WHEN TRUST MATTERS

Vessel Technical Index and RP on Technical Ship Performance

SFI SmartMaritime

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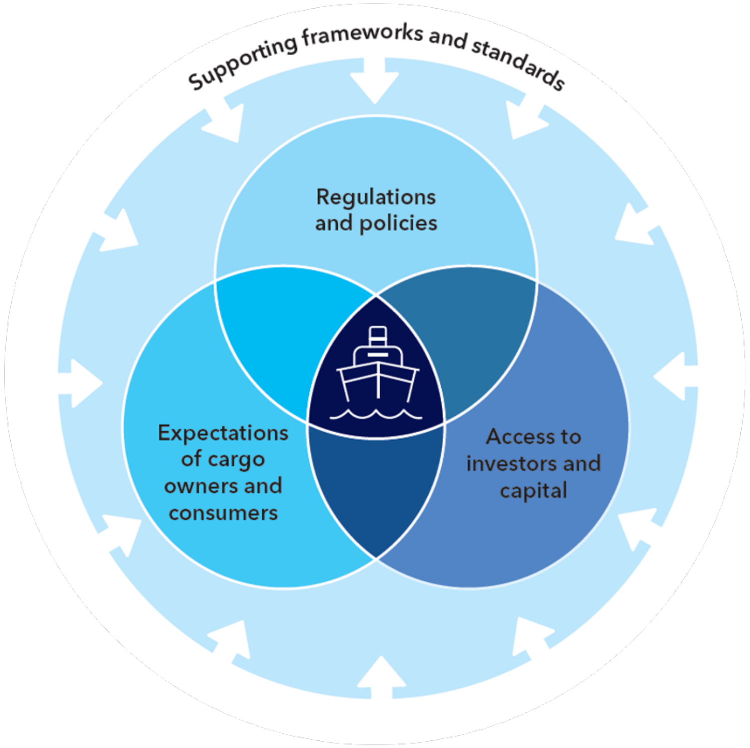
Background and Motivation

Key drivers influencing ship decarbonization



- Regulation will be increasingly putting pressure on shipping to decarbonize, but environmental performance will have a business impact beyond regulatory compliance
  - Access to cargo and capital (asset value and commercial attractiveness)
  - FuelEX i) keeping the energy demand low will be more important with more expensive fuels ii) the business case for energy efficiency measures will be improved with the introduction of more expensive low carbon fuels iii) direct cost of emissions
  - New business models could emerge (compliance by the hour)

Environmental data will be monetized which demands for transparency and trust!

The Frameworks Must be Targeted and Empower the Stakeholders that has the Opportunity to have an Impact

- CII can be a good measure to calculate the carbon efficiency (CO_2/ton-miles) for the world fleet
- Improving the CII takes collaborative efforts between i) owner (technical condition) ii) charterer (operations) and iii) customer (needs).
- When business critical decisions will be made - stakeholders need to be measured on what they can influence! Transparency and trust is key!

CII

AER

EEOI

Yards

Charterers

Operators

Ship Owners

Ports

- Weather Impact
- Speed Instructed
- Cargo Carried
- Ports to Call
- +++

=

Vessel Technical Index

Set the standard on how to measure, evaluate and verify technical condition of ships

Use Cases

Setting requirements on how to measure and evaluate the technical condition of ships, rests heavily upon the intended use.

1. A consistent way to work with ship performance data and a way to set a baseline
2. Comparing the technical condition of different ships – creating performance/sustainability adjusted CP's
3. Identify the need for maintenance and evaluate effect of maintenance
4. Evaluate and verify the effects of energy efficiency devices and other technical measures

