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Maritime Insurance and Liability in a Changing Risk Environment in India

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ABSTRACT

A unique convergence of the technological revolution, the ambitions of the shipping sector towards decarbonization, and geo-political tensions are unbalancing the Indian shipping industry and forcing change. The incorporation of Artificial Intelligence in autonomous ships, smart ports, and the vision outlined for Maritime India Vision 2030 and at key terminals such as JNPT and Adani Mundra, shifts the locus of liability in tort from human error to complex product and software liability. The maritime shipping industry's use of ammonia and hydrogen as alternative fuels to decarbonise the industry will almost certainly pose new, unquantifiable risks, and thus, unparalleled underwriting challenges for underwriters in India. These risks are largely a function of unquantifiable fire and loss histories. The risks created by the decarbonised, unmanned shipping vessels and the extended use of unmanned aerial vehicles (drones) in the shipping sector will magnify the limitations posed by the Marine Insurance Act, 1963, the underwriting and indemnity legal canon of shipping which inscribed the legacy of the fossilised and manned shipping industry.

To ensure a healthy Indian maritime environment that is still insurable in the age of unprecedented transitional change, it is therefore essential that Indian insurers, regulators technologists and lawyers work together to develop innovative insurance products, responsive underwriting programs, and new domestic legal frameworks that can provide certainty and clarity.

Keywords: *Insurance, Artificial Intelligence, Technological innovation, Decarbonisation, Underwriting, Liability, India, Marine Insurance Act 1963.*

I. INTRODUCTION

A. The New Trilemma: Navigating Technology, Decarbonization, and Geopolitics in Indian Maritime Trade

The ambitious Maritime India Vision 2030 (MIV 2030), which seeks to elevate the nation to the status of one of the world's leading maritime hubs, is driving the Indian shipping industry

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to the brink. However, this new path is being negotiated over the choppy seas of what can be referred to as the "New Trilemma": the connected and contemporaneous strains of geopolitical instability, the green imperative (decarbonization), and technological disruption (autonomy and artificial intelligence). India's economy is especially vulnerable to these conflicts because over 95% of its merchandise trade volume is mostly dependent on the sea.

As evidenced by the launch of "smart port" projects at prominent terminals like Jawaharlal Nehru Port Trust Deendayal Port Authority (Kandla) and leading private sector innovators like Adani Mundra, technology is promising cost savings, efficiency, and sophisticated logistics. However, the combination of information technology with operational technology introduces a greatly increased surface area for systemic risk, especially cyber-physical attack. At the same time, the global push for Net-Zero emissions puts Indian shipping on the route away from methanol and LNG and toward the more risk-advantaged frontier options of hydrogen and green ammonia. By removing a carbon issue, these substitutes create completely new toxicity, flammability, and containment risk profiles that are just too expensive for current risk models.

Lastly, Indian carriers bear a financial and physical cost as a result of the growing geopolitical unrest, which includes fighting in the Red Sea and Arabian Sea as well as shifting global power dynamics that affect important commerce chokepoints. The scope of standard insurance coverage is constantly being expanded, supply chain schedules are getting longer, and war risk and piracy premiums are rising. According to convergence, a marine catastrophe nowadays is almost often a complex one involving algorithmic failure, data loss, and new kinds of environmental contamination rather than a collision or running aground.

B. Problem Statement: The Increasing Obsolescence of India's Current Maritime Insurance and Legal Frameworks

India's maritime law is essentially based on the Marine Insurance Act, 1963 (MIA 1963), and concepts drawn from 19th and early 20th-century English common law. This system is marked by a backward-looking, fault-based system designed for human-oriented maritime operations and recognized physical perils.

This legacy system suffers on three key fronts:

1. Causation and Liability: Proximate cause principles have difficulty identifying fault in automated accidents in which the chain of causation involves proprietary software, outside data feeds, and intricate sub-systems. Who is responsible when an AI has made a killer mistake? The absence of clear domestic direction produces gigantic judicial uncertainty.

2. Regulator Under-Preparation: The Directorate General of Shipping (DG Shipping) has not

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made any explicit laws or regulations on safety and operational requirements for autonomous ships or new fuels.

