TECH mahindra

Whitepaper

# MARITIME 4.0 FOR MANUFACTURING AND VESSEL OPERATIONS

## Voyaging through the 4th Industrial Revolution

# Abstract

With the shifts in customer needs and a growing demand for future proofing in the maritime industry, manufacturing and operations of vessels need to adapt to the new paradigms. Those that build, operate, and maintain the most adaptable, cost-effective, connected, and sustainable vessels are the ones who would define the future. But how do organizations get there? This is where the fourth industrial revolution is transforming traditional maritime into maritime 4.0.

Maritime 4.0 promises to transform the ship manufacturing facilities into 'smart shipyards' that enables them to create 'smart vessels' which have improved effectiveness, efficacy, and quality. It brings in the necessary digital levers that have started disrupting the business-as-usual for maritime in multiple dimensions.

This whitepaper talks about ways in which the necessary evolution can be brought about in vessel manufacturing and operations. The role of vessels would get transformed from being a central mechanism to an enabler of value creation. Everyday activities like vessel maintenance would ride the path of innovation and leverage latest technologies to deliver a much better value.

# Key Takeaways

# Introduction

Traditional methods of shipbuilding and operations would not stand the test of time. Vessels are gradually getting outdated, as they are not capable of adapting to changing business models and keeping up with the race from peers. Engineers, shipbuilders, and ship operators need to address the challenge of futureproofing of vessels head-on by exploring ways to leverage new technologies and derive better value from investments.

The technology-based innovation introduced by the maritime 4.0 paradigm would propel the future maritime ecosystem where innovation-driven manufacturing would create smart vessels characterized by new design principles and operational capabilities, that will replace traditional vessels, in a fully connected ecosystem. The other side of the coin is the need for safety and sustainability. Ship owners need to avoid situations like what happened in 2021 when the container ship 'Ever Given' got stuck inside the Suez Canal causing an estimated trade loss of 54 BN USD . Regulatory bodies bring in their environmental constraints, like the 0.5% global sulphur cap by International Maritime Organization (IMO) effective from 01-Jan-2020 which has mandated design and operational parameters of vessels.

Empowered with digital hardware like sensors, actuators, processors, computing systems, and digital technologies like IoT, big data, analytics, cloud computing, artificial intelligence, APIs, the 4th industrial revolution has started bringing about a lot of innovation on vessel design / manufacturing, maritime transport, vessel maintenance, chartering, vetting, route/load optimization, safety, navigation, and monetization.

The disruption would revamp three industry segments:

- **Core industries** - Shipbuilding, ports, energy, waterways, chartering
- **Subsidiary industries** - Spares, financial services, maintenance, repair
- **Dependent industries** - Fishing, tourism, logistics, sports, retail

# Transforming the Maritime Industry with I4.0

## Evolution for different pillars of the maritime industry

The application of the principles of the fourth industrial revolution in the maritime industry brings in Maritime 4.0, which is characterized by the IoT and the IoS. This transformation incorporates future-oriented digital technologies, that employs digital principles to the physical world, and improves the integration between the physical and the digital world.

A comprehensive effort is required for various sectors of the maritime industry to design / build future-ready vessels, operate them in a 'smart' way by application of digital technologies, and gradually journey towards Maritime 4.0. The data collected from myriad journeys is integrated, stored, shared, and used for continuous evolution. In the next section, we discuss the application of digital on important maritime pillars.

## Design and Shipbuilding

Vessel design and shipbuilding heavily relies on knowledge from past projects. Vessel design needs to be future-ready and needs to take care of the vessel class. The shipbuilding process needs to combine design principles, inherit usage data from the past, and be automated. This can be done by adopting the digital thread approach.

Various digital technologies like data lake, data science, intelligent simulation, analytics, robotics, additive manufacturing and AR-VR can be used for design and shipbuilding. 3D imaging tools can be used for a better design that complies with classification standards. Engineering simulation would help in testing of vessels.

