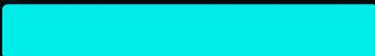




Mastering
maritime data
for competitive
advantage



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Unlock
maritime data

Unlock performance

Today, high quality maritime data navigates a route to compliance and acts as a catalyst for commercial success. Poor quality data can hamper reporting, and many organisations are slipping behind the curve when it comes to mastering maritime data and attaining a competitive level of digital maturity.

Markets and regulators press for more traceability from maritime transport and major regional jurisdictions reward greater transparency. While readily available technology can supply the transformation those regulators and jurisdictions require, the distance between actual and ideal states remains significant.

This report explores how the maritime industry can close this gap. Drawing on Lloyd's Register (LR) and OneOcean expertise, it shows how trusted, standardised data can unite compliance, commercial, and operational goals and improve reporting when matched with the right technology.

5 ways this report will benefit you

1

Discover where data delivers value

The industry collects more operational data than ever before, but not all data adds value. Learn where data genuinely drives efficiency, cuts carbon costs, and protects commercial margins.

2

Learn how fleets turn compliance into advantage

With overlapping frameworks such as the EU Emissions Trading System (ETS) and FuelEU Maritime impacting operating margins, discover how leading maritime organisations use verified datasets to stay compliant and ahead of their competitors.

3

Understand what makes data trustworthy

Accuracy and traceability are measurable qualities. This report breaks down how governance, verification, and metadata combine to turn numbers into decisions that regulators and charter parties can rely on.

4

Learn how to create a future-ready digital strategy

From AI readiness to open-standard integration, see what distinguishes digital maturity, and explore why structure often determines success.

5

Gain practical guidance for your next step

Whether you manage a single vessel or a global fleet, this report gives you a roadmap to build data discipline, align teams, and extract value across technical, regulatory, and commercial domains.

The data-driven era for maritime operations

Across the globe, there is a growing expectation for shipping to operate digitally. From Singapore's digital bunkering records, to China's energy consumption logs, California's at-berth emissions dashboards and the IMO's Maritime Single Window, regulators, charter parties, service providers and cargo owners all acknowledge that quality data is vital for proof of compliance, efficiency, safety, and much more besides.

Inspection and vetting requirements are key drivers for digital transformation. Under schemes like SIRE 2.0, RightShip, and CDI-Marine, inspectors rely more on structured digital data sets that can be syndicated across systems.

These factors create momentum which redefines what digital maturity means in practice. A successful maritime data strategy needs to take account of these dynamic 'carrot and stick' actors and, as we will see in this report, remain grounded in a realistic overall business strategy. Mastering maritime data is only the means to an end, rather than an end in itself.

According to [Global MaritimeTrends 2025 Digital Transition Barometer](#), the joint research programme by LR and Lloyd's Register Foundation, one of the key barriers to progress in the maritime digital transition is the lack of standardisation and interoperability of digital systems, across the maritime ecosystem.

Going deeper, using LR's latest Digital Maturity Index (DMI) insights from 2025, we can see that among the identified enablers of digital transformation, standardisation, is in the middle of the maturity scope, scoring 2.23 out of 4, underlining that systems integration is highly underestimated. This inconsistency means that companies currently have multiple versions of same data in different silos with inconsistent values, rather than flows between systems.

Inspection and vetting requirements are key drivers for digital transformation

Success depends as much on effective implementation as it does on planning. LR's latest DMI data for 2025 shows that while overall industry maturity is 2.23 out of a top score of 4, progress remains uneven across its five pillars: connectivity, cyber, culture, strategy, standardisation. As we will see, this inconsistency means that the whole sector lags behind the adoption rate necessary to be well-prepared for the operating environment of 2030.

As the volume of digital information grows, the need for accuracy, consistency, and shared standards becomes even more pressing. Yet many fleets still manage some or all key operations on paper or spreadsheets, often with fragmented chains of custody. This leaves reporting vulnerable to error and delay and keeps potentially transformative data hidden. Building a deliberate and coherent strategy in this environment is essential, not only for compliance readiness, but for competitiveness in today's increasingly data-demanding marketplace.

The scale of the challenge

Some of the systems organisations use to meet new data demands reveal their limits. In many cases, data remains incomplete, inconsistent, or difficult to use. LR's 2025 DMI results again underline the extent of the challenge. Having assessed close to fifty maritime-specific examples in detail, three-quarters of organisations are still classed as 'emerging', rather than digitally 'mature'. While tools for fleet tracking (96%) and performance monitoring (89%) are approaching universal in liner trades, deeper capabilities such as integration, analytics, and effective governance remain limited. In most cases, digitalisation remains tactical and vendor-led rather than strategic and truly transformative.

As the volume of digital information continues to grow, the need for accuracy, consistency, and shared standards becomes even more pressing

The value of reliable data

Reliable datasets not only steer investment to where it will deliver the best returns, but also underpins digital uses like bunker planning, route optimisation and carbon accounting. Maritime cost exposure and compliance obligations are both becoming more onerous. Modelling these factors using data is a source of strategic advantage.

Mastering maritime data can generate significant and immediate upsides. For example, in May 2025, TotalEnergies chose OneOcean after concluding a successful trial of machine-learning voyage-optimisation tools across its chartered fleet. The company realised savings of 725 tonnes of fuel and 2,256 tonnes of CO₂, showing what can be achieved when high-frequency vessel data, shoreside routing expertise, and verifiable analytics are deployed effectively.

In another example, maritime services and ship management company NSB GROUP announced the rolling out of OneOcean's regulatory management platform Regs4Ships across its fleet of 45 vessels. This enables crew and shore teams to gain shared access to compliance data in near real-time. As a result, NSB reduced inspection times and improved confidence in their audits, unlocking potential for more time at sea and fewer unplanned delays for survey and inspection issues.

Mastering the four domains of the data lifecycle



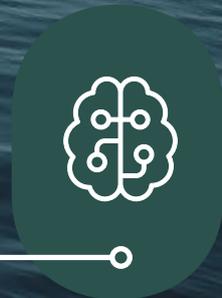
Data collection
& validation



Data transfer



Data processing
and verification



Data use and
decision-making



Behind every voyage, every emissions report, and every performance dashboard lies a chain of data interactions that spans ship and shore

Gaps in quality, timing, structure, and transparency mean that the journey from the moment data is generated to the point it informs a decision is rarely straightforward.

Understanding where things can go wrong and where value can be added begins with mapping the full flow of data through maritime operations.

