NUS Rightship Hackathon, Team "Wait We're Doing This?"

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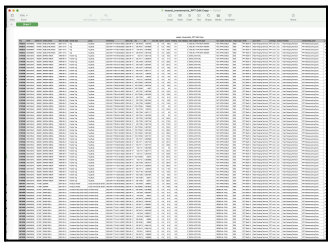
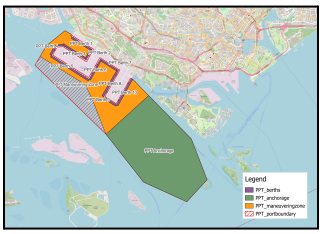
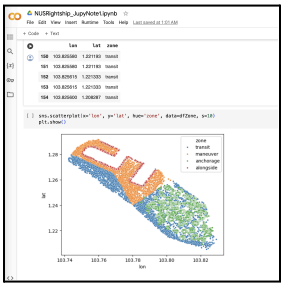
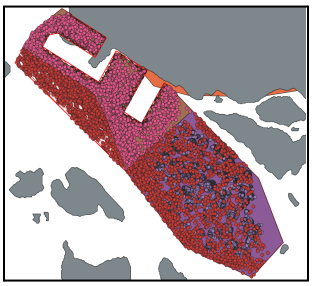
Calculating CO2 emissions of thousands of ships manually is complex, time consuming and prone to errors. In this paper, we automate the process using Python (Open Source Programming Language) to process an AIS file (Automatic Identification System) which is the global standard to monitor ships and QGIS (Geographic Information System) to visualise. The data sample ranges from Aug-Sep 2023 and located in Singapore Pasir Panjang Port, with 2778 ships, emitting an estimated 475326.852 MtCO2e. In the discussion we venture in the potential reduction in CO2 emissions in a scenario in which all the vessels are electrified using zero emission sources. In 2024, shipping contributes about 3% of the global greenhouse gas emissions and Singapore has been one of the busiest ports in the world in terms of shipping tonnage, with 37.5m teu in 2021[1], and an annual average of 140,000 vessel calls since 1986 [2]. Singapore plans to peak CO2 emissions to 65 MtCO2e around 2030, reduce by half to 33 MtCO2e by 2050 while achieving net zero emissions. We employ a data-driven approach, utilizing advanced analytical tools such as Python and QGIS, and drawing upon comprehensive AIS data provided by Spire. The aim is to assess the current state of CO2 emissions in the local shipping industry and project the environmental benefits of a shift to electric vessels. This involves estimating the current quantity of CO2 emissions, the current electrical load from the current level of Pasir Panjang terminal's shore side electrification.. By calculating this, we are also assessing by how much the CO2 emissions is projected to falt as a result of the port's greater electrification as per

our recommendations. Having a fast, accurate and affordable suite of tools to calculate CO2 emissions and understand the infrastructure needed to electrify the fleet would be strategically important for the ports that intend to reduce their CO2 emissions and remain competitive.

Methodology

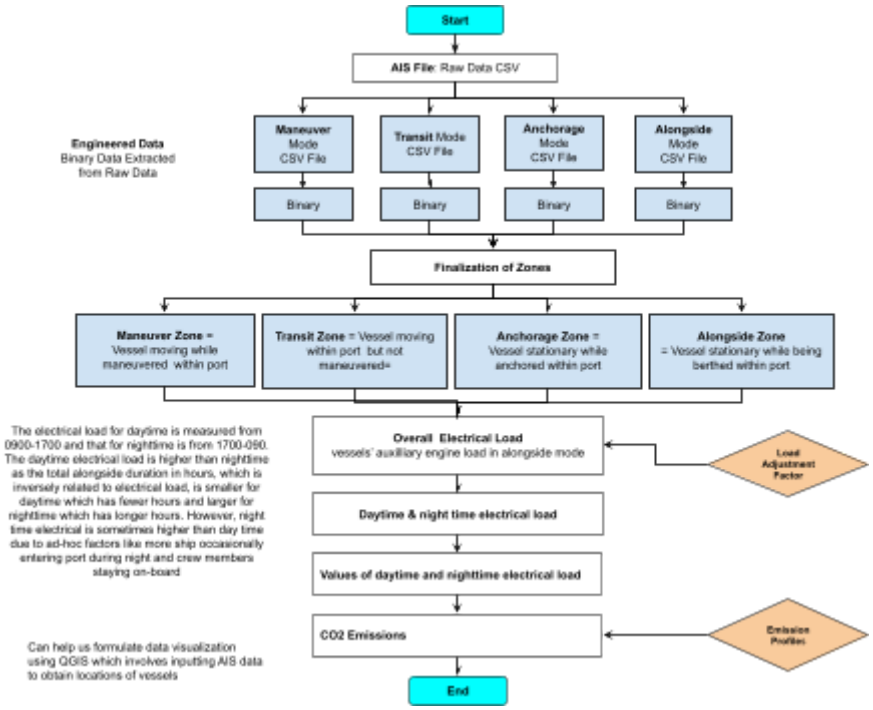
In order to obtain an accurate estimate of the CO2 emissions of ships in the Pasir Panjan Terminal area, we worked with a large AIS data set, of 1,048,576 lines in a CSV format.

