HOW BIG DATA CAN MAKE SHIPPING GREENER

O. SEKKESAETER[1]

[1]Geneva School of Economics and Management, University of Geneva, 40 bd du Pont d'Arve – CH-1211 Geneva 4, ola.sekkesaeter@etu.unige.ch

ABSTRACT

This conference short paper tackles the subject of Big Data, which increasingly looks to become a prevalent industry application in shipping as the maritime industry catches up with other industries such as healthcare and banking. In an era of increasing focus on greenhouse gas (GHG) emissions and energy efficiency, policymakers such as the EU and IMO have many important decisions to make in the future. In order for the policymaking to be as successful as possible it is imperative that it is based on truthful data of high quality. This is where maritime Big Data can play an instrumental role, and it is this short paper's aim to demonstrate the importance and feasibility of this.

Keywords: Big Data, GHG emissions, maritime data, AIS, shipping, low carbon shipping, IMO

INTRODUCTION

Greater environmental awareness is slowly making itself felt across the maritime shipping industry, and this is much needed given the significant portion of greenhouse gas (GHG) emissions that are borne by the industry. However, whether this awareness translates into concrete action remains to be seen, as to this date, the rate of progress has been rather slow. However, increasing regulation from the EU, and similar efforts by the IMO, may see the tides turn as mandatory compliance schemes such as the IMO fuel consumption data collection system gradually come online. One question surrounding these efforts is how the maritime GHG emissions can be monitored in order to ensure compliance, and this is where the concept of Big Data may come to play an important role.

This short conference paper provides an outline of the concept of maritime Big Data and, in particular, examines the extent to which maritime Big Data may aid the compliance of new environmental regulation and thereby simply make shipping greener.

THE REGULATORY BACKGROUND

In terms of the concrete regulation surrounding the maritime shipping industry's GHG emissions, this regulation can be divided into two:

Firstly, there is the regulation coming out of the IMO (International Maritime Organisation). The 70th session of the Marine Environment Protection Committee (MEPC 70) in October 2016 marked a significant step along IMO's roadmap which focuses on developing a comprehensive strategy for the reduction of GHG emissions from ships by 2023. However, the meeting contained more policy action than just the establishment of 1st January 2020 as the entry-force-date of the 0,5% global sulphur cap for marine fuels. The meeting was also significant as it formally adopted a mandatory data collection system for fuel consumption for ships expected to enter into force on 1 March 2018 but with 2019 as the first calendar year of reporting. As part of the policy, ships over 5,000 gross tonnes and above- which represent 85% of the global fleet's CO2 emissions- will be required to submit to their flag state, annual reports on fuel oil consumption and transport work parameters[1]. Flag state administrations will then submit these aggregated data to IMO, which in turn will assemble and maintain these data in a fully anonymised IMO Ship Fuel Oil Consumption Database (Ibid).

Secondly, there is the regulation coming out of EU. EU's policy effort on maritime GHG emissions, called EU MRV (Monitoring, Reporting, Verification) regulation, also requires ship owners and operators to monitor and report CO2 emissions and transport work. The reported CO2 emissions, along with other data, are to be verified by certified bodies like Lloyds' Register who then will forward the data to the European Maritime Safety Agency (EMSA). Aggregated ship emission and efficiency data are then expected to be published by the EU on 30 June

[1] Hughes, Edmund. Recent developments at IMO to address GHG emissions from ships. http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/UN%20Joint%20side%20event%20presentation.pdf .

2019. However, EU's policy contains some differences to IMO's version. EU's string of regulation only applies to ports of EU and EFTA (Iceland and Norway), it has different reporting parameters, data collection takes place on per voyage basis, and it is scheduled to come into effect from 1 January 2018[2]. Prior to the final enforcement date of the legislation, ship owners and operators had to deliver an emissions monitoring plan for each of their ships, which then was to be verified by a certified body before finally being submitted by 31 August 2017.