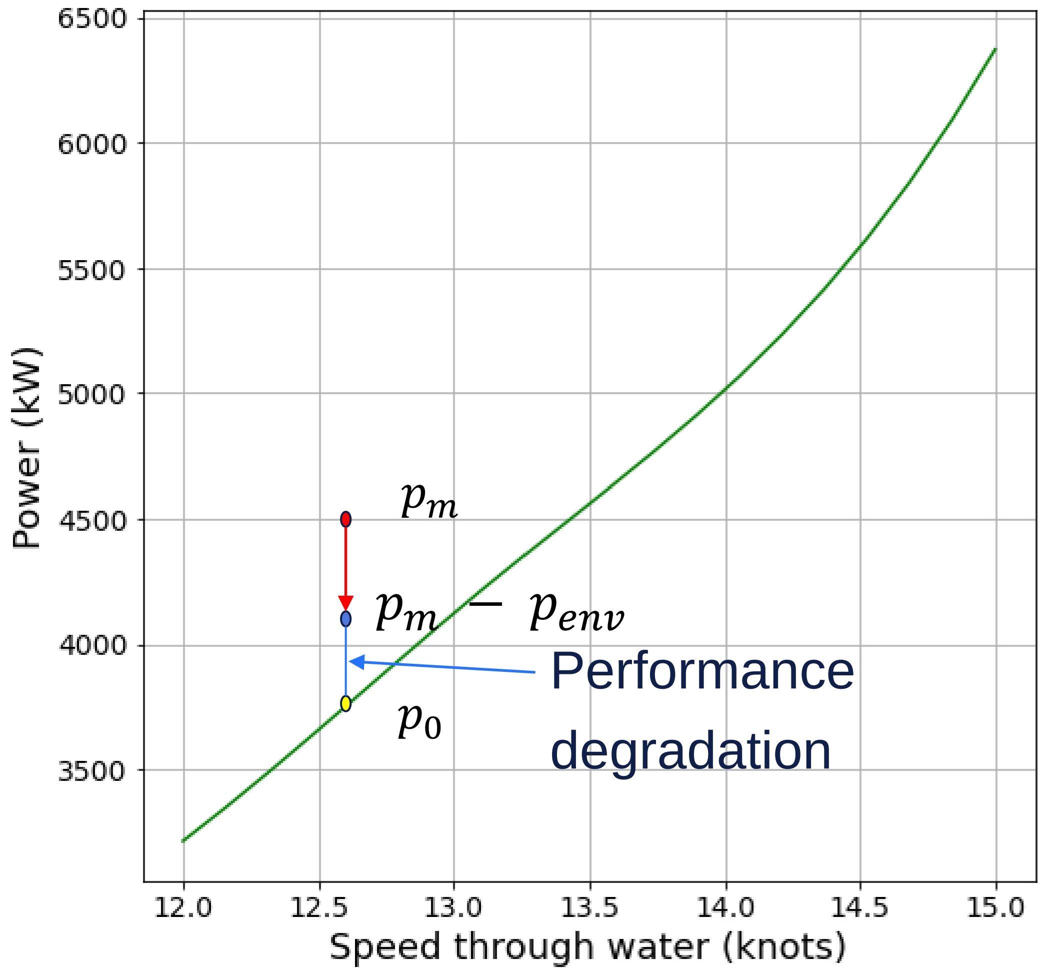
The Vessel Technical Index - VTI

VTI definition

$$VTI = \frac{p_m - p_{env}}{p_0}$$

where

- p_m is the measured shaft power
- p_{env} is the power due to environment
- p_0 is power in ideal condition (reference power)

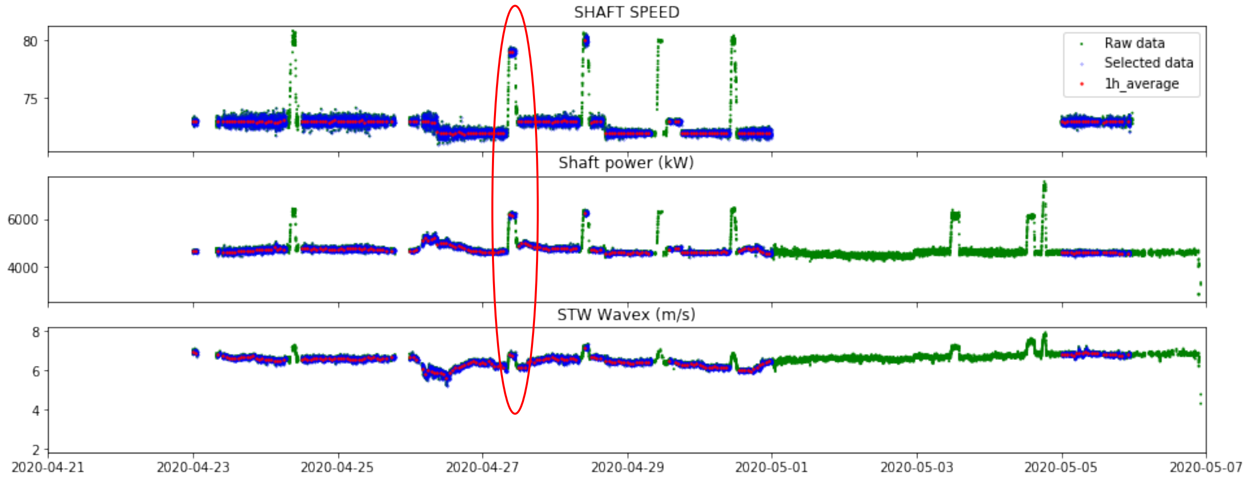


Data used for calculation

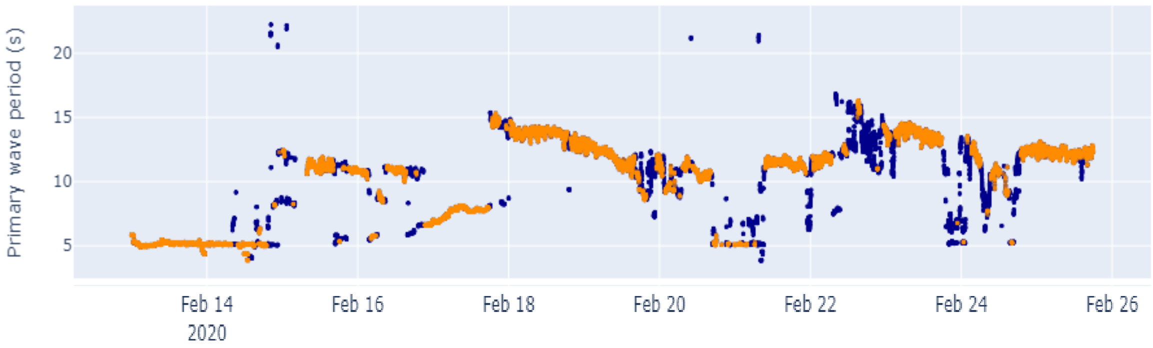
Parameters		Unit
1	Shaft Revolutions*	rpm
2	Vessel Heading*	Deg.
3	Water Temperature*	°C
4	Relative Wind Speed*	m/s
5	Relative Wind Direction*	Deg.
6	Significant Wave Height	m
7	Primary Relative Wave Direction	Deg.
8	Primary Wave Period	s
9	Speed Over Ground*	m/s
10	Speed Through Water_abb	m/s
11	Shaft Power_abb	kW
12	Water Depth_abb	M
13	Displacement-DRAFT*	m^3