The maritime data lifecycle can be pictured as a continuous loop made up of four connected domains:

- Data collection and validation
- Data transfer
- Data processing and verification
- Data use and decision-making

Each domain builds upon the integrity of the last. Together, they determine how effectively data can move from ship to shore, from raw record to insight, and from compliance to commercial value.

In the following sections we explore each domain in turn, defining its goals, examining emerging trends, addressing persistent challenges, and highlighting the solutions that influence digital maturity across the sector.

Domain 1

Data collection and validation

Goals

The data lifecycle begins onboard. Every noon report, sensor feed, or voyage log represents a moment where value is either created or lost. Effective collection and validation means capturing operational, navigational, and environmental data that is complete, accurate, and consistent at source.

An appropriately outfitted vessel records very large quantities of information. Noon reports from the bridge, high-frequency engine data, environmental readings, electronic logbooks, and integrated navigation systems all form the foundation of a vessel's digital footprint, and could be used as the basis of a digital 'twin'. When these inputs are reliable and well-structured, they feed everything from emissions calculations, fuel-efficiency modelling and maintenance planning, to fixture rates and post-contract arbitration.

Barry Hooper, Vice President of Product and Technology at OneOcean, reminds us why data valid at the point of collection is so important. He says, "When data is validated at source, you remove hours of potential reworking and set a firm underpinning of quality that will track through every subsequent stage in the chain of custody."

The goal of effective data collection and validation is to know that information is trustworthy from the moment it is created, so every downstream process from compliance to decision-making operates on fact rather than assumption. Every latter stage depends on the integrity of the foundation established at source.

Trends

The quality of digital maritime data is just as important as the quantity. Digitally mature operators invest in tools that blend automated and manual entries to improve accuracy and reduce operator workload. Hooper notes that blending automated and manual entries, "can drastically reduce the volume of errors that are realistically going to enter the pipeline. If you improve the data quality at source, you won't have to chase the vessel for corrections later. This approach reduces man-hours and makes your workflow more reliable and improves downstream decision making."

As a result, maritime organisations increasingly embed validation logic to support increased automation. The best data-capture tools cross-check

inputs such as speed, position, and fuel consumption against vessel-specific performance models to flag anomalies as they arise. This reduces administrative burdens on crews and creates a cleaner validated data stream for the next stages of the lifecycle.

"We want standardisation to be useful, not theoretical. That's why we've focused on harmonising real-world structures."

Jeremy Daoust,
Head of Market Management & Insights at OneOcean

The drive for better standardisation gathers momentum. Initiatives like the Smart Maritime Network Standardised Vessel Dataset (SVD) and Energy LEAP harmonise formats for common datasets such as noon reports, fuel data logs, and more. LR and OneOcean actively participate in programmes like these, so new standards remain realistic for shipboard use and interoperable across platforms.

Jeremy Daoust, Head of Market Management and Insights at OneOcean, says standards should be kept grounded and aligned: "We want standardisation to be useful, not theoretical. That's why we've focused on harmonising real-world structures like noon reports in collaboration with industry partners. It's about solving actual pain points, not just meeting a specification."

These developments show how the tide is turning in favour of data collection that is automated, standardised, and readily verified, creating firm foundations for maritime data processing at scale.

Challenges

Despite these advances, collection remains one of the weakest links in the maritime data chain. Reporting formats still vary widely between vessels and systems. Data is often entered manually under time pressure or left incomplete when bandwidth or software compatibility is an issue. Without shared standards, even accurate entries can be difficult to merge or audit later. These inconsistencies create noise in the dataset and slow the validation process.

Many fleets still struggle to capture data that is complete, consistent, and validated. **The Benchmark: Measuring the Progress of Digital Transformation in Ship Operations**¹ found that manual entry remains the dominant method of shipboard data collection, with information often exchanged by email or spreadsheet. As the report points out, these processes are, “riddled with risks to data quality.”

DMI data from 2025 reinforces this picture, highlighting its cultural aspect. Considering that Culture, as key enabler for digital maturity, scores only 2.2 out of 4, being one of the lowest performing pillars, this underscores that technology alone cannot resolve alone data quality challenges unless it is matched with the workforce equipped with skills, habits and confidence to use it effectively. Embedding digital discipline into organisational culture, is therefore essential for building reliable datasets, from the very start of the lifecycle.

In part, the problem is the irregularity of data application and oversight. As Hooper notes, “Until data governance and validation are embedded in the collection process itself, the industry will continue to clean up errors downstream rather than preventing them upstream, potentially devaluing the data as a result.”

Solutions

Progress can be made in several ways. First by automating collection with a system that includes assurance logic. For example, OneOcean and LR have embedded validation routines directly within their platforms so that data is checked as it is captured.

This principle of verification by design is fast becoming standard practice among more mature data handlers. By aligning data collection tools with verifier expectations for transparency and

traceability from the outset, operators can detect anomalies immediately, rather than discovering them during audit or submission. Or worse, using misleading data used to make an important decision.

The second is to consider governance and accountability foundational principles. LR’s digital-assurance frameworks and initiatives like Digital Compliance readiness tiers help maritime businesses formalise how their data is structured, recorded, and approved. “Governance is what makes data actionable,” says OneOcean’s Daoust. “With it, you can demonstrate compliance, share data across teams, and make faster decisions with confidence.”

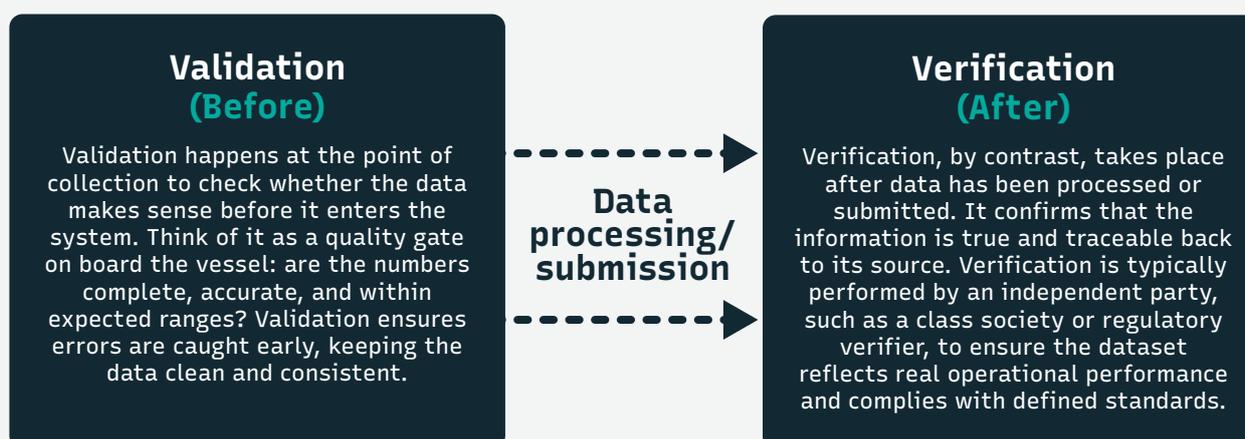
Finally, the human element remains critical throughout. Competence and ownership help to build digital literacy at sea and onshore according to Roger Cornish, In-Service Product Manager at LR. “Pick people who care about recording data and build progression for them. If you’re concerned about over-reliance on spreadsheets, invest in dedicated tools and training, and make it a human-led initiative,” he advises.