3. Insurance Exclusion and Ambiguity: Standard insurance policies are based on general London market provisions, especially Protection & Indemnity (P&I) and Hull & Machinery (H&M). The Institute's Cyber Attack Exclusion Clause's scope and the ambiguous language pertaining to new environmental harm in general result in a gap. The adoption of future-proof maritime technologies in India is limited because risks are either explicitly excluded or have coverage that is unclear due to weak definitions.

C. Thesis Statement

The Indian shipping industry needs to quickly transition from its adherence to a static, outdated compensation structure to a predictive, data-driven, and forward-looking approach to risk management. The shift is necessary for global competitiveness and regulatory assurance in addition to financial sustainability. The change includes:

- Harmonization of Laws: The immediate updating of the MIA 1963 and the use of tailored legislation to combat cyber, product, and algorithmic risk.
- Technology Integration: In order to perform real-time risk assessment and replace static one-time premiums with dynamic real-time underwriting, it is necessary to utilize IoT, Big Data analytics, and machine learning.
- Ecosystemic Synergies: Forming a codified business and regulatory partnership between legal authorities, technology companies, shipping regulator DG Shipping, and insurance regulator IRDAI in order to work together on a strong, shared risk framework.

II. THE SHIFTING MARITIME RISK ENVIRONMENT IN INDIA

A. Technological Disruption: The Arrival of AI in Autonomous Ships and "Smart Ports"

Algorithmic risk is introduced by AI-enabled systems like machine vision, remote diagnostics, and ultimate autonomy. This risk arises from "drift" in the AI model's performance over time, bias in the training data leading to poor decisions, or non-malicious software code failure. Because a single software program or sensor type may be utilized throughout the fleet, there is a systemic risk of a catastrophic simultaneous failure.

The most important risk categories are:

- Cyber-Physical Cascades: An intrusion that starts in the IT network (like admin systems)

and spreads to the OT network (like cargo cranes and ship propulsion). The world's standard is still the 2017 Maersk NotPetya assault, which demonstrated the serious BI (Business interruption) damages that can render an Indian port inoperable.

- Integrator Liability: Dozens of subsystems from numerous suppliers are used by 90% of the newest ships.
- Liability for Data Breach: Smart logistics entails exchanging vast amounts of private company data. The breach carries penalties and third-party litigation several orders of magnitude larger than those associated with classic maritime dangers under India's comparatively new data protection legislation.

B. The Green Imperative: Analysing the Unmeasured Risks of Alternative Fuels

- Toxicity and Flammability Profile: Ammonia requires specialized high-pressure storage and containment systems due to its high toxicity (posing a major inhalation threat) and corrosive nature. A spill in a bigger port, like Chennai or Mumbai, may constitute a public health emergency. Although hydrogen is cleaner, it must be handled cryogenically or at extremely high pressure, is highly combustible, and requires significantly different bunkering and vessel design. Major port trusts in India now require significant infrastructure upgrades and, most importantly, specialized Emergency Response Procedures (ERPs) for these currently underdeveloped materials.
- Environmental Liability Multiplier: Conventional pollution limit restrictions, which are typically derived from oil pollution conventions, are undoubtedly insufficient to address the severe, regionally focused catastrophic harm brought on by a significant ammonia leak inside an ocean ecosystem. Claims for ecological harm and expenses related to public health might easily surpass P&I limits or present contributions to the International Oil Pollution Compensation (IOPC) fund. Second, the cost of assessment and mitigation is unpredictable due to the lack of standardized worldwide cleanup procedures for these novel chemicals.
- Class Risk and Vessel Modification: It takes sophisticated engineering and significant structural alteration to convert older ships to utilize new fuels.
- Insurers and Classification Societies (e.g., the Indian Register of Shipping - IRS) are rigorous in their examination. Failing to meet specialized class notations or failing to disclose modifications appropriately may lead to a breach of H&M policy warranties, such as voiding coverage on occurrence.