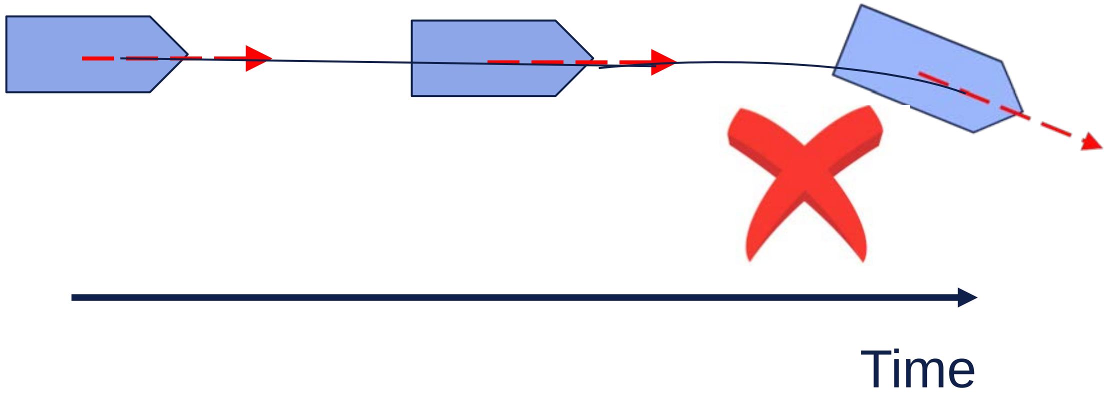
- All the data will be synchronized to every 1 min
- It requires that all different parameters are steady at the same time.

$$VTI = \frac{P_m - P_{env}}{P_0(\Delta, V)}$$



Data used for calculation





Criteria for steady state

Parameter	| Process variability	| time period
	(1.0*std)	[min]
Vessel heading (deg)	2 deg	30
Primary wave direction relative (deg)	10 deg	60
Wind direction relative (deg)	10 deg	60
'Significant wave height (m)	0.15m	30
Primary wave period (s)	0.5 s	60
STW Wavex (m/s)	0.1 m/s	30
Speed over ground (m/s)	0.1m/s	30
Water temperature (C)	0.5(C)	60
Wind magnitude relative (m/s)	15%[-]	30
Shaft speed(rpm)	t-student	10

Correcting weather effects

Measured propeller shaft power

Estimated power effects from the environment

$$VTI = \frac{P_m - P_{env}}{P_0}$$

Vessel's reference performance based on tank tests and sea trial

$$P_{env} = P_{wave} + P_{wind} + P_{temp}$$

$$P_{env} = \left(R_{wave} + R_{wind} + R_{temp}\right) \cdot V_{STW}$$

Added resistance induced by waves from arbitrary directions *Liu and Papanikolaou (2020)*

ISO 15016:2015(E) (2015) Annex C

ISO 15016:2015(E) (2015) Annex F

Use Case 1 – VTI used in CP contracts

Standard CP terms:

	Service speed		Eco speed	
	LADEN	BALLAST	LADEN	BALLAST
Speed (kts)	14	15,5	10	12
Consumption (mt/day)	36	36	25	25

TC hire: 20000 USD/day

< Beaufort force 5

Adjusted CP terms based upon VTI:

	Q1 2023			
	Service speed		Eco speed	
	LADEN	BALLAST	LADEN	BALLAST
Speed (kts)	14	15,5	10	12
GHG emissions (MT CO2_eq/day)	112	112	78	78
VTI (-)	1,2	1,2	1,2	1,2
TC hire (USD/day)	20000	20000	20000	20000

Dynamic CP terms based upon VTI:

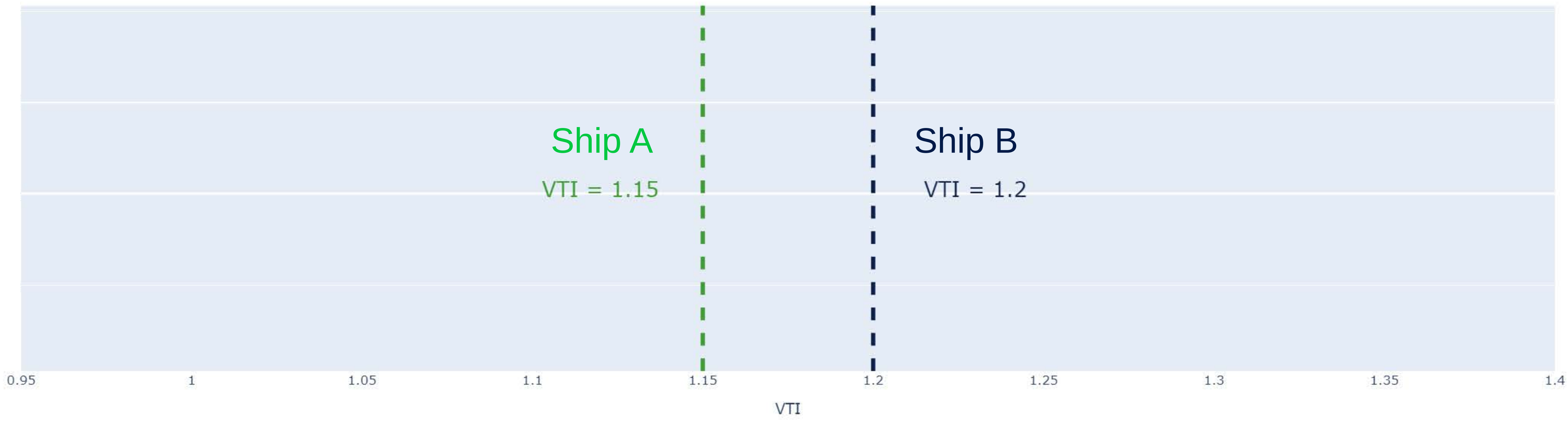
Q2 2023				Q3 2023				Q4 2023			
Service speed		Eco speed		Service speed		Eco speed		Service speed		Eco speed	
LADEN	BALLAST	LADEN	BALLAST	LADEN	BALLAST	LADEN	BALLAST	LADEN	BALLAST	LADEN	BALLAST
14	15,5	10	12	14	15,5	10	12	14	15,5	10	12
115	115	81	81	106	106	75	75	106	106	75	75
1,3	1,3	1,3	1,3	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1
19000	19000	19000	19000	21000	21000	21000	21000	21000	21000	21000	21000