Automated validation, structured governance, and capable people define reliable data collection and validation. Established organisations are not necessarily those with the newest systems. Those treating every data set as a regulated asset, verified on collection and trustable throughout its lifecycle will see the greatest benefit.

The next domain in the data lifecycle is about ensuring data reaches the shore intact, complete, and in a verifiable condition.

¹LR and Thetius (2024) The Benchmark: Measuring the Progress of Digital Transformation in Ship Operations. London: LR. Available at: <https://www.lr.org/en/knowledge/research-reports/2024/the-benchmark/>

What’s the difference between data validation and data verification?



Domain 2

Data transfer

Goals

The value of maritime data reflects how timely and reliably it reaches shore so that it can be seen, verified, and used in some way. Effective data transfer preserves accuracy, integrity, and context from point of origin to destination, whether that's a verifier's dashboard, a compliance submission portal, or a fleet performance system.

At sea this process is far from trivial. High-frequency sensor feeds, environmental metrics, and voyage reports must all be transmitted over satellite or terrestrial data networks, often in unfavourable weather and sea conditions. Vessels need a secure, structured, and auditable pipeline where every packet of data can be traced to its source and verified on arrival.

Transfer determines whether data is usable. If the pipeline fails, the lifecycle falters, no matter how good the sensing and collection.

Trends

Until recently, maritime data exchange was periodic and manual. Files would be emailed or uploaded during port calls, with hours or even days of latency.

The spread of Low-Earth-Orbit satellite constellations such as Starlink have transformed ship-to-shore bandwidth and reliability, allowing near-real-time transmission of operational data. Shoreside teams can now continuously monitor vessel performance, make weather-based route adjustments mid-voyage, and detect compliance deviations as they happen.

Parallel to the hardware leap, cloud adoption has become the default medium for data exchange. A growing proportion of ship-to-shore information now passes through encrypted cloud environments where structure, metadata, and access controls determine whether data can be analysed, verified, or reused across systems.

“High-frequency and manually entered data can only deliver value if the transfer process itself is secure and verifiable. Every stage needs to preserve context and integrity, so users on shore can trust what they see.”

Barry Hooper

VP Product and Technology, OneOcean

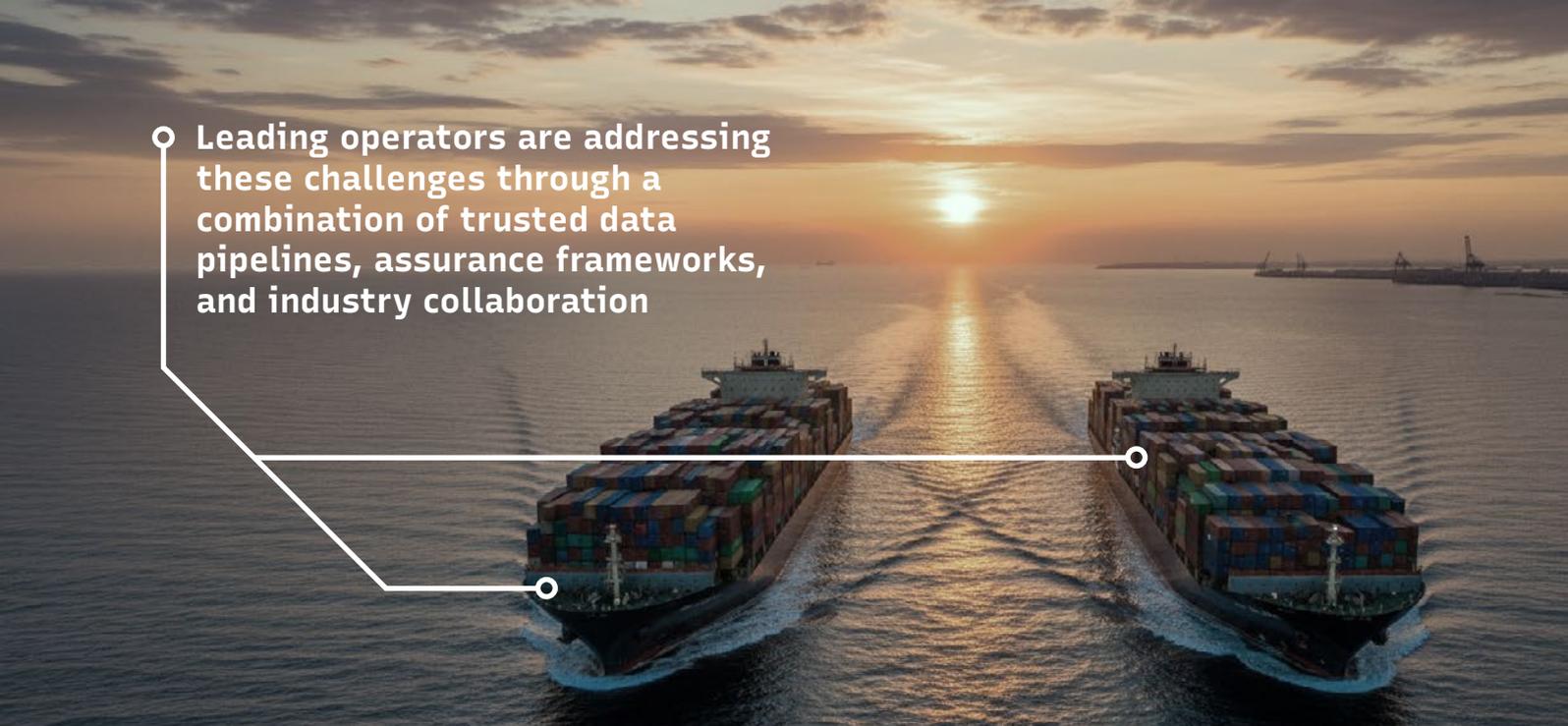
This always-on connectivity reshapes expectations. As Pranav Kumar, LR Global Advisory Lead - Operational Excellence, says, “Fleet connectivity and integration improvements, whether through cloud-based systems or new digital infrastructure, allow shoreside teams to engage more directly in operational decisions, aligning shipboard and office systems in real time.”