## Operations and Maintenance

To improve operational availability and obtain lower operating costs, the maritime industry needs to capitalize on the sea of data available from the entire vessel enabled by sensors/IoT, by transitioning to a fully integrated approach of ship service and maintenance. This can be enabled by having the digital product and process twin in place.

An extended asset life and better availability can be obtained when operational data is captured into a data Lake then baked with digital levers to produce actionable insights, that enables cognitive and predictive vessel maintenance. Asset management strategy needs to be categorized based on different class of vessels, for instance, the bulkheads classification 'A', 'B' and 'C'. Knowledge upgrade and necessary certification for the support staff also need to be done at required levels.

## Communication and Navigation

Critical data belonging to the vessel, voyage, performance, crew / passengers, and safety need to be sent to the control centre close to real-time. Connects with the other vessels nearby needs to be maintained. A hybrid ship-to-shore and ship-to-ship connectivity that uses the combination of a robust surface GSM (5G preferred) and a satellite-communication service would provide the network of the future.

Intelligent navigation would allow real-time tracking and positioning of vessels in transit. This would enable route optimization, help collision avoidance, provide information display, enable monitoring/alerts/communication, and ship management.

## Cyber Security and Knowledge Management

Ship-owners need to have a cyber maturity model in place. They need to conduct vulnerability assessment of IT and OT assets, network architecture and firewall review, and penetration testing of applications. The gap analysis report needs to be used to improve network segmentation and zero trust, risk and vulnerability management, threat detection and response, SOC integration, and centralized management.

Knowledge is retained with skilled people, and tribal knowledge evaporates with retiring workforce. The industry needs to adopt digital knowledge management, which is the process of digitally identifying, collecting, documenting, organizing, and centralizing organizational knowledge. The content needs to be created and curated as per the audience groups, and the rendering needs to be multi-channel and device-agnostic, with access control.

### Voyage Planning and Capacity Optimization

Voyage planning needs to provide a fully digital workflow, enhance decision-making through AI, reduce risk through customization, and leverage the maritime data collected in the past. Visualization should include passage planning, route generation, weather dependency, safety checks, and scenario evaluation (like political unrest, blockades).

In the I 4.0 framework, the primary objective of the supply chain is a complete end-to-end visibility of all types of cargo. The paradigm being followed is LARG - lean, agile, resilient, and green. A big data platform that acts as a single source of truth, along with AI and ML algorithms would enable more efficient planning, capacity utilization, logistics and visibility.

### Telematics and Fleet Management

The basis of modern-day fleet management is telematics, which is a combination of telecommunication and informatics. Fleet telematics gathers a range of data using global positioning system (GPS) technology, sensors and vessel engine data to provide fleet operators with the information they need to manage their fleet.

Telematics is changing fleet management by enabling tracking of vessel health, optimization of route, improved vessel utilization, fuel cost minimization, port call optimization, scheduling of maintenance, dry-docking, risk management, and performance monitoring. Ship operators can deploy tools that provide a more accurate ETA. This helps deployment of vessels with appropriate capacity on various voyages and maximize the utilization.

### Port Berthing and Turnaround

Optimized turnaround enables minimum lag between individual port operations. Consolidating the data for port planning into a central platform provides a single source of truth, where machine learning(ML) algorithms help to provide a better predictability for vessels, terminals, and service providers.

Effective berthing plans minimize the waiting time before and after port operations. Simulation of the entire port and data modelling is necessary to cater to many use cases. Real time data from port resources, like cranes / quayside structures / refueling stations, are fed into the platform continuously. Artificial intelligence (AI) and machine learning (ML) algorithms allocate appropriate resources to the vessel and enable suitable berthing plans to be created.

## Safety and Sustainability

Maritime 4.0 technologies are scaling up to address vessel safety. Using augmented reality and simulation in ship design makes the vessel better prepared. Autonomous guidance and navigation technologies help preventing collisions. A robust framework comprising of internet of things (IoT), data-driven technologies, real-time analytics, advanced tracking and tracing, intelligent systems, and cloud computing are essential for a better safety.

