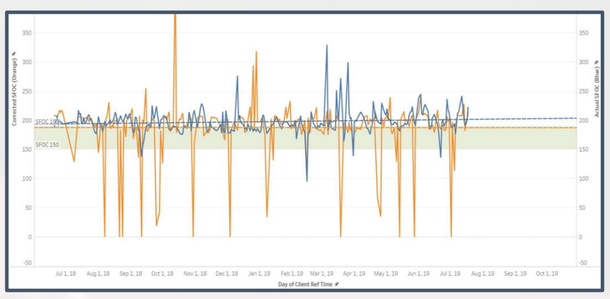
Further Improvements

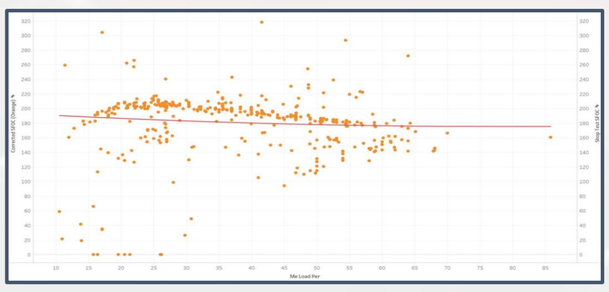
Parameter Correction with Machine Learning

Machine Learning was used to develop a regression model that explains the relationship between MEHFOSLR*, one of the key vessel parameters, and other variables such as wind and sea direction with reference to the vessel's direction.

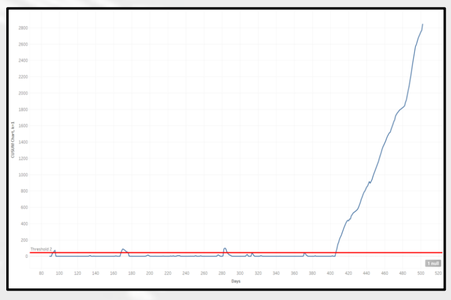
By adjusting the effects of external factors in play, the level of engine deterioration can be better assessed by comparing the correct SFOC* against the Shop Test SFOC.

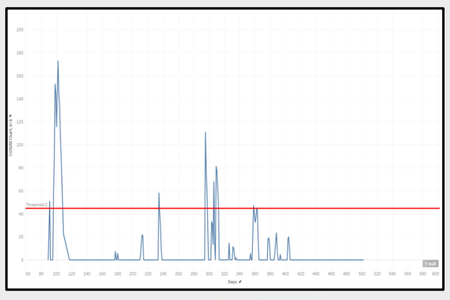
$$SFOC = \frac{MEHFOSLR * 1000^2}{STEAM\ TIME\ SLR * ME\ LOAD\ SLR}$$





Statistical Process Control Charting





- A CUSUM process control chart can be applied to observe a deviation from a desired level of operational engine output.
- By deciding on an appropriate level of threshold level H and allowable slack K, the CUSUM Chart can be used to observe a cumulation of deviation away from a desired level of target value.

Recommendations

- ✓ Recommend investing in **employee upskilling for digitalisation**
- ✓ Combine **Data Visualisation with Data Analytics** for more holistic analysis
- ✓ Create a process of **data preparation** to better support Prescriptive Analytics
- ✓ Involve more applications of **Operations Research methodologies** in cost-related problems with **better processed set of data**

Conclusion

This project has helped PIL **achieve in-house Vessel Monitoring & Analysis** while exploring possible improvements to the in-house system through **Machine Learning** and **Process Control techniques**. These tools can be applied to more parameters by extension and is a possible area for PIL to work on in the near future.

*MEHFOSLR – Main Engine High Sulfur Fuel Oil Consumption Since Last Report | *SFOC – Specific Fuel Oil Consumption