Hooper says this rapid dissemination of data helps to preserve its value. “High-frequency and manually entered data can only deliver value if the transfer process itself is secure and verifiable. Every stage needs to preserve context and integrity, so users on shore can trust what they see.”

Challenges

Transfer and governance of maritime data is constrained by fragmented and tightening regulation. Regional laws such as the EU's General Data Protection Regulation (GDPR) and Digital Services Act can impose differing controls on cross-border information exchange, complicating collaboration across fleets, ports, and supply chains.

The United Nations Convention on the Law of the Sea (UNCLOS), drafted long before digital technologies emerged, sets out how far coastal states can exploit their waters, but not activities such as deep-sea data collection and autonomous underwater operations.



Leading operators are addressing these challenges through a combination of trusted data pipelines, assurance frameworks, and industry collaboration

New research suggests that more than 78% of maritime companies accelerated digital initiatives during the COVID-19 pandemic,² and this growth in connected systems has outpaced coherent governance. The study argues that a patchwork of rules and interfaces has complicated the secure, interoperable transfer of operational and environmental data, limiting the maritime sector's ability to validate, share, and act upon information at scale.

For many fleets, particularly those operating mixed-age or chartered tonnage, ship-to-shore data flow remains intermittent and inconsistent. Bandwidth limitations, cost constraints, and reliance on legacy onboard networks often result in delayed or down-sampled datasets and key timestamps or metadata may be lost in compression.

Fragmented software ecosystems amplify the problem. Different vendor systems can export data in incompatible formats, forcing manual re-entry or ad-hoc conversions that strip away context needed for verification. According to Hooper, "blending automated and manual entries reduces errors at source, improving data quality, dramatically reducing pain points and time spent correcting data later. Interoperability must extend throughout the data lifecycle. Data must be accessible if it is to be used at scale, for stakeholders to easily interact with a single source of truth across workflows and platforms."

Security adds another layer of complexity. The growing number of connected systems, including bridge sensors, satellite gateways, and cloud APIs, have expanded cyber-risks. The maritime sector could implement encryption, access control, and integrity checks similar to those applied in the finance or aerospace sectors.

Solutions

Leading operators address these challenges through a combination of trusted data pipelines, assurance frameworks, and industry collaboration.

Best practice focuses on end-to-end encrypted, structured pipelines designed for interoperability. These systems ensure that once data leaves the vessel, it retains its structure and metadata throughout its journey. End-to-end encrypted, trusted data pipelines allow data to flow between systems without repeated manual entry or reformatting. These pipelines should be structured for interoperability, and standardised enough to integrate with voyage-management, charter-party, or fleet-performance applications.

This "assurance-by-design" design philosophy embeds quality control within the transfer process rather than applying it retrospectively, so systems are verified not only for output accuracy but for the integrity of the transfer logic itself. This approach aligns to LR's wider approach to digital assurance. The introduction of the VC-L+ descriptive note in 2025, benchmarking vessel connectivity against defined levels of data accessibility, integrity, and cybersecurity, gives a measurable mark of trust for shipowners.

In parallel, initiatives like ISO 19848, Shipdex, and the Port Call Optimisation Task Force Standards, class societies, vendors, and operators are harmonising how operational data is structured and transmitted. These common frameworks not only streamline data movement but also reduce the likelihood of transcription errors or missing fields during transfer.

² Sustainability (2025) Digitalisation of the Maritime Sector: A Review of Trends, Challenges and Governance Gaps. Sustainability, 17(9526), p. 4. DOI: 10.3390/su1709526.

Finally, cloud-based verification environments tighten the loop between data submission and validation. OneOcean exemplifies this approach by integrating emissions data directly with LR's Emissions Verifier, keeping LR experts in the loop so compliance information is already structured, traceable, and secure upon arrival.