- Enable informed contracting decisions between charterer and owner
- Incentivise the technically good ships
- There will be a need for one source of truth
- Making the CP’s VTI adjusted allows for sharing of risk/reward
- Improving VTI is incentivised
- VTI is a better index than CII for this purpose

DNV

VTI with uncertainty
informed decisions

Use Case
Compare the technical condition of two sister ships travelling at the same speed and with the same loading condition

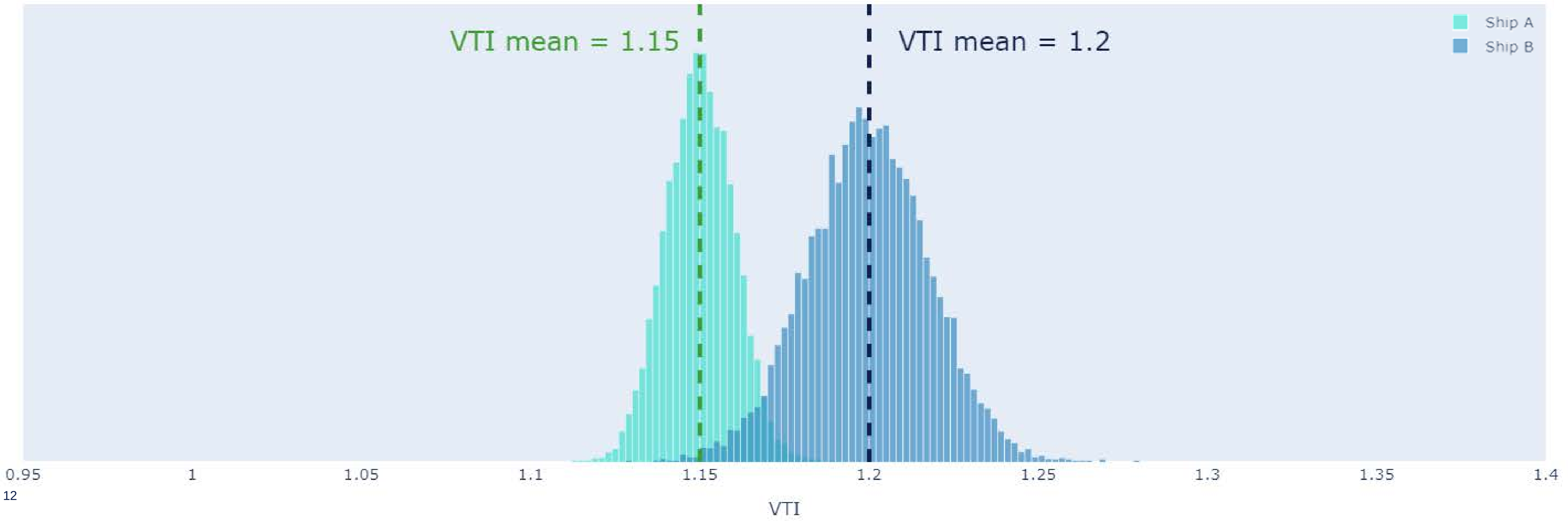


VTI with uncertainty
informed decisions

Use Case

Compare the technical condition of different ships

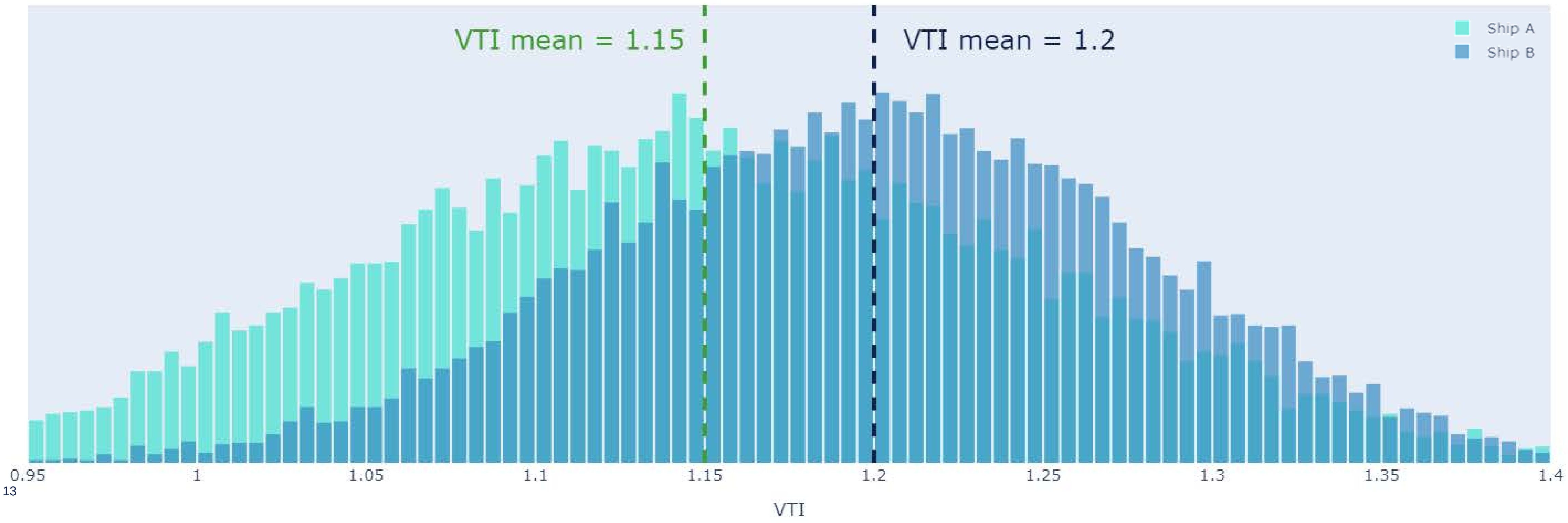
Prob. VTI of Ship A < Ship B = 0.99



VTI with uncertainty
informed decisions

Use Case
Compare the technical condition of different ships

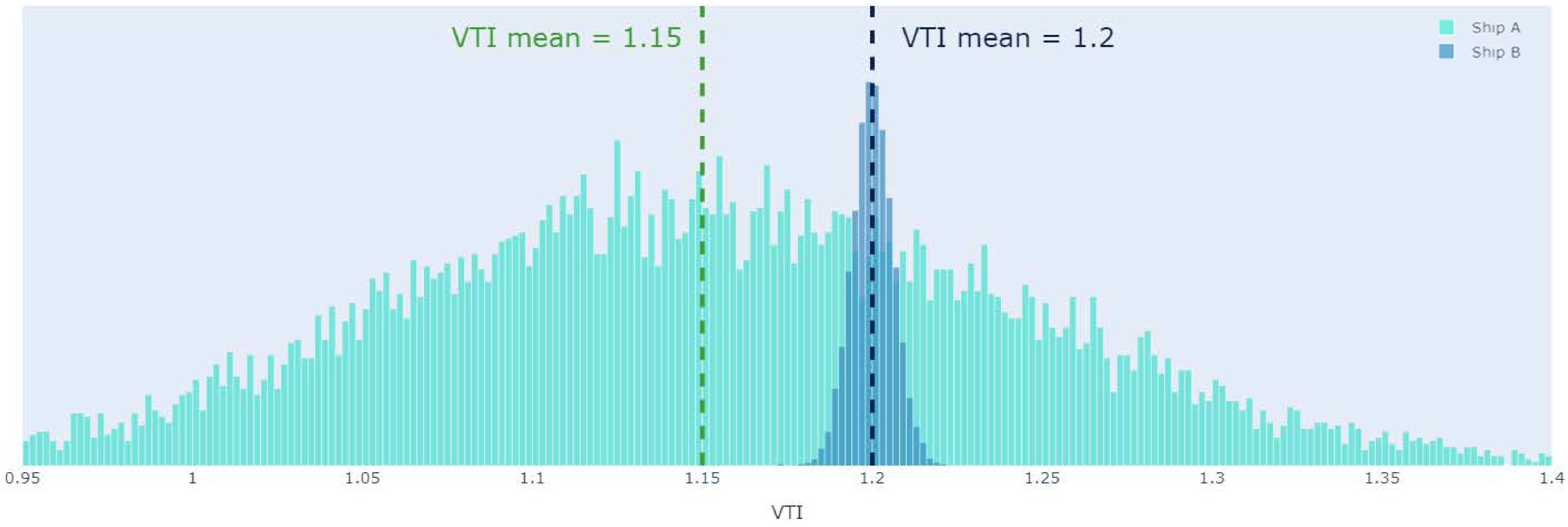
