Data Driven Operations in Maritime Decarbonisation

Enabler of Progress or Hidden Environmental Burden?

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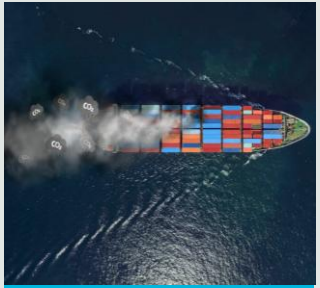
Data-Driven Operations: Current and Future uses

Predictive Maintenance

AI and sensor data are used to anticipate equipment failures before they occur, allowing timely repairs that reduce fuel waste, extend asset life, and prevent costly downtime.

Voyage Optimisation

Real-time analytics support adjustment of vessel speed, route, and propulsion settings based on weather and sea conditions to minimise fuel consumption and emissions during transit.



Emissions Tracking

Onboard systems continuously monitor fuel use and greenhouse gas output, enabling compliance with IMO regulations and supporting transparent sustainability reporting.

Port Logistics Automation

Data platforms manage berth scheduling, cargo handling, and vessel traffic to reduce port congestion, shorten turnaround times, and lower emissions from idling ships and port operations.

Disposal / Recycling

Advanced analytics and robotics automate dismantling processes, optimise material recovery, and ensure compliance with environmental standards.

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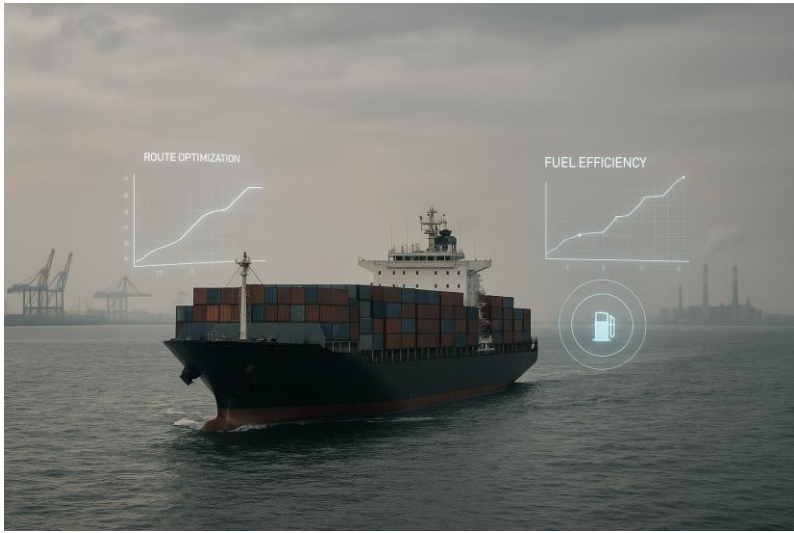
Data as an Enabler – Energy & Emissions

- **Operational Optimisation:** Capacity and voyage optimisation can deliver 10–24% efficiency gains, reducing fuel consumption and GHG emissions (*Global Maritime Forum, 2023*).
- **Voyage Optimisation Impact:** Up to 7.3% CO_2 reduction per voyage and 5–6% CII improvement, extending compliance by 2–3 years (*NAPA & ClassNK, 2023*).
- **Port Digitalisation:** Smart scheduling and cargo handling reduce idle time, cutting emissions by 16–24% (*UC Santa Barbara, 2023*).



Data as an Enabler – Fault prevention and waste

- Predictive maintenance optimises engine performance, reducing unnecessary fuel burn and lowering CO_2 emissions (*Soshianest, 2025*).
- 50% of maritime incidents are equipment-related, many causing inefficient fuel use and higher emissions (*Simion et al., 2024*).
- Predictive maintenance can reduce fuel consumption by 5–10%, translating into significant emissions savings across fleets (*Kiyak, 2025*).
- SHEREC project's use of digital twins and AI planning tools allows for optimised dismantling sequences, which maximises material reuse and minimises waste.

Data as an Enabler – Reporting & Compliance

- **Accurate Reporting:** Standardised environmental performance data enables regulatory compliance and builds trust across the supply chain.
- **Strategic Impact:** Emissions metrics are starting to influence trade deals, charter agreements, and investment decisions, making data a competitive advantage.
- **Industry Transformation:** Transparent data is becoming a key criterion for decarbonisation targets and negotiations, shaping future maritime commerce.
- **Future Outlook:** Emissions data is emerging as a currency in global shipping, companies with robust reporting will lead the green transition (*Global Maritime Forum, 2023*).

Environmental Burden: Energy and Emissions

- Digitalisation in shipping relies heavily on data centres, which are often powered by fossil fuel, especially in regions with limited renewable energy integration.

- Data centres supporting maritime operations consumed 300 TWh of electricity globally in 2020, accounting for 1.5% of global electricity demand. Cooling systems are a major contributor to this footprint. Switching to 100% renewable energy can reduce GHG emissions by up to 90%, regardless of cooling method (*Franke, 2025*).

- PFAS chemicals, often used in two-phase immersion cooling systems for data centres

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Environmental Burden: Waste

- *“The digital economy, often praised for its virtual and intangible nature, has created the illusion of a world unburdened by material waste*.” – Rebeca Grynspan – Secretary-General of UNCTAD.