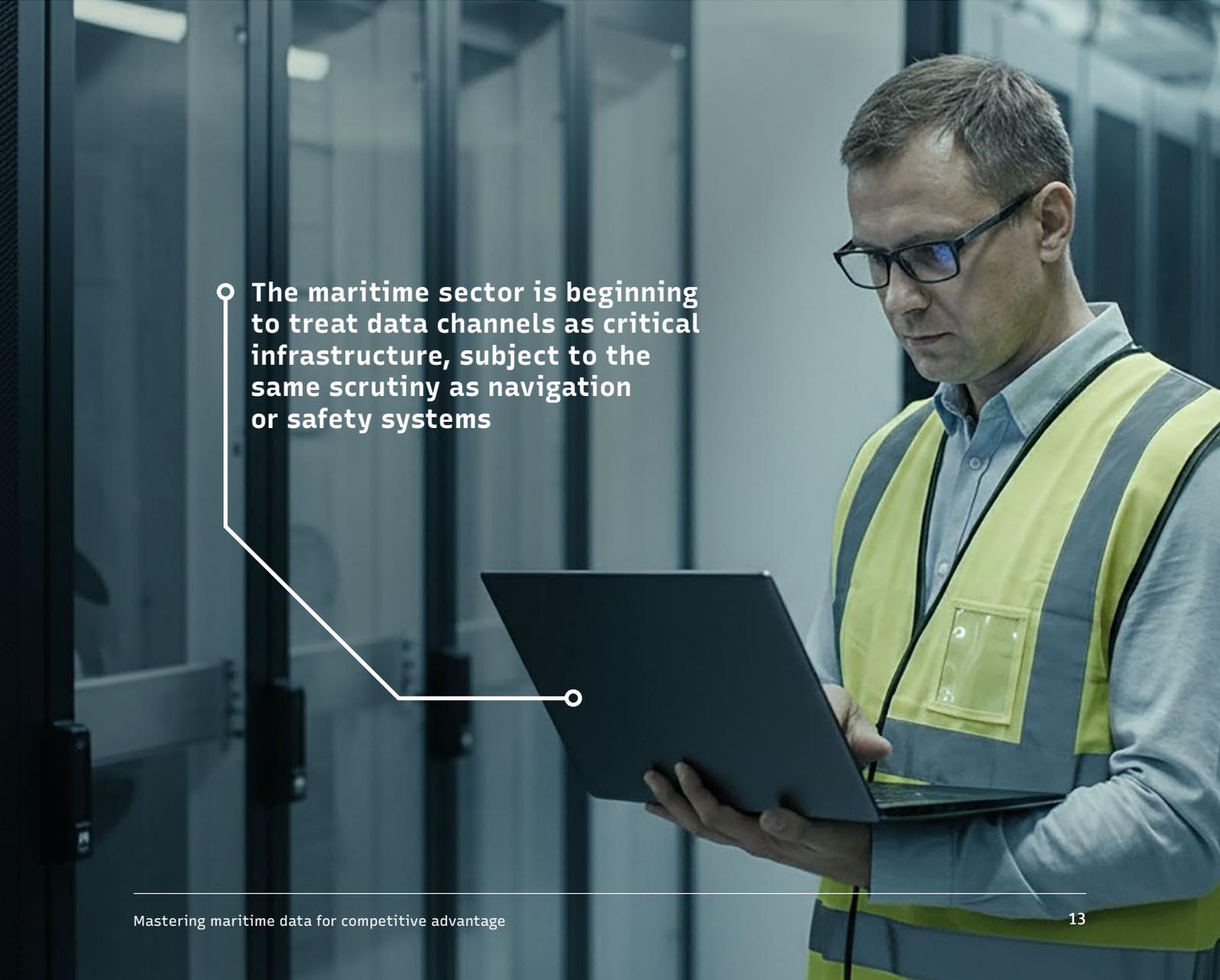
As OneOcean's Hooper explains, "We collaborate closely with LR Advisory and our regulatory team about how calculations should be implemented and how the data translates between collector, verifier, and regulator. As a result, data we handle is already in the right format when it arrives at its destination."

Finally, there is a growing focus on cyber-resilience and continuous monitoring. The maritime sector is beginning to treat data channels as critical infrastructure, subject to the same scrutiny as

navigation or safety systems. Initiatives such as the Digital Compliance framework develop graded assurance tiers for connected vessels, establishing clear criteria for encryption, redundancy, and data-integrity validation.

With the right tools, it is possible to build processes where data moves seamlessly, securely, and verifiably between ship and shore, maintaining its integrity and context at every step. As the industry embraces high-capacity, low-latency internet connections and integrated cloud ecosystems, guaranteeing data provenance across this pathway will be a defining marker of digital maturity.

Once data arrives ashore, its next transformation involves turning raw input into verified, analysable information ready for compliance and decision-making.



The maritime sector is beginning to treat data channels as critical infrastructure, subject to the same scrutiny as navigation or safety systems

Domain 3

Data processing and verification

Goals

Processing and verification convert raw operational inputs into structured, traceable, and regulator-ready information that can support analysis and decision-making. Validation aims to keep data clean and consistent, with errors caught early.

Verification is uniquely challenging in shipping, where moving assets, overlapping regulatory regimes, and compressed submission windows make even small data errors difficult to resolve.

Clarity and provenance matter. Stakeholders need to know where each data point originated, whether it met the required format and frequency, and whether it can be used confidently for compliance submissions or performance forecasting.

By cleaning, aligning, and validating datasets while preserving their contextual metadata, or the timestamps, system IDs, and quality flags that make them auditable processing is both a technical and a governance task. When all these attributes are maintained, data can stand up to scrutiny. When they are lost, even accurate numbers can fail verification.

Trends

Data processing is moving rapidly from manual reconciliation to automated, rule-based validation, enabled by an emerging set of frameworks. Standards such as ISO/CD 23656, which covers marine environmental data quality, and the COACT Data Governance Model, promote consistent stewardship practices. These standards lay the foundations for digital assurance at-scale by establishing how accuracy, completeness, and traceability should be shown and audited.

In parallel, shipping companies of all types and sizes now process data flows to generate new insights. Among large fleet operators, progress has gathered significant pace. Maersk now processes more than 2.5 billion data points each year to model weather, currents, and performance variables, helping optimise routing and fuel consumption.³ MSC

reports similar advances through AI-enabled vessel-management and weather-routing systems that deliver up to 25% fuel-efficiency gains on selected trades.⁴

Smaller operators like Navigator Gas, an innovative mid-size chemical tanker operator, recently reported making significant investments in real-time emissions-tracking and performance-management systems to capture up to 500 data points per vessel. Combined with predictive-maintenance algorithms and digital trim optimisation, Navigator Gas reports that these tools have delivered measurable fuel savings and reduced machinery downtime.⁵ Such investments show that sophisticated data analytics are not the preserve of mega-fleets; but are attainable for a broad section of the market.

Challenges

Many organisations struggle with quality management. Independent verification helps, but verifiers can only work with the data they are given. LR's verification teams regularly flag common issues, including:

Incomplete fuel transaction records.

Inconsistencies between voyage logs and actual position tracking.

Formatting errors that obscure otherwise valid data.

Jeremy Daoust notes says the lack of contextual cues contributes to verification failures. "A file might contain all the right numbers. But if there's no metadata, like time stamps or equipment IDs, you can't validate its source. That's a big barrier to trust."

A further challenge lies in inconsistent governance. While many companies have adopted advanced analytics, relatively few have embedded the policies defining how to approve, modify, or archive. Without version control and audit trails, errors propagate silently through dashboards and reports.

³ A.P. Moller – Maersk A/S (2025) Annual Report 2024. Copenhagen: A.P. Moller – Maersk A/S. Available at: <https://www.maersk.com>

⁴ Mediterranean Shipping Company S.A. (2025) MSC Sustainability Report 2024. Geneva: Mediterranean Shipping Company S.A. Available at: <https://www.msc.com>

⁵ Navigator Holdings Ltd (2025) Navigator Gas Sustainability Report 2024. London: Navigator Holdings Ltd. Available at: <https://www.navigatorgas.com>



“A file might contain all the right numbers, but if there’s no metadata, like time stamps or equipment IDs, you can’t validate its source. That’s a big barrier to trust.”