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C. Geopolitical Volatility: Regional Conflicts and Changing Trade Alliances

- War Risk Exclusions and Grey Zones: General H&M and P&I policies across the board exclude loss, damage, or liability arising from War, Civil War, Revolution, Rebellion, Insurrection, or hostile action by or against belligerent power. War risk insurance is bought independently in an unstable market. More recent events like attacks on merchant ships in the Red Sea or the Arabian Sea frequently exist in a "grey area" where the attackers' identity and the official classification of the conflict are not clear-cut. The resulting uncertainty initiates legal disputes regarding whether a claim is covered by the basic policy or the war risk policy.
- Sanctions Compliance and Trade Restriction: India's complex trading relationships have strict requirements to comply with global and unilateral sanctions regimes. Insurance on a ship or cargo can be forfeited if a trade is discovered to be sanction breach, even unintentionally. Indian shipping operators require robust digital compliance platforms to mitigate this financial and legal risk.
- Delay and Disruption of Supply Chain: Geopolitical conflicts create significant routing adjustments (e.g., avoiding the Cape of Good Hope). Though cargo insurance can cover physical loss, it is often non-covered for delay unless due to an insured cause. The huge financial losses due to delay and resultant market volatility are to a great extent uninsured, placing systemic financial pressure on Indian EXIM trade.[3]

III. Shifting Liability: From Human Error to Algorithmic and Product Fault

A. Recasting "Perils of the Sea": Cyber-attacks, Software Failures, and Data Breaches as Emerging Maritime Risks

Marine Insurance Act, 1963, Section 51, defines "perils of the sea" to mean "fortuitous accidents or casualties of the sea." This is a definition which is intrinsically concerned with the physical environment.

- Cyber as a Proximate Cause: The most important legal issue is whether a cyber-attack that results in a physical impact (e.g., computer system failure resulting in a collision) qualifies as a fortuitous accident and hence an insured cause, or is an excluded cause under the Institute Cyber Attack Exclusion Clause (extensively used by Indian insurers).

[3] Agrawal, V., 2024. Comprehensive Analysis of India's Maritime Laws: Examining Insurance Impact and Geopolitical Dynamics. *Issue 3 Int'l JL Mgmt. & Human.*, *7*, p.3411.

Judicial precedent is limited and contradictory worldwide. A landmark case such as the "The CMA CGM Libra" (UK) established the significance of due diligence in navigation. In the virtual world, cyber-seaworthiness should be dealt with as an element of due diligence. In case the owner did not update with obligatory security fixes, the cyber-attack leading to collision could qualify as an excluded loss since the owner violated the implied warranty of seaworthiness.

- Software and Sensor Malfunction: A malfunction of a proprietary sensor resulting in navigational error is an engineered, latent flaw. According to conventional H&M policies, this could be insured under the Inchmaree Clause (latent defect in machinery) provided the flaw was not discoverable through due diligence. This clause, however, was intended for mechanical malfunction, not software code. Contemporary systems necessitate the formulation of a "Digital Inchmaree Clause" for explicit coverage of non-malicious algorithmic and software malfunctions.
- Economic Loss Due to Data Breach: Loss of data e.g., breach of proprietary commercial cargo manifests or logistics algorithms is an economic loss and is not within the purview of conventional H&M or P&I policies, which focus mainly on physical damage or third-party physical injury/property damage. This requires specialized Cyber Liability coverage that specifically addresses BI, forensic expenses, and regulatory penalties.

B. The Black Box of Liability: Challenges of Allocating Fault Among Shipowners, Software and Equipment Developers, and Manufacturers in Autonomous Accidents

1. The Operational Liability of the Shipowner: The shipowner is still the party responsible to third parties for collision, pollution, and loss of cargo. Their sole recourse would be to bring a product liability action against the equipment or software supplier.
2. Product Liability Against Tech Sellers: This is the most difficult path. To establish liability against the software manufacturer, the shipowner must establish the product was faulty. Indian legal discovery mechanisms may be insufficient to compel foreign tech firms to release such sensitive information. In addition, numerous software end-user license agreements (EULAs) have provisions that dramatically restrict or preclude liability.
3. The Algorithmic Black Box: Fault may not lie with the code itself in a Machine Learning (ML) system but with the training data or the live algorithmic decision-making process.

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Establishing that a particular ML algorithm was negligent is much harder than establishing that a human was negligent because he or she did not adhere to a procedure.[4]

C. Loss of Traditional Defences: An analysis of the Challenges to Traditional Legal Rules such as "Error in Navigation or Management of the Ship"

The age-old protection enjoyed by carriers under the Hague-Visby Rules (and Indian practice) for negligence in "the navigation or management of the ship" is being undercut to its core.

