NUS-RightShip Hackathon

Reducing Greenhouse Gas Emissions at Port of Singapore

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Group CatLovers

Submitted by

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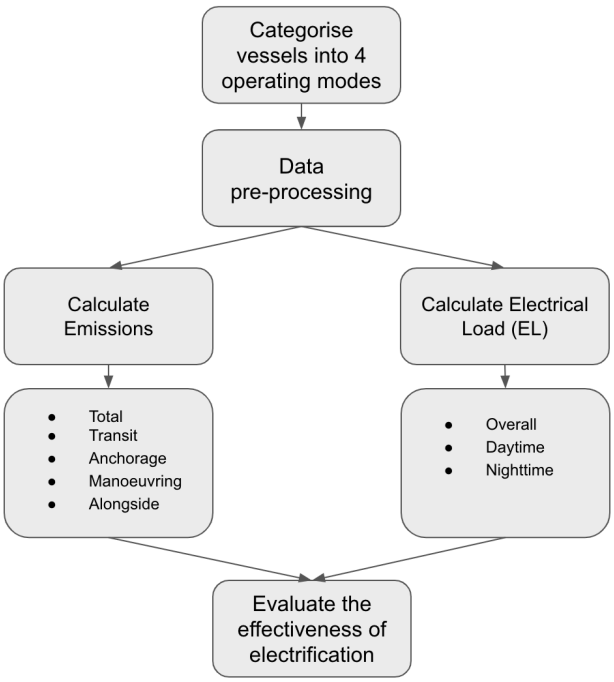
1. Abstract

The critical challenge of mitigating climate change in the maritime sector is addressed in this study, focusing on the Port of Singapore, a pivotal hub in international shipping. This research aims to establish a baseline for greenhouse gas (GHG) emissions from vessels at Singapore ports and evaluate the potential of electrification as a means to reduce these emissions. Leveraging data from August to September 2023, including Automatic Identification System (AIS) movement data and vessel characteristics, we analyze the emissions from ships at both Pasir Panjang Terminal. The study explores the effectiveness of vessel electrification, a key strategy in Singapore's Maritime Green Initiative, by quantifying the reduction in GHG emissions achievable through this method. Our findings aim to inform and enhance the Maritime and Port Authority of Singapore's (MPA) policies and initiatives, contributing to the global efforts led by the International Maritime Organisation (IMO) to achieve net-zero GHG emissions in the shipping industry.

2. Flow Chart



3. Process Breakdown

3.1 Categorisation (Step 1)

The preprocessing of vessel movement data involved several key steps. Initially, the data was loaded from "vessel_movements_PPT.csv" into a pandas DataFrame and transformed into a GeoDataFrame using vessel longitude and latitude. Shapefiles representing various port zones (Port Boundary, Maneuvering Zone, Anchorage, Berths) were integrated to spatially identify vessels within these zones, with spatial joins adding boolean columns to the DataFrame for zone presence. A custom function, `operating_modes`, was then created to categorize vessel movements into modes such as Transit, Anchorage, Maneuvering, and Alongside/Hotel, based on speed, navigation status, and zonal location. This categorization was applied to the DataFrame, generating a new 'mode' column and entries not fitting these categories were filtered out, streamlining the dataset for further analysis.

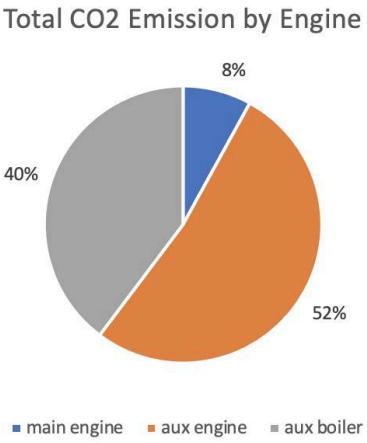
3.2 Data Pre-processing (Steps 2-6)

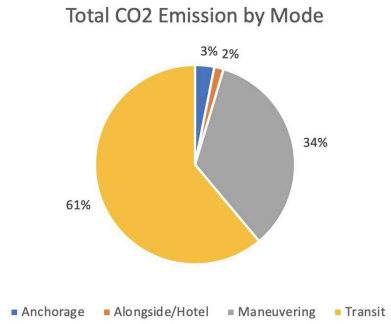
The vessel movement data preprocessing included importing the data into a pandas DataFrame, converting timestamps for chronological sorting by IMO number, and calculating time differences to identify event durations, with non-continuous events marked for segmentation. Vessels were categorized as Ocean Going Vessels (OGVs) or otherwise, with Emissions Tiers assigned by build year. A consistent fuel category for 2023 and specific consumption metrics for main and auxiliary engines were compiled, enhancing the data for environmental impact assessment.

3.3 Emissions Calculation (Step 7)

The results table shows the total emissions in tonnes for different operating modes: Transit, Anchorage, Maneuvering, and Alongside. The largest emissions are observed during Transit

mode, indicating that vessels consume the most fuel and consequently emit the most CO2 when they are moving through the port. The emissions during Maneuvering and Anchorage modes are significantly less, which would be expected given that vessels are either moving at reduced speeds or are stationary, respectively. The Alongside mode shows the least emissions, likely due to engines being turned off or operating at minimal levels.





3.4 Electrical Load Calculation

The vessel electrical load analysis indicates that auxiliary engines primarily supply power when docked, with the main engine off. The time-weighted average electrical demand is higher at night, suggesting more intensive use of onboard systems or port activities during these hours.