Jeremy Daoust,
Head of Market Management & Insights at OneOcean

Finally, the industry faces an emerging test of trust in automation. As machine-learning models and AI-driven analytics enter verification processes, operators and regulators must be confident these systems apply rules transparently and preserve evidence chains. Achieving that balance between automation and accountability is the next frontier of digital assurance.

Solutions

The maritime sector’s more digitally mature organisations approach these issues on three fronts: designing data validation and verification into systems, strengthening governance, and aligning with recognised assurance standards.

Effective processing depends on clear ownership of the data pipeline. For example, LR’s Digital Compliance framework offers graded assurance levels for digital systems, assessing how well inputs are documented, versioned, and secured. Many organisations have created ‘data steward’ roles to maintain these standards.

To prevent fragmentation, class societies, technology vendors, and owners are converging on shared data models. Several industry standards initiatives define common schemas that preserve contextual integrity across systems. By aligning processing rules with these open standards, all maritime organisations eliminate repeated conversions and ensure that data verified in one environment remains verifiable in another.

As maritime data systems mature, the industry will gain a single version of digital truth, trusted because it has been validated at each stage. With data now validated and assured, its full value can finally be realised, transforming verified information into operational insights and a strategic advantage.

Domain 4

Data use and decision making

Goals

The final domain turns verified information into action. Once data has been collected, transferred, processed, and validated, its value is linked to whether it fulfils a 'license to operate' by satisfying compliance protocols, and how it supports operational and commercial decision-making.

The goal is for every verified data point to contribute to measurable outcomes, whether that means optimising voyages, reducing fuel use or choosing fuel mixes, sharpening carbon-exposure forecasting, or enabling more accurate financial planning for improved commercial outcomes. The smart use of data becomes a continuous feedback loop: insight informs action, and new operational data verifies the result.

A digitally mature approach often involves designing decision systems that are integrated, traceable, and role-specific, allowing technical, commercial, and regulatory teams to act from a single, trusted version of events.

Trends

The decision cycle is shrinking. Where reporting and planning once took days, connected digital platforms now enable real-time adjustments based on verified information streaming from ship to shore.

Artificial intelligence (AI) and predictive analytics can forecast the financial impact of regulatory changes on carbon exposure and allowance trading. In Regs4ships, large language model tagging maps new legislation to operational realities within hours of publication. These systems illustrate a wider trend, where data still describes the past, and can help you anticipate the future.

Environmental and regulatory intelligence converge with operational data in the same environment. For example, OneOcean's EnviroManager+ visualises more than 78,000 regulated transit zones across 182 nations, linking them directly to voyage plans so that officers can foresee compliance boundaries before they are crossed. As Jeremy Daoust explains, data flows give crew the ability to understand

the voyage at a deeper level and make decisions accordingly. "Context turns compliance data into something operationally useful, giving teams the confidence to act quickly and correctly," he says.

Across the industry, solutions like FleetManager consolidate performance, routing, and compliance feeds into unified dashboards. This integration ensures that decisions are not only faster but consistent across departments, aligning environmental goals, charter-party obligations, and financial performance within one analytical framework in addition to better alignment and decision-making by connecting vessel and shoreside teams.

Challenges

Even as analytics capabilities advance, two obstacles, data quality dependency and human trust, persist. These have been explored in previous domains, but it is important to reflect on how predictive systems are only as good as the data that feeds them.

Where upstream processes remain fragmented, advanced analytics risk amplifying noise rather than insight. Incomplete fuel or emissions records can skew optimisation algorithms and inconsistent noon report formats can distort benchmarking models.

The second challenge is cultural. Many maritime organisations still separate digital tools from operational judgement, leading to duplication or hesitation. Shoreside teams may distrust algorithmic recommendations. Onboard crews may see analytics as external oversight rather than collaboration. Bridging that divide is essential to realising the promise of digitalisation.

A further issue lies in integration. Without open APIs and shared data models, good information still becomes trapped within proprietary systems. This limits insights, performance or independent verification across fleets. The result is an ecosystem of partial truths rather than a unified operational picture.

Solutions

The best-prepared fleets show what data-driven decision-making can achieve when these challenges are addressed through integration, transparency, and accountability.

OneOcean's suite of tools link voyage planning, compliance management, and performance oversight in a single environment. Shoreside teams can gain live situational awareness through tools like FleetManager, which connects directly to onboard systems to visualise voyage data. By merging operational, regulatory, and commercial data, these systems replace reactive decision-making with predictive control.

The next evolution is explainability. Predictive models should be chosen not only for their ability to highlight anomalies or articulate risks, but because they are able to show the logic behind the output. It's important that users are able to validate AI outputs and act on them with confidence – OneOcean has built and deployed AI and machine learning concepts for more than 20 years. This balance of machines bringing patterns to the surface, with humans retaining the ability to understand the context, is what will ultimately support trust in automated data support.

As digital systems automate routine data input and validation, crews can focus on higher value operations and problem-solving. Access to transparent data improves engagement and retention, making technology a differentiator for the next generation of maritime professionals.

“We go to great lengths to ensure that our outputs stand up in arbitration. There’s no hidden bias and we avoid practices like ‘double dipping’ on fuel claims that could undermine credibility. If our clients end up in a claims dispute, our data must hold up.”

Barry Hooper

VP Product and Technology, OneOcean

Finally, more mature operations close the loop by feeding outcomes back into collection and validation systems. Every voyage becomes an opportunity that can help refine the next one in a continuous cycle of data collected, validated, transferred, and processed, returning as actionable intelligence. This feedback cycle is what will make digital transformation sustainable rather than episodic.

Having established current trends, challenges, and solutions across the data lifecycle, next we look at how the maritime data ecosystem will evolve into the near future, and what future readiness will mean for organisations seeking to lead rather than follow.

Case Study:

Data-driven condition-based maintenance with NYK



Across a 15-year fleet sample, vessels equipped with LR's data-Driven Condition-Based Maintenance (DCBM) framework recorded more than 30% lower cumulative maintenance spend than comparable ships using conventional, calendar-based routines. The savings were consistent across lubrication, repairs, spare parts, docking, and survey costs, and widened as the vessels aged.

This was the result of a multi-phase collaboration between NYK, LR, and the Monohakobi Technology Institute, which set out to transform conventional Condition-Based

Maintenance into a data-driven practice. The project combined sensor integration, real-time data acquisition, and machine-learning diagnostics to extend asset life and reduce operating expenditure.