Prob. VTI of Ship A < Ship B = 0.65



VTI with uncertainty
informed decisions

Use Case
Compare the technical condition of different ships

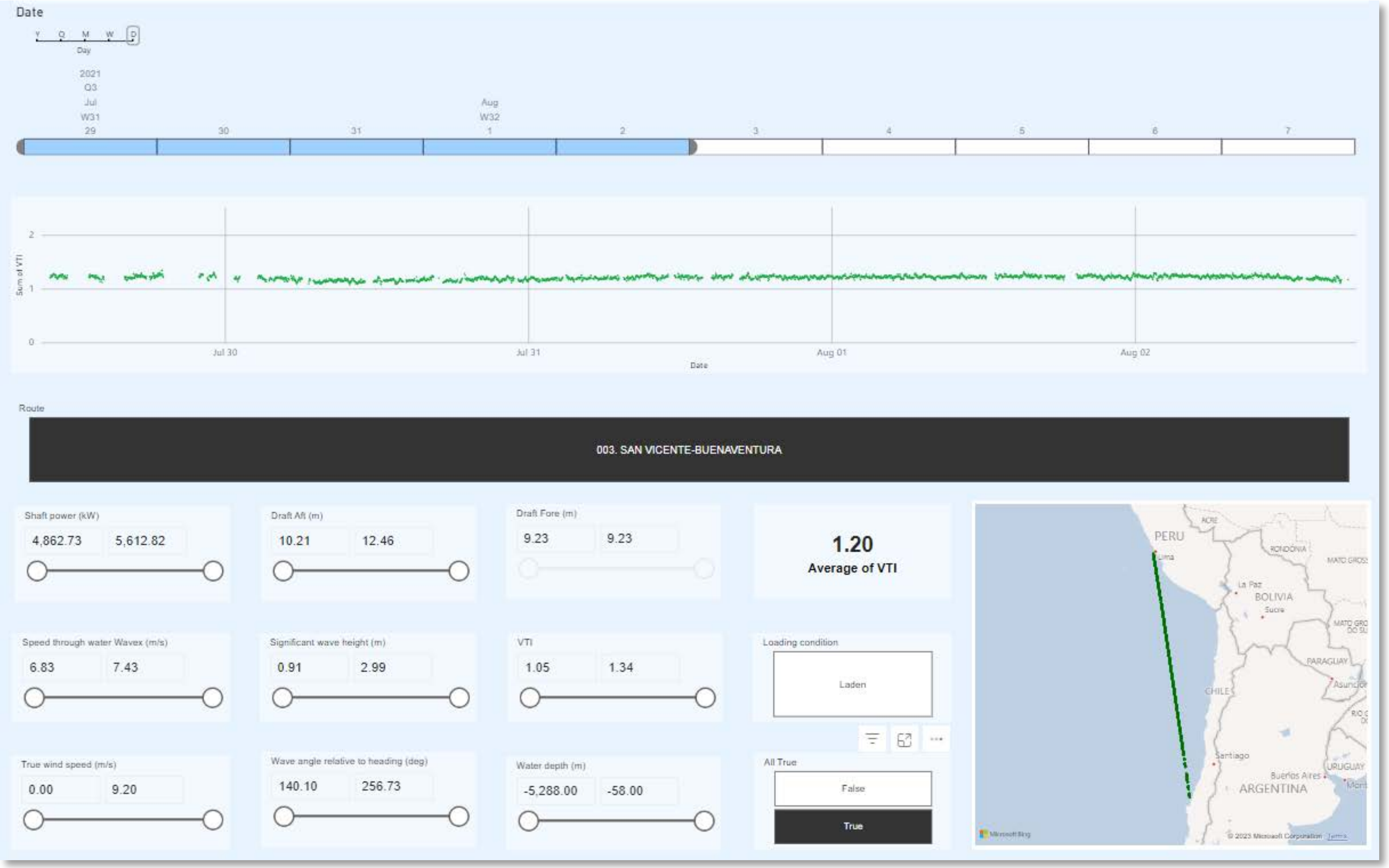
Prob. VTI of Ship A < Ship B = 0.7

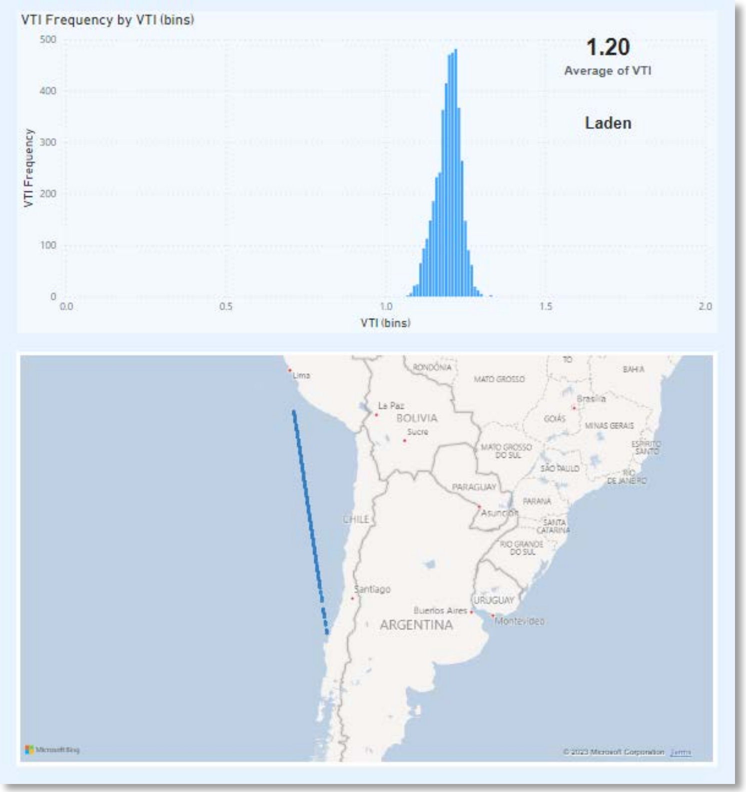


Use case 2 – Maintenance

WORLD VIRTUE (Ultramax Bulk Carrier)

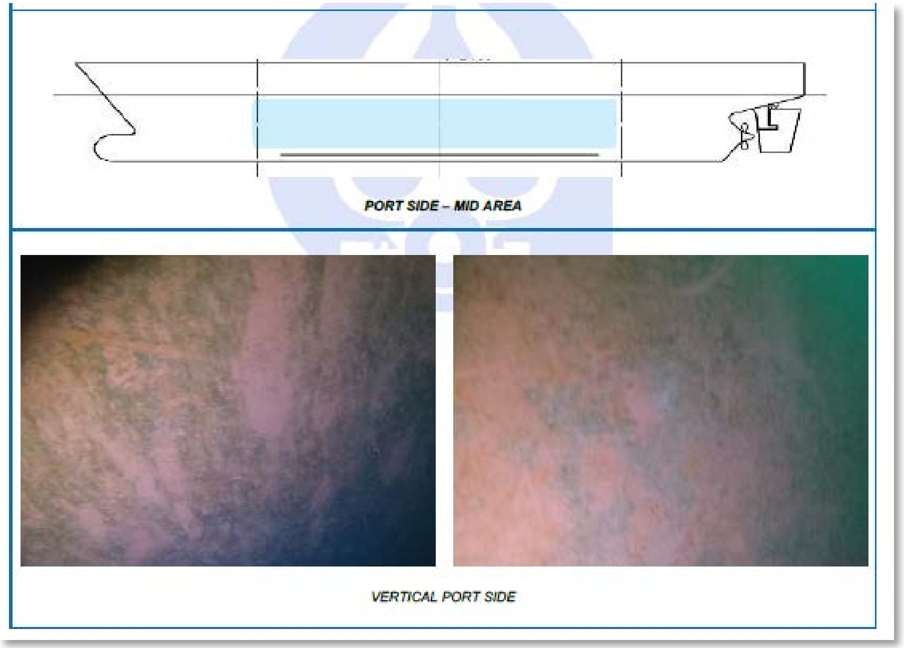
San Vincente (29-07-2021) – Callao (01-08-2021)