Pollutants include plastic, oil, toxic chemicals, sulphur dioxide, greenhouse gases, ballast water, radioactive waste, sewage and underwater noise. Different applications of computer vision and remote sensing, along with GIS and decision support systems, can provide sophisticated methods for monitoring marine pollution, plastic litter, and algal blooms. Sensing systems use digital interventions like AI, ML, neural networks, and data analytics, to measure multiple parameters.

## Autonomous Vessels

Autonomous vessels are gradually becoming a reality. Advanced technology interventions like IoT, AI, ML, GPS, and computer vision are allowing vessels to be controlled from a remote-control centre, thereby enabling autonomous navigation and sailing. GPS positioning is key for navigation, which enables the vessel to move in a predetermined route and dock at the intended location.

The maritime industry proposed a variety of taxonomy to represent different level of autonomy, starting from level zero with no autonomy, to level six where vessels are fully autonomous ships capable of decision making and execution without human intervention. The IMO has classified 4 levels of autonomy.

## Utilization and Monetization

Technology-led innovation has the potential to introduce a dramatic effect on how the maritime industry does business. Connected technologies such as the IoT, bigdata, AI, APIs, and sensors, are creating a smart marine ecosystem to weave smart business models for customers. Typical examples could include using cargo ships as floating warehouses that travel around the world and serving multiple geographies, or tugboats being also used as charging stations.

Measuring and enhancing customer experience [CX] is critical for a continuous improvement of business models, be it cruise or logistics. Products, assets, and services need to capture real-time data, that would be used for actionable insights and marketing events. Personalization and quicker on-boarding of customers is important.

## A unified data ecosystem across myriad journeys

Today, in the maritime industry, it is important to make faster and more accurate decisions to gain a competitive edge. The data and the underlying decision-support technologies are key to this. Data volumes and frequencies are growing every day. This creates opportunities, but also challenges in terms of how to extract high value. Downstream systems are only as good as the data that is going into them.

Different kinds of data across the different stages of a vessel's life, right from the design stage, are valuable for future interventions like ship building, operations, safety, asset health predictions, decision making, voyage planning, utilization, and emission control. Managing the data in a strategic way is necessary to build a connected ecosystem that delivers the necessary insights to support and enhance all business processes and provide monetization opportunities.

Let us look at the different categories of maritime data and understand the high-level strategy of managing that.

### Data collection from different journeys across the entire life of the vessel

By bringing together all product information and processes into a centralized data management system, shipbuilders and owners can effectively manage the complexity of their ships' lifecycles and be agile enough to respond to the future market, regulatory, and technological changes. The various sources of data include sensors/IOT, transactions, third party systems, partners, and social media.

**Ship Design**

**Shipbuilding**

**Ship Launch**

**Voyages**

**Berthing**

**Cargo Loading**

**Maintenance**

**Canal Transit**

**Transactions**

### A transformation strategy on the unified data ecosystem derives wisdom

Having a single source of truth is key to success. Managing the data throughout the lifecycle of the vessel is critical. The maritime industry is evolving to take advantage of the latest technological advances in managing data and deriving wisdom out of it. Each milestone provides a new set of insights which can help evolve the future journeys. A schematic representation of the data management is provided below. The derivation of intelligence is enabled by various digital levers that are mentioned on the next page.