As LR's Digital Advisory team notes elsewhere in this report, achieving similar results requires an integrated digital strategy that aligns technology, governance, and business objectives; something smaller operators can build progressively through the same data-driven principles.



The future for maritime data

Data as a competitive advantage

Data is an operational imperative. Initiatives such as EU ETS, FuelEU Maritime, and the IMO DCS give owners, managers, charterers and operators the impetus to gather detailed, verifiable performance data. The companies with the greatest advantage are those treating this information not just as a reporting obligation but as business intelligence.

Barry Hooper believes this is a turning point. "Compliance used to be the goal. Now it's the baseline. Companies are using verified data to optimise operations, manage exposure, and improve margins," he says. Jeremy Daoust notes that interpretation, not collection, is where the competitive edge lies because, "everyone collects data. The question now is who can turn it into faster, better decisions."

Digital maturity depends heavily on alignment between data and business strategies. Pranav Kumar notes that, "over half the companies we engage with have a digital strategy, but in most cases it isn't aligned with their business goals."

"A digital strategy that isn't embedded in the business strategy risks becoming shelfware. When the two are aligned, every data point starts earning its keep in operational, commercial, and compliance terms."

When data programmes are embedded in commercial planning, verified datasets become a source of both compliance assurance and measurable return on investment.

Bounded automation

AI, automation, and cloud integration expand what verified data can do, but they only work as well as the governance behind them. Jeremy Daoust cautions against seeing automation as a cure-all: "AI is not magic; it's applied logic trained on good data." Transparency and explainability remain the foundations of trust. "If the inputs are fragmented, you'll automate the wrong conclusion," says Barry Hooper, from his experience with machine-learning vessel models.

Connected ecosystems and collaboration

Shipping has always been an interconnected value chain of shipowners, charterers, ports, class societies, regulators, and others. But digital transformation has often unfolded in isolation. Each stakeholder has digitalised their own processes without aligning the standards, interfaces, or objectives that connect them. That is beginning to change.

Barry Hooper stresses the importance of standardisation. "You own your data, but its value grows when it can move cleanly between systems." According to Roger Cornish, "Collaboration doesn't

mean exposure. Owners need confidence that shared data won't compromise commercial privacy." Clarity on these issues will be a key feature of the next few years.

Those who manage data ownership, flow, and purpose will shape how the industry evolves. Data has a tangible value. "AI needs data, and data needs a home," Daoust explains. "Our goal is to create data gravity for customers, where their verified datasets become the centre of their digital universe."

"Know the value of your data and understand the difference between ownership and a licence to use it"

Roger Cornish

In-Service Product Manager, Lloyd's Register

Barry Hooper describes this new phase as, "a digital ecosystem where class, technology, and operations finally speak the same language." The advantage, he explains, lies in proximity. Secure data sharing will define the next phase of collaboration. As regulatory and commercial networks interlink, owners will need confidence that their data can move freely without losing control of its use or provenance.

Jeremy Daoust points to open APIs as a key piece of architecture in this evolution. "Integration is not optional anymore," he says. "If you can't connect outwards, you will begin to struggle. The future will likely favour companies that make data exchange simple, transparent, and trustworthy for governments and trade partners."

Roger Cornish says cultural factors will continue to play an important role. "Technology partnerships only succeed when people trust one another's intent as much as their systems."

Cyber-resilience

The same data connectivity that enables intelligence also creates exposure. Every new interface, application, or integration point becomes a potential vulnerability. Cyber resilience will have a significant impact on the future trajectory of maritime data capability.

Currently, cyber resilience differs across the maritime sector. The LR DMI scores paint an improving picture with cyber security increasing to 3.01 / 4 in 2025, representing the second most mature of the five pillars beneath connectivity.

However, recent research by Thetius, Cyber Owl, and HFW offers some cautionary exceptions. Their report suggests that only one in six shipowners can recognise what a cyber-secure vessel looks like on delivery, and only 17% of shipyards have in-house cybersecurity expertise. Half of marine equipment manufacturers have faced a cyberattack in the past year, showing how risk extends through the entire supply chain.⁶

The human dimension also remains decisive. More than nine in ten crew members feel under-prepared for cyber incidents (Thetius, 2024). Roger Cornish points out that "technology fails safely when people are trained to respond," while Pranav Kumar adds that risk and resilience must be considered long before implementation: "Every digitalisation effort should include a structured risk assessment and consultation with insurers, class, and regulatory experts."

The decade of integration

Barry Hooper reflects on the logical destination of the industry's evolution. "We've built the plumbing," he says. "Now it's about what flows through it and making sure data moves between class, owners, ports, and regulators with the same reliability as any other form of infrastructure."

Jeremy Daoust foresees a similar convergence. "We'll stop talking about digitalisation as a separate discipline," he predicts. "It will simply be how shipping works. When data is standardised, trusted, and transparent, you can focus on the decisions made possible."

For Roger Cornish, leadership will determine how fast the sector moves. "The technology is ready," he says. "The question is whether boards and bridge teams are ready to lead with data, and to make it part of the culture."

The only certainty in maritime is more change, which means that decisions taken now are critical because they will endure for 15-25 years, the life of your vessel.

⁶ Thetius, CyberOwl and HFW (2024) The Lifecycle Dilemma: The Realities of Maritime Cyber Security Across the Vessel Lifecycle. London: Thetius Ltd. Available at: <https://thetius.com>

Recommendations

The coming era will transform digitalisation from a set of parallel efforts into a unified maritime data ecosystem. The fleets that master this transition first will not only meet regulation and improve their reporting, but will likely influence the next chapter of maritime progress.

Success will depend on how well the industry consolidates its gains from the first decade of digitalisation and applies them consistently across the next. The following recommendations consolidate the key findings of this report and outline some practical steps organisations can take to achieve digital maturity with confidence and credibility.

1

Prioritise governance to avoid costly errors.

From noon reports to ETS submissions, inconsistent formats or missing timestamps can derail verification. "Governance is what makes data actionable," OneOcean's Jeremy Daoust reminds us. Embedding governance from collection to use ensures that data remains trustworthy and defensible at every stage.

2

Unify compliance and commercial planning.

EU ETS, FuelEU, and GFI affect voyage margins as much as they shape reporting. Treat emissions exposure as a core KPI which is managed alongside cost, routing and charter party performance.

3

Build for open integration.

Avoid data silos by choosing platforms that support APIs and industry standards such as SVD and Energy LEAP Vessel Emissions Reporting Standard (VERS). This ensures data can move across systems, teams, and partners without duplication or re-entry.