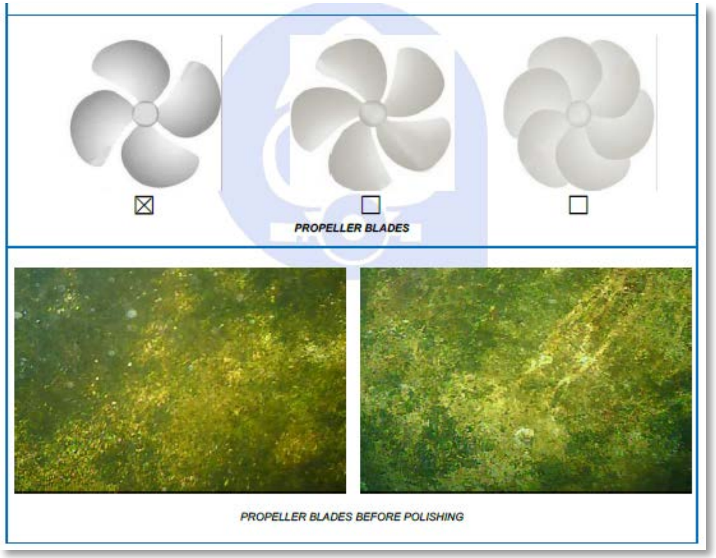




Average VTI of 1.20 indicate hull and/or propeller fouling

VTI – Propeller cleaning





Before

After

Diver’s inspection in Callao 03-08-2021

- Light hull fouling (slime)
- Propeller heavy fouled (slime, barnacles, sea grass)

It was decided only to clean and polish the propeller

VTI – Propeller cleaning

Propeller cleaning resulted in:

VTI reduction ~8% point

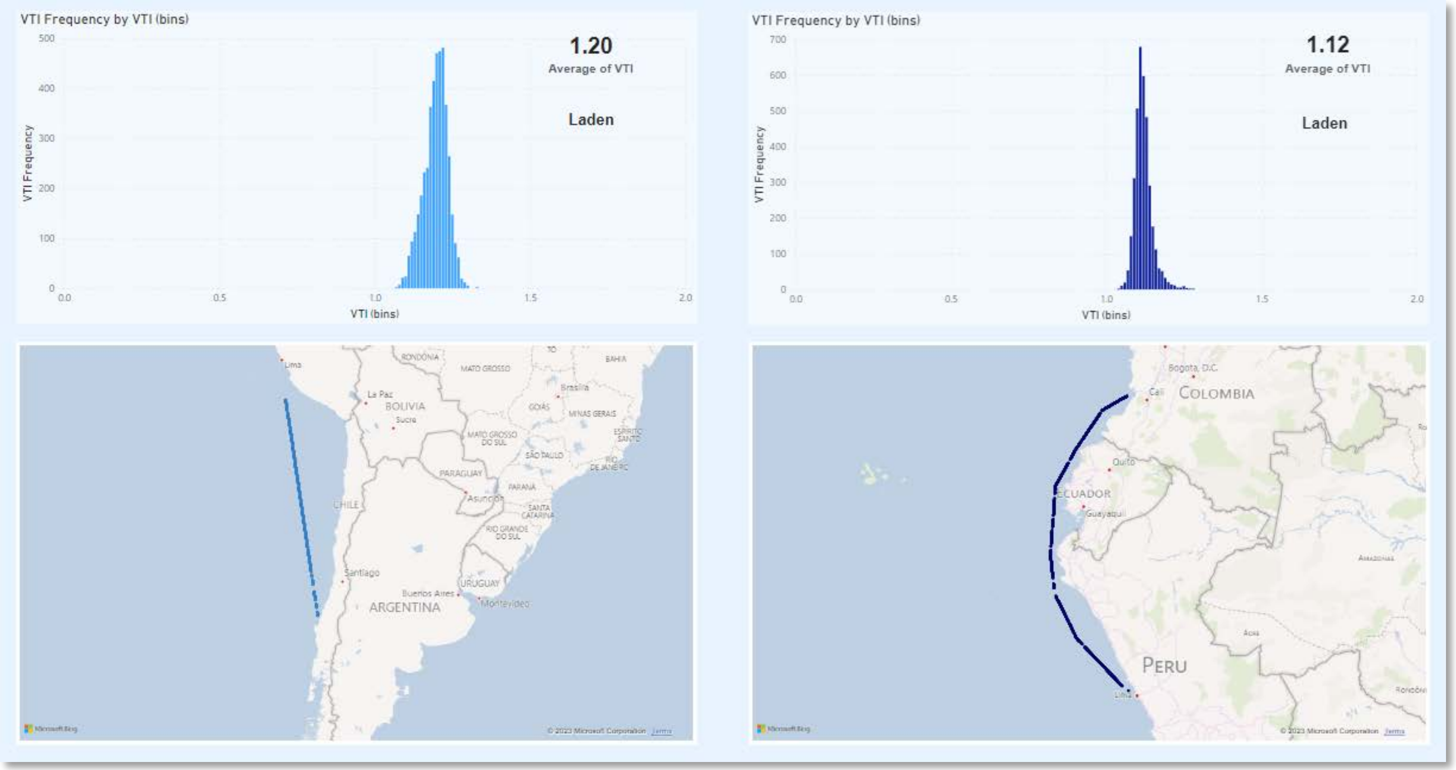
Fuel Saving of ~1.5 t/day on the following 4 days voyage.