The emergence of these two pieces of environmental regulation should give public authorities worldwide the data and information much needed for informed policymaking with industry-wide impact. The data collected is meant to give such authorities the necessary platform to eventually see how and where GHG emissions in the maritime shipping sector should be curbed.

Table 1.0: Emissions data collection- EU vs IMO[3]

	EU MRV	**IMO System**
Area of monitoring	Ships 5000 GT and above Voyages to/from EU port of calls EU Monitoring Plan Starting 01st January 2018	Ships 5000 GT and above All voyages Updated SEEMP Starting 01st January 2019
First monitoring period	2018	2019
Key parameters	Fuel consumption and CO_2 Actual cargo on-board Distance travelled Time at sea & in port	Fuel consumption and CO_2 Design deadweight Distance travelled over ground Hours underway
Reporting	Fuel consumption (port / sea) Transport work (based on actual cargo carried) Distance Time	Fuel consumption Distance Time
Reports to	European Commission	Flag state
Disclosure	Public	Confidential

However, despite the emergence of these regulations, ship owners and operators are free to burn as much fuel as they want, and such actors are undoubtedly more concerned with the requirements around the 2020 sulphur cap than these emission reporting requirements.
In addition to this, critics argue that public actors like the IMO have no ability to assess whether the emissions data collected from shipping actors is truthful. It is not unthinkable that ship owners and operators will have an incentive to "under-report" the amount of fuel oil used and possibly "over-report" the distance travelled, in order to come across as more energy efficient than in reality.

MARITIME BIG DATA

This is where maritime Big Data can serve a very strong purpose. As defined by Mayer-Schonberger and Cukier (2012), Big Data uses the "ability of society to harness information in novel ways to produce useful insights or goods or services of significant value". In the maritime shipping industry, Big Data may take many different shapes and forms. There is a wide range of different actors ranging from machinery manufacturers to ship managers, and each actor will have a particular Big Data need. However, as shown by Sekkesaeter (2017), the vast majority of actors in the maritime shipping industry are most likely to be interested in operational data, ie.

[2] DNV GL. EU MRV Regulation. https://www.dnvgl.com/maritime/eu-mrv-regulation/index.html
[3] https://www.green4sea.com/eu-mrv-vs-imo-fuel-consumption-data-collection-system/ EU MRV vs. IMO fuel consumption data collection system

ship reporting data.
To this end, AIS data, is a key type of maritime Big Data that can be useful to shipping players.
AIS (Automatic Identification System) is a transponder system designed for the exchange of navigational marine data between ships on the seas as well as between ships and control stations on shore. Using VHF (Very High Frequency) radio and GPS technology, AIS data is used for live displays of ship traffic through RADAR and PC Charting software. Through the maritime VHF radio frequency band, ships automatically transmit both static and dynamic information to the benefit of surrounding ships and control stations on shore. This constant stream of data messages (for which the compliance is mandatory) provides a lot of information that benefits many different shipping actors, from port authorities, flag states and tonnage charterers.

AIS data is particularly relevant to the Big Data domain given its high values of Big Data characteristics such as[4]:
i) Variety (there are a total of 27 different AIS message types, and the relevance of each type depends on the type of ship)
ii) volume (just for AIS message type 5 it has been estimated that almost 400 GigaBytes of data is transmitted globally on an annual basis)
iii) Velocity (EMSA's network of AIS data stations process 100,000,000 AIS positions every month)

Table 1.1: AIS message data and reporting intervals[5]