- Automated Negligence: The defence was introduced to strike a balance between the interests of the cargo owner and the carrier by pardoning the inescapable human weakness of the crew. Can an algorithmic judgment be interpreted as an "error in navigation"? Legal theorists contend that an autonomous failure is a flaw in the instrument (the machine/software), a non-delegable duty for which the carrier is always responsible, and it should be considered as unseaworthiness. If unseaworthiness is assigned to an AI error, the defence of the carrier is eliminated altogether, radically altering liability exposure.[5]
- The Non-Delegable Duty of Seaworthiness: Under the Hague/Hague-Visby regime, the carrier is under a non-delegable obligation to exercise reasonable diligence to make the ship seaworthy at the beginning of the voyage. In the autonomous age, this obligation needs to extend to 'cyber-seaworthiness' and 'system-seaworthiness.' A ship setting sail with antiquated software, unpatched security systems, or an untested AI model is arguably not seaworthy from the start.

IV. Comprehensive analysis of India's legal and insurance paradigm

A. The Marine Insurance Act, 1963: Assessing its Sufficiency in the Context of Non-Traditional Risks

- Outdated Principles: The Act's emphasis on *uberrimae fidei* (utmost good faith) must be thoroughly modernized to full disclosure of cyber-risk management.
- Inflexibility for Contemporary Products: MIA 1963 is strictly indemnity-oriented with a need for proof of measurable loss. This framework discourages the extensive utilization of parametric insurance, an indispensable instrument to hedge non-physical

[4] Rathod, P. and Mhaske, S., 2025. Navigating The Legal Currents–Marine Insurance's Role in Mitigating Oil Pollution Along India's Coastline. *International Journal of Humanities and Information Technology*, *7*(01), pp.8-13.

[5] Zhou, F., Endendijk, T. and Botzen, W.W., 2023. A review of the financial sector impacts of risks associated with climate change. *Annual Review of Resource Economics*, *15*(1), pp.233-256.

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risks such as catastrophic delay, when payment is initiated upon attachment of an agreed index (e.g., harbour closure for 48 hours). There is a need for a legislative update to allow the enforceability of marine insurance products that are not indemnity-based.[6]

- Jurisdictional Ambiguity: The MIA 1963 fails to offer precise guidelines about where a claim resulting from a software failure triggered outside India but resulting in damage in Indian waters should be adjudicated, making it difficult to enforce against foreign technology vendors.

B. International Conventions vs. Indian Law: Gaps in the Application of Rules such as Hague-Visby and the Unratified Rotterdam Rules

Liability Limits and Hague-Visby Rules: India is subject to a system of reduced cargo liability limits as a result of its non-ratification of the Hague-Visby Rules, which does not protect cargo owners from the reality of just-in-time, high-value supply chains. Multimodal transport is also made more challenging by the absence of a modern, standardized framework. Although not all countries have adopted the Rotterdam Rules, they do address the problems facing India. Regulations that specifically allow electronic records are essential for autonomous logistics and smart ports. In line with future integrated supply chains, such as those in Indian coastal shipping, they expand carrier liability periods to door-to-door operations, the entire logistics chain, and more. Compared to Hague-Visby, the Rules permitted higher liability limits. Due to India's non-ratification, its laws are incompatible with future paperless, multimodal transportation, forcing shippers and carriers to rely on awkward, patchwork contracts.

C. Constraints of Conventional P&I (Protection and Indemnity) Coverage: Scanning the Exclusions and Uncertainties for New Cyber and Environmental Liabilities

Mutual P&I Clubs are essentially risk-shy to unforeseen, disaster-type liabilities.

- Cyber Exclusion and Consequences: The International Group of P&I Clubs' default is to exclude the direct monetary loss of a cyber incident (e.g., ransomware, data recovery) but include the physical damage (e.g., oil spill or cargo damage caused by the attack). This distinction is no longer viable in cyber-physical systems. An owner who pays a huge ransom to recover possession of a ship is arguably preventing a physical loss, but the ransom is not covered. The uncertainty leaves the owner at risk for the worst financial threats.[7]

[6] Bennett, P., 2001. Mutual risk: P&I insurance clubs and maritime safety and environmental performance. *Marine Policy*, *25*(1), pp.13-21.
[7] Das, P., Singh, S. and Kalia, D., 2025. Rivers of Justice: Navigating Maritime Arbitration Practices in India.