4

Deploy AI only on clean, contextualised data.

AI and machine learning deliver value when fuel, voyage, and emissions data are accurate and structured. Invest in high-quality data pipelines, and AI-based solutions for predictive compliance, forecasting, or optimisation.

5

Ship managers: invest in structure to reduce burden.

Ship managers often carry the heaviest load from poor data. Unified strategies that replace manual reconciliation with structured workflows cut reporting effort and free time for operational priorities.

Recommendations

6

Choose partners aligned with verification standards.

Select digital providers whose outputs reflect verifier expectations. This ensures submissions stand up in arbitration, reduces compliance friction, keeps updates aligned with evolving regulation, and helps maintain a more competitive fleet.

7

Integrate digital and business strategy from the outset.

Digital projects developed in isolation underdeliver. Align investments with commercial objectives so new systems generate the right data, in the right format, and can scale with regulatory and market change so digital initiatives link to business objectives, quantify return on investment, and ensure every data-driven decision contributes directly to operational and commercial outcomes. As Pranav Kumar, LR Global Advisory Lead - Operational Excellence, explains, "digital strategy is not an add-on, and it should reflect the business strategy executed through data."

8

Invest in traceability and audit trails.

Metadata, provenance, and auditability are as important as the data itself. Without them, verification is delayed and trust is lost. With them, maritime organisations can prove compliance and defend positions with confidence.

9

Anticipate overlapping regulatory exposure.

The same tonne of CO₂ may fall under multiple regimes (EU ETS, FuelEU, GFI). Model exposures across all likely frameworks to avoid unexpected liability and strengthen commercial planning.

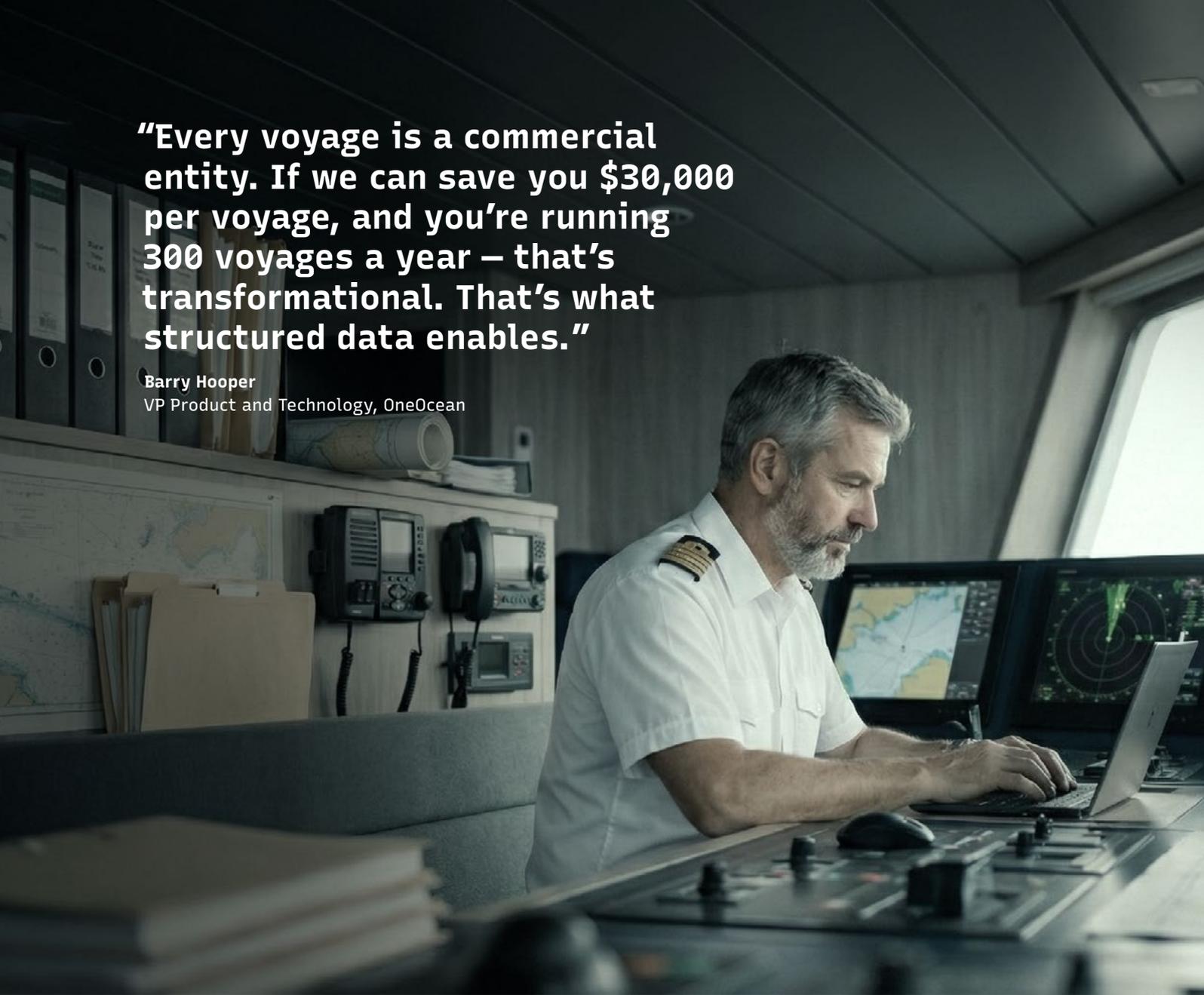
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Address the last mile of data transfer.

APIs and digital pipelines mean little if regulators still require manual uploads or XML files. Build processes to manage these analogue stages reliably to prevent delays during critical compliance windows.

“Every voyage is a commercial entity. If we can save you \$30,000 per voyage, and you’re running 300 voyages a year – that’s transformational. That’s what structured data enables.”

Barry Hooper
VP Product and Technology, OneOcean



The maritime sector has laid the foundations of connectivity, assurance, and collaboration. The challenge is to use them coherently, making trusted data the connective tissue of compliance, efficiency, and innovation.

LR and OneOcean support you through that journey. With the right data, tools, expertise, and strategy, the maritime sector can do more than adapt: it can lead.

Contact OneOcean today to learn how your business can benefit from digital solutions that provide the right data, manage it effectively, and use it to enhance compliance, commercial performance, and business outcomes.

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