Fuel saving 4 x 1.5 x 600 USD/t, ie 3,600 USD

Cost for propeller cleaning 3,200 USD in Callao

Before

After



- **Hull and/or propeller fouling identified by real-time VTI measurements**
- **Cost-benefit of propeller cleaning verified**
- **Pay-back time for propeller cleaning was less than 4 days!**

RP – documentation and verification

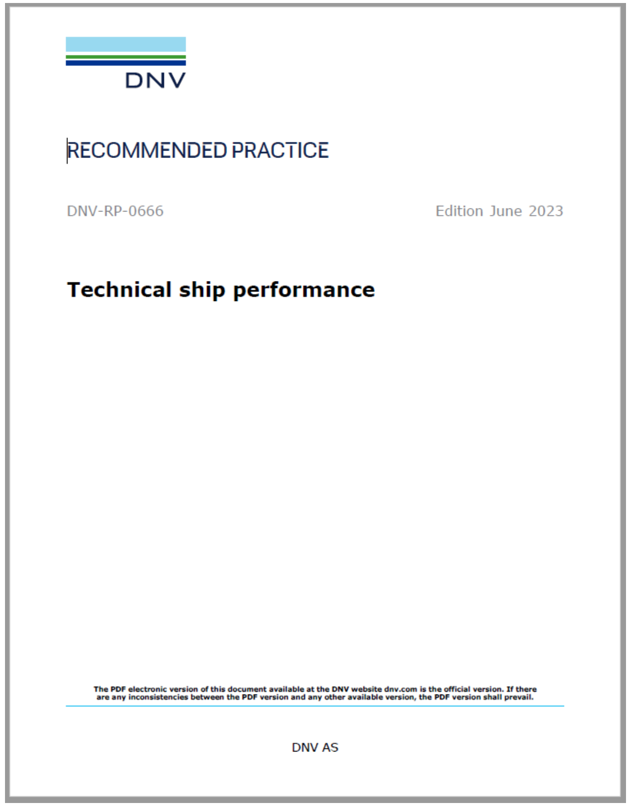
Recommended Practice

Aim: **Make a standard with transparent procedure to facilitate scaling**

- What to measure
- How to handle data
- How to calculate VTI

The RP is on public hearing now. We welcome your feedback!

Hearing Document


DNV

RECOMMENDED PRACTICE

DNV-RP-0666 Edition June 2023

Technical ship performance

The PDF electronic version of this document available at the DNV website dnv.com is the official version. If there are any inconsistencies between the PDF version and any other available version, the PDF version shall prevail.

DNV AS

Collaboration with SFI Smart Maritime

Projects

- Co-Cii: Collaborative strategies for GHG emission reduction through the Cii
  - VTI as the technical index
- Ship Technical Performance evaluation System (STEPS)
  - Working together with NTNU
- 3F- TRIPLE FUEL SHIPS WITH COST AND RISK REDUCTIONS
  - Piloting VTI on new Skarv ships

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Papers

Reliable Hull Performance Analysis using Vessel Technical Index

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Abstract

Proper evaluation of ships' hull performance is important for ship owners to optimize the maintenance schedule for ships and reduce emissions. Vessel Technical Index (VTI), originally proposed by DNV, presents a robust and reliable methodology to analyze the hull performance. VTI is calculated based on measured operational data, using the hydrodynamic model of a ship. Thus, the uncertainty in measurement data and hydrodynamic model will propagate to VTI value. the uncertainty in VTI could not be subdued even after adopting several constructive measures, such as, using measurement data from advanced sensors, steady-state and extreme weather filtering, etc. Therefore, this paper will analyze the uncertainty in VTI using a well-known data analysis tool, namely, Principal Component Analysis (PCA). the prominent factors contributing to the uncertainty in VTI is identified, and the solutions are further developed to reduce it for a reliable hull performance analysis.

Evaluating Vessel Technical Performance Index using Physics-based and Data-driven Approach

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Abstract

The ship's performance and its emissions are affected by several factors like its loading, weather condition, operational state, and maintenance condition. Rating ships with performance indices, such as EEOI or AER, is not really helpful as these factors are affected by both ship's technical and operational condition, which obscures the benefits of energy-saving technologies and improved maintenance condition. In other words, it is not fair for ship owners to rate ships using such indices, which cannot be controlled by ship owners. To promote energy-efficient ships and reduce emissions, DNV proposed Vessel Technical Index (VTI) which is expected to represent ship's technical efficiency. It can be used to fairly rate ships as well as compare energy efficiency of different ships. This paper investigates two different schemes to apply these corrections, namely, physical-based and data-driven approach. The two approaches are compared by analyzing the measured in-service data from a bulk carrier equipped with advanced sensors for speed and wave condition measurements. The in-service data is filtered rationally to subdue noise and uncertainties. The weather corrected and filtered data is further used to obtain reliable and robust estimates of VTI. The uncertainty in the results is reduced almost by half using the measured wave spectrum for physics-based VTI, whereas data-driven VTI creates an opportunity for ship performance monitoring without the need for speed-through-water measurements, which are considered unreliable for most ships.

Thanks for your kind attention!

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