- Between 2010 and 2022, the volume of e-waste from screens and IT equipment grew by 30%, reaching 10.5 million tons globally (*UNCTAD, 2024*).

- The demand for critical minerals like graphite, lithium, and cobalt is projected to increase by 500% by 2050 to support the growing digital and low-carbon technologies (*UNCTAD, 2024*).

Lifecycle Assessment of Data Systems

- **Mandatory for Fuels:** IMO's 2024 guidelines require full Well-to-Wake LCA for alternative marine fuels. These assessments cover emissions from production, transport, and onboard use to ensure transparency and accountability (*IMO, 2024*).
- **Missing for Data Systems:** Despite the growing energy footprint of digitalisation, no equivalent LCA requirement exists for data-driven operations. This creates a blind spot in sustainability strategies (*Thetius, 2024*).
- **Call for action:** With LCA we can help ensure that the emissions from digital infrastructure are accounted for. By adopting a standardised LCA for digital systems, supported by a chain of custody, the industry will be able to avoid shifting emissions upstream and ensure true decarbonisation.

Human and Operational Implications

Transformation of Crew Roles

- Over 89,000 additional officers are needed by 2026 to crew the global merchant fleet contributed by the rise of digital technologies (*International Chamber of Shipping, 2024*).
- 68% of new maritime hires now receive digital literacy training upon onboarding (*Linder, 2025*).
- Only 35% of maritime workers feel confident in their digital skills, with 45% of employers reporting skills gaps *(Linder, 2025)*.
- 72% of maritime companies plan to increase their investment in reskilling their workforce *(Linder, 2025)*.

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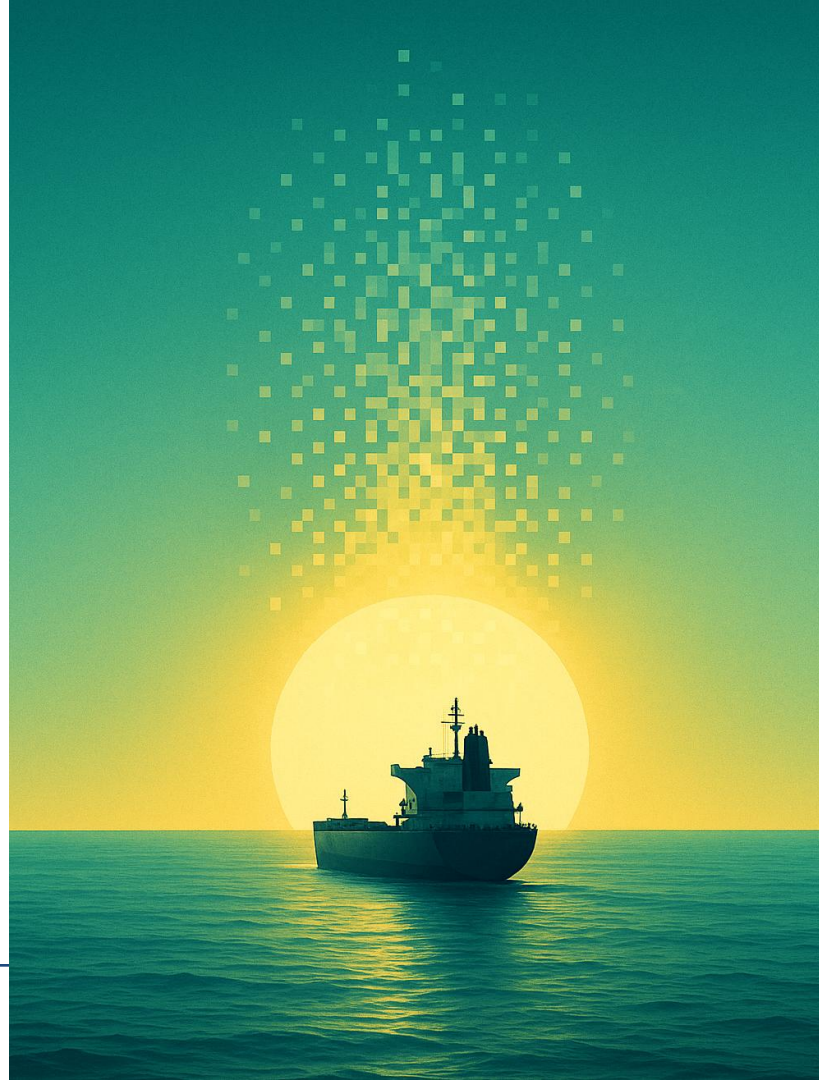
Conclusion

- **Data-Driven Operations Are Positive:** Enable immediate, scalable emissions reductions through optimisation, predictive maintenance, and compliance support.
- **Caution Is Needed**: Rapid digitalisation introduces hidden environmental burdens - energy-intensive data centres, e-waste, and lifecycle impacts that remain unaccounted for.
- **Emerging Risk:** AI adoption is projected to drive a 165% increase in global data centre power demand by 2030, amplifying the urgency for sustainable digital strategies (*Goldman Sachs, 2024*).
- **Path Forward:** Embrace strategies for a resilient maritime digital framework.



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Thank you

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