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- Novel Fuel Liability Gap: The P&I market is based on historical records to price risks. There is no history of a catastrophic spill of green ammonia. The boundaries of P&I coverage are enormous but limited. In the case of an outbreak of high-toxicity, widespread pollution, Clubs would be compelled to make heavy calls for additional monies from members, with the potential to break the financial backbone of the whole maritime fraternity. The risk must be transferred either by way of a government-backed scheme or a specialist insurance consortium.[8]
- Uncertainty of Autonomous Manning: P&I conditions tend to be based on the vessel being "properly manned." DG Shipping needs to give precise regulations stating the minimum remote manning requirements for different levels of autonomy. In the absence of this regulatory clarity, a P&I Club can legally contend that an autonomous ship sailing under remote watch is technically 'improperly manned' in the event of an incident, enabling them to invoke a breach of condition and refuse cover. This regulatory void is the greatest solitary inhibitor to insuring Indian autonomous fleets.

V. CASE STUDY: AN INTEGRATED REALITY OF EMERGE RISKS WITHIN INDIAN WATERS

A. The Factual Background: The M.V. Chem Pluto and the New Geopolitical Threat

On December 2023, a merchant ship M.V. Chem Pluto, chemical tanker en-route to Mangalore port and owned by an Israeli-connected company, was hit by a suspected drone or missile some 200 nautical miles off the Veraval coast in India's Exclusive Economic Zone (EEZ). The attack left the ship physically damaged and on fire, but fortunately, no casualties amongst the largely Indian crew, so the ship was able to make its way to Mumbai for inspection and repair under escort by the Indian Navy.[9]

Although the Chem Pluto incident did not include AI failure or new fuel, it is a very compelling real-world example for the following emergent threats:

1. Geopolitical/War Risk in Grey Zones: The attack illustrates the proximate risk of wars beyond India immediately affecting Indian trade-dependent shipping routes, notably challenging the use of insurance War Risk conditions.

2. Cyber-Physical Attack: Although the attack was kinetic (physical) in nature, contemporary

In *Rivers Unbound* (pp. 55-66). Routledge.

[8] Dlugolecki, A.F., 2000. Climate change and the insurance industry. *The Geneva Papers on Risk and Insurance-Issues and Practice*, *25*(4), pp.582-601.

[9] Kimball, J.D., 2012. The Central Role of P&I Insurance in Maritime Law. *Tul. L. Rev.*, *87*, p.1147.

threats tend to include cyber targeting to incapacitate systems prior to a kinetic attack, or a cyber-attack itself replicating a weapon strike (e.g., disrupting GPS/AIS/navigation systems).

3. Ambiguous Causation: Whether the incident is within standard Hull & Machinery (H&M) coverage (accident by chance) or the extra-paid War Risks cover is the focal point insurance battle.

B. Analysis of Liability and Causation: Tracing the Liability in the Chem Pluto Incident

1. The War Risk/Exclusion Battle (The Proximate Cause Test):

- Challenge of Insurance: The Arabian Sea attacks are usually blamed on non-state actors or actors not duly recognized as "belligerent powers" in a declared war. The ship's insurer (H&M) and the War Risk underwriter are compelled to an expensive legal examination to establish the proximate cause. If the loss is then found to be a hostile act connected to a conflict, the War Risk underwriter settles.[10] If it is considered a "terrorist" act outside of an official conflict area, the use can be even more complicated, generally needing the Terrorism Exclusion Clause specifically, pricey clause to be overridden.
- India's Vulnerability: The attack compelled the Indian government and the DG Shipping to issue an urgent, defensive response, as it underlined the urgent need for unambiguous, uniform domestic regulations defining a "war zone" versus a "piracy/high-risk area" for ships flying the Indian flag and shipping in Indian waters, affecting premium rates and coverage directly.[11]

2. The Challenge of Limitation of Liability

While the incident was not a collision, were it to have led to a mass casualty or significant pollution (for example, if the drone crashed into a fuel tank), the vessel owner would attempt to cap their liability under Indian maritime law. But, if an investigation (by the Indian Navy and security agencies) revealed that the shipowner defaulted in its duty of due diligence, such as sailing without obligatory security measures in place, disregarding intelligence tips, or neglecting to equip anti-drone capabilities, claimants would be able to challenge the right of the owner to limit liability, seeking full compensation.