**Identification and Acquisition**

**Ingestion and Structuring**

**Organizing and Processing**

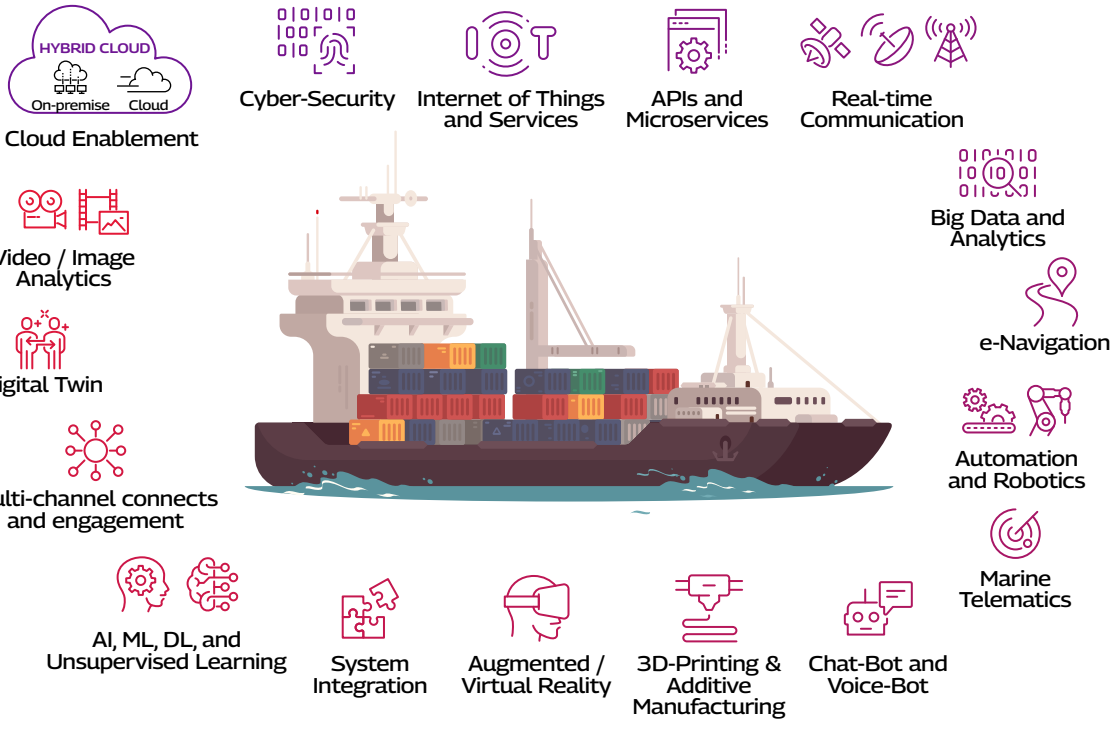
**Intelligence Derivation**

**Visualization and Triggers**

**Security and Governance**

## Disruptive digital levers contributing to Maritime 4.0

The spectrum of digital levers that have started bringing in the evolution for Maritime 4.0 are provided in the diagrammatic representation below. These would need to be deployed in a collaborative manner, depending on the use-case in focus.



# Conclusion

The maritime sector is constantly under the influence of emerging technologies and intense competition. Manufacturing the future-ready vessel, and operating it in a smart way, is a process of evolution that has started, and would get better with time. This is being enabled with the magic wand of maritime 4.0, powered by digital technologies, which is crucial in bringing in the necessary evolution in design, manufacturing, operations, safety and sustainability.

A bright example of today's trend is the high efficiency ro-ro [HERO] vessel of Wallenius Wilhelmsen which is their latest technology vessel with innovative features, increased capacity, reduced emissions, and better fuel efficiency. The features, flexibility and adaptation to latest business models are making today's vessels smart and future ready, thanks to the technology levers brought forth by the fourth industrial revolution.

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Debashish has more than 20 years of experience. He has a B.Tech (Hons.) from IIT-Kharagpur and is a 'senior management professional' certified from IIM-Ahmedabad. He has been a part of various growth programs for focused accounts across the globe on various industry verticals that include payments, retail, distribution, ecommerce, supply chain, manufacturing, travel, transport, logistics, utilities, healthcare, public services, and BFSI. His earlier avatar includes solution architecture, delivery management, consulting, service delivery, and ownership of top-line growth and bottom-line optimization, with engagements on Waterfall and Agile, and account sizes of up to 60MN USD. At times, he loves to put on the 'techy' hat and go that extra mile, which has been aptly demonstrated while creating the retail business insights leaderboard single-handedly for a customer at Kenya.

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