AIS platform	Reporting interval
Static information:	6 min interval/upon request
Mobile Maritime Service Identity (MMSI)	
IMO number (if assigned)	
Call sign	
Name	
Length and beam	
Ship location of AIS	
Voyage information:	6 min interval/upon request
Where (not a real field)	
Destination/ETA	
Cargo	
Dynamic information: **(Position, course, speed, heading)**	
Base station	10 s interval (10 s nominal)
Class A ship	2 s to 3 min interval (approximately 7 s average)
Class B ship (the true heading is optional for Class B CSTDMA ships)	5 s to 3 min interval (30 s nominal)
Search and rescue aircraft	10 s interval
Aid to navigation	3 min interval
Dependent on speed and course change	At anchor: 3 min Slow moving: 0-14 knots: 3 1/3 s to 10 s Fast moving > 14 knots: 2 s - 6 s
Safety and administrative messages	As required
Data message	As required

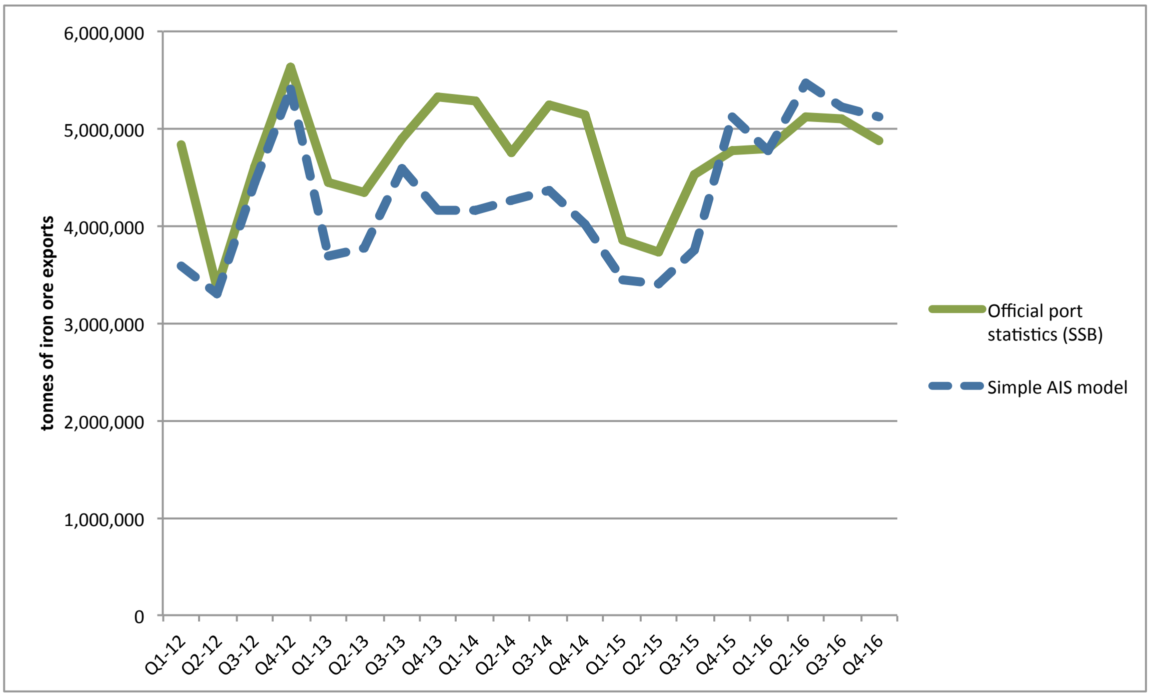
4 As established by Sekkesaeter , O (2017)
5 www.Arundal.com AIS Reporting Interval. http://arundale.com/docs/ais/ais_reporting_rates.html and Sekkesaeter, O (2017)

As seen from table 1.1, AIS data contains a wide variety of information that could be useful to organisations like EMSA and flag state administrations in order to verify the truthfulness of the CO2 emissions data submitted by the ship owners and operators. There are two simple ways in which EMSA and flag states can use AIS data to fact check the quality of their emissions data.
Firstly, the voyage of each individual ship can be cross-checked with historical AIS data in order to see if the reported "distance travelled", "hours underway" and "design deadweight" actually correspond to reality. The EU MRV regulation will here benefit strongly from EMSA's SafeSeaNet VTS system, which is EU's network of over 700 AIS data stations. As for the IMO regulation, there are plenty of 3rd party providers of AIS data that also provide dynamic charting software with plenty of analysis tools for flag state administrations.

