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# Uncovering Insights: Maritime Shipping's Carbon Footprint

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*Assessing the State of Carbon Dioxide Emissions in Maritime Shipping Through Big Data Analysis*

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# Abstract

This is the abstract.

# Acknowledgements

I would like to thank...

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# Chapter 1

# Introduction

## 1.1 Background and Motivation

In the 21st century, Climate change is the biggest challenge faced by humanity. It poses a substantial danger to the survival of the inhabitants of our planet. Human activities such as deforestation and burning of fossil fuels have led to a rise in global temperatures. Becuase of this rise, there has been a rise in sea levels, extreme weather events, and loss of biodiversity. There is an urgent need to reduce greenhouse gas emissions and transition to a sustainable, low-carbon future.

Maritime is essential to the global economy, transporting 90% of the world's goods by volume. It is also a major source of greenhouse gas emissions, with the International Maritime Organization (IMO) estimating that maritime shipping accounts for 3% of global carbon dioxide emissions. While 3% may seem small, it is important to note that this is a rapidly growing sector. Without action, maritime shipping contribution to carbon emissions can increase upto 10-13% in the next few decades.. Due to this fact, there is a growing global effort to reduce emissions from this sector. (King, 2022).

In accordance with sustainable Development Goal 13, in 2018, the inital stratergy was adopted by IMO's Environmental Protection Committee (MEPC), during its 72nd session at IMO Headquarters in London, United Kingdom. Accorging to this stratergy, the IMO will work towards reducing the total annual greenhouse gas emissions from international shipping by at least 50% by 2050 compared to 2008 ("UN body adopts climate change strategy for shipping", 2018). In 76th ssssion MEPC in 2021, serval mandatory measures were adopted to reduce greenhouse gas emissions from international shipping, which will help in achieving the goal of reducing emissions by 50% by 2050 ("UN body adopts climate change strategy for shipping", n.d.). One of the important measures is the carbon intensity indicator (CII).

Maritime shipping is a complex and highly volatile system, generating very large data sets. Big data analytics can be used to understand the complex system and make informed decisions. It can facilitate operations such as monitoring of emission and predictive analysis of vessel performance. This can help in reducing emissions and improving the efficiency of

the maritime sector (Zaman et al., 2017).

## 1.2 Big Data Analysis

Big data analytics is where advanced analytic techniques operate on big data sets. Hence, big data analytics is really about two things — *big data* and *analytics*.

### 1.2.1 Big Data

As the name suggests, big data is a large amount of data. There are other important attributes of big data. These are: data variety and data velocity.

Thus we can define big data using 3 V's: *volume*, *variety*, and *velocity* as showin in figure 1.1.

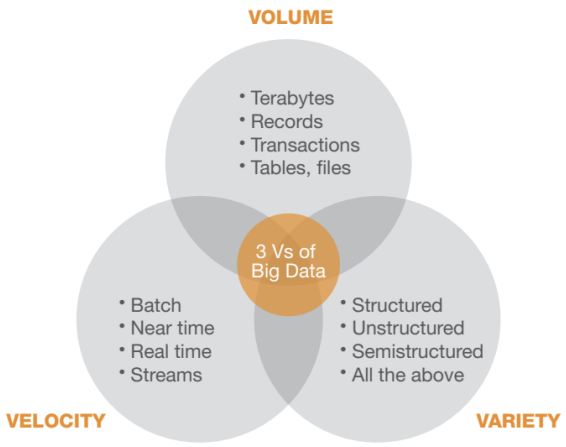


Figure 1.1: Big Data: 3 V's (Lukoianove & Rubin, 2013)

Beyond these three V's, Big Data is also about how complicated the computing problem is. Given the number of variables and number of data points for analysing the maritime shipping data. It is a very complicated problem. Thus, in addition to the three V's identified by IBM, it would also be necessary to take complexity into account as shown in figure 1.2 (Pence, 2014).

### 1.2.2 What is Big Data Analytics?

Big data analytics is the process of examining large and varied data sets to uncover hidden patterns, unknown correlations, market trends, customer preferences and other useful information that can help organizations make more-informed business decisions.

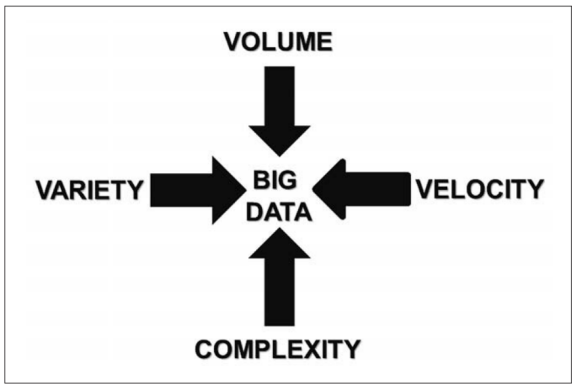


Figure 1.2: Big Data: Beyong 3 V's - volume, velocity, variety, and complexity

## 1.3 Problem Statement

Carbon emissions from maritime shipping have been identified as a major contributor to global greenhouse gas emissions, with the International Maritime Organization estimating that shipping is responsible for around 3% of global CO2 emissions (King, 2022). To address this issue, the shipping industry has set targets to reduce its carbon footprint, and governments and international organizations have introduced policies and regulations to encourage emissions reduction.

However, measuring and monitoring carbon emissions from maritime shipping can be challenging due to the complexity of the industry and the lack of reliable data. The Energy Efficiency Operational Indicator (EEOI) and the Carbon Intensity Indicator (CII) have been proposed as two metrics to assess the carbon efficiency of ships and enable comparison between different vessels and fleets (Chuah et al., 2023; Zhang et al., 2019). However, there is a need to better understand the relationship between these indicators and carbon emissions, as well as to identify the factors that influence them.

Therefore, the aim of this thesis is to conduct a big data analysis of carbon emissions in maritime shipping, using EEOI and CII as the main metrics. Specifically, the study will:

- Calculate EEOI and CII for a sample of vessels using real-world data on fuel consumption and other operational parameters.
- Analyze the relationship between EEOI, CII, and carbon emissions, using statistical methods and machine learning algorithms.
- Identify the factors that influence EEOI and CII, such as vessel age, size, speed, and route, and examine their impact on carbon emissions.
- Evaluate the usefulness of EEOI and CII as metrics for monitoring and reducing carbon emissions in maritime shipping, and recommend potential improvements to these metrics.

Overall, the findings of this thesis will contribute to a better understanding of the carbon efficiency of maritime shipping and inform the development of policies and strategies for emissions reduction in this sector.

## 1.4 Research Question

This theis will focus on answering following research questions:

1. What is the relationship between vessel age and carbon emissions in maritime shipping?
2. How do shipping routes affect carbon emissions in maritime shipping?
3. What role do fuel types and engine technologies play in carbon emissions in maritime shipping?
4. How can EEOI and CII be used to monitor and reduce carbon emissions in maritime shipping?

## 1.5 Report Outline

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