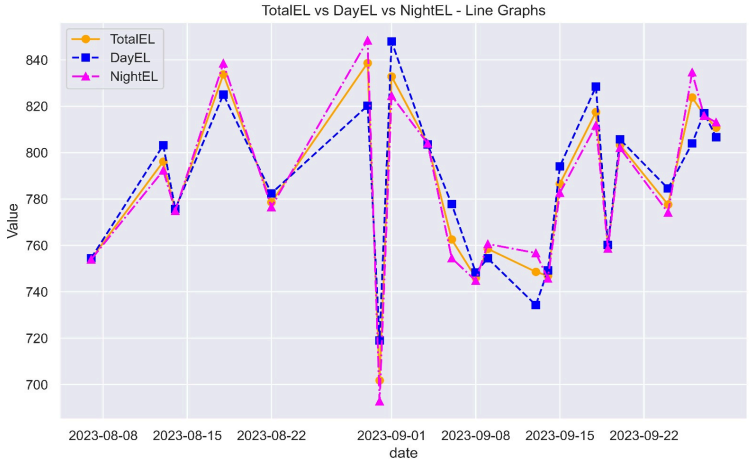
			
AIS (Automatic Identification System) CSV (Comma Separated Value File). SPIRE File provided by NUS RightShip Hackathon.	Pasir Panjan Terminal Open Street Map Version, provided by NUS RightShip Hackathon.	Google Jupyter Notebook using the "Scatterplot" command showing every AIS reported locations.	Data vizualisation of the AIS file within QGIS

Emission Profile

Manoeuvering: 48%, Transit: 36%, Alongside: 11%, Anchorage: 5%

Flowchart





Total Electrical Load Graph

Results, Discussion

We converted CSV files to binary data involving 1 and 0 where 1 means the speed is non-zero hence the vessel is in motion and 0 means the speed is zero hence the vessel is stationary. Using this data, we classified all vessels in Pasir Panjang part into one of 4 possible zones based on

original position of ship, vessel speed and vessel's movement within original zone. Analysis of the AIS data revealed the extent of CO2 emissions at present. Our findings show that the total CO2 emissions from August-September 2023 was 475,326.852 tonnes. This is a sum of the individual CO2 emissions. This is the maximum value by which we can reduce CO2 emissions. Our calculations note that the electrical load supporting Pasir Panjang Terminal's current electrified system of charging vessels, anchoring, berthing and transiting amounts to 784.280 KW. As we recommend further electrifying the port to reduce GHG emissions, the current electrical load must increase from this baseline value onwards.

Conclusion, Recommendations

1) Electrifying the harbourcrafts as well as vessels coming to Port

2) Cleaner Energy Mix: replacing Singapore's current fossil fuel-dominated energy supply with nuclear and renewables including solar energy, wind energy and hydropower

3) Increase quantity of vessel charging stations to charge primarily by electricity and reduce vessel delays via reducing vessel waiting time within port.

4) Connecting environmental data and public health data to reduce the likelihood of air pollution-related disease and mortality.

References

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