However, more than just distance and time can be checked with AIS data. As a second attribute, AIS data can also be used to provide a rough estimate of the truthfulness of the fuel consumption. Firstly, historical AIS data will reveal the historical voyage speed of the ship, and authorities can therefore- based on the ship's speed & consumption figures- work out how much fuel is likely to have been burned during the voyage. Secondly, AIS data can be used to see whether the ship actually has called key bunkering ports such as Gibraltar and Las Palmas, and then to see if the ship's draught changed accordingly after bunkering up with fuel. The ship's underwater draught is another useful feature of AIS data, and, although not always entirely accurate, it can provide a useful means to double-check the truthfulness of a ship's fuel consumption.

AIS data has previously been shown to have decent forecasting powers. Sekkesaeter (2017) demonstrated how AIS data could be used to estimate iron ore exports out of the Norwegian port Narvik over a five-year period. With a very simple AIS model developed for this purpose, a correlation coefficient of 72% was produced, which registered 91% of all iron ore volumes out of Narvik for the period.

Figure 1.0: AIS data study- Actual iron ore output vs. estimated iron ore output (Narvik, Norway)[6]



Similar developments were also made by Chen et al (2014), who used advanced positioning techniques along with ships' GPS coordinates in order to successfully estimate container throughput in the ports of Singapore and

[6] Sekkesaeter, O (2017)

Hong Kong.

CONCLUSION

With the careful back-testing of emissions data through the use of AIS data, flag state administrations and the EU alike will massively enhance the data quality with subsequent positive impact on eventual GHG emissions curb regulation that may arise in later years. As aforementioned, there is already empirical research confirming that AIS data has strong forecasting powers for advanced cargo estimation purposes. It is therefore highly likely that similar rates of success can be reached in the more straightforward "fact-checking" process of emissions data provided by ship owners and operators worldwide. As the IMO continues to steam ahead with its three-step approach of data collection, data analysis and final decision-making, it is crucial that the data is of a high standard. With truthful data being collected instead of biased and potentially misleading data, the IMO will have a solid foundation for an objective and transparent policy debate going forward. At the core of this data collection process lie billions of AIS data points readily available at the authorities' disposal. Such a solid foundation should then aid the public authorities in introducing legislation that is both justified, and not the least, realistic for shipping actors to comply with. Big Data like AIS data should give a helping hand at just that, and thereby contribute to making shipping greener.

REFERENCES

arundale.com. AIS Reporting Interval. Retrieved August 27th 2017, from: http://arundale.com/docs/ais/ais_reporting_rates.html

Chen, Longbiao, et al. "Container throughput estimation leveraging ship GPS traces and open data." *Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing*. ACM, 2014.

DNV GL. EU MRV Regulation. Retrieved August 27th 2017 from: https://www.dnvgl.com/maritime/eu-mrv-regulation/index.html

green4sea.com (2016). EU MRV vs. IMO fuel consumption data collection system. Retrieved August 27th 2017 from: https://www.green4sea.com/eu-mrv-vs-imo-fuel-consumption-data-collection-system/

Hughes, Edmund (2016). IMO. Recent developments at IMO to address GHG emissions from ships. Retrieved August 27th 2017 at: http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/UN%20Joint%20side%20event%20presentation.pdf .

Mayer-Schönberger, Viktor, and Kenneth Cukier. "Big Data: A revolution that transforms how we work, live, and think." (2012).

Sekkesaeter, Ola. *Shipping in the digital age: how feasible is the application of big data to the maritime shipping industry, and under what conditions can it be developed to become an integral part of its future?*. Diss. University of Geneva, 2017.