[10] Pavliha, M., 2010. Overview of Marine Insurance Law. *IMO International Maritime Law Institute (9–10 January 2010)*.
[11] Pandey, S.K., 2023. A Thorough Analysis Of The Issues And Solutions Facing Maritime Security And Marine Insurance Laws In The Twenty-First Century. *Russian Law Journal*, *11*(5), pp.209-218.

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C. Insurance Response: The Challenge to Traditional Indian H&M and P&I

The Chem Pluto case is a perfect stress test for the Indian insurance industry's overdependence on conventional indemnity models:

- H&M Insurer: An Indian H&M underwriter would have indemnified the physical loss, but their first interest would be to subrogate the claim to the War Risk underwriter. Of crucial importance is that the Business Interruption (BI) loss to the owner—the cost of detention, diversion to Mumbai, and delayed cargo delivery—is usually not insured under typical H&M policies. This economic loss is where a new, Parametric Insurance product (paying based on confirmed physical damage or security incident) is acutely needed.[12]
- P&I Club: The P&I Club's exposure would be mainly triggered in case of crew injury or pollution. Although there were no fatalities, the likelihood of a catastrophic pollution incident from a chemical tanker collision was present. International Group P&I Clubs are the only ones permitted to pool this risk, but the event highlights the systemic risk that one highly-complex geopolitical/cyber-physical incident can present to the solvency of the mutual system.
- The Uncovered Gap (Cyber): If the drone attack followed a successful cyber-attack that crippled the ship's automated defense or navigation systems, the owner would be immediately faced with the Institute Cyber Attack Exclusion Clause. The immediate loss (ransomware, systems repair) would be excluded, and the resultant physical damage claim would become a legal quagmire, perhaps leaving the owner with enormous uninsured losses.

VI. THE PATH FORWARD: A PARADIGM SHIFT TO PROACTIVE RISK MANAGEMENT

The required shift from mitigation to compensation requires a synthesis of technology, regulation, and finance.

A. From Static Premiums to Dynamic Underwriting: Using IoT, Big Data, and Predictive Analytics for Real-Time Risk Assessment

- Ongoing Risk Surveillance: IoT sensors should track engine condition, hull stress, fuel cleanliness/containerization, and, most importantly, the Cyber Security Posture (CSP)

[12] Thomas, D.R. ed., 2023. *The Modern Law of Marine Insurance: Volume Five*. Taylor & Francis.

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of the ship's OT/IT network. This information must be safely fed to the shipowner and the insurer/P&I Club.[13]

- Dynamic Risk Scoring (DRS): Machine Learning can be utilized by Insurers to analyze this vast, real-time data stream and incorporate externalities (geopolitical indexes, weather reports, congestion levels) to evaluate a Dynamic Risk Score (DRS) for each vessel. Low DRS (high risk) may automatically trigger a notification to the owner to take immediate action (e.g., compulsory system patch, route correction) and potentially lead to a temporary, marginal premium increase per day.[14]
- Incentivization: This scheme incentivizes security and environmental compliance. A carrier whose DRS is persistently low as a result of careful maintenance and adherence to security procedures is rewarded with special, lower premiums, in effect linking insurance expense directly to real-time risk reduction performance. This brings the shipowner's and the insurer's financial incentives into alignment for the first time.
- Parametric Triggers: Dynamic underwriting enables parametric insurance. For instance, a policy may read: if the proprietary AI-based navigation system of a vessel fails (as confirmed by its black box records) to cause a deviation by over 5 miles, automatic payment of a set amount for consequent delay is triggered. This obviates the long, subjective process of traditional loss adjustment.

B. Innovative Insurance Products: The Call for Parametric Insurance, Specialized Cyber Policies, and Green Technology-Eligible Coverage

The market will have to complete the current gaps in coverage using specialized products:

- Specialized Maritime Cyber Risk Insurance (M-CRI): This shall be distinct from P&I and H&M and include coverage for:

1. First-Party Loss: Ransom payment, forensic investigation cost, data recovery, and huge BI loss due to port/vessel operational halt.

2. Third-Party Loss: Liability for data breaches, regulatory penalties (e.g., from an Indian Data Protection Authority), and third-party claims for delay or systemic failure.

- New Fuel Disaster Cover (NFDC): A dedicated, high-limit policy for toxicity and containment expenses due to ammonia, hydrogen, or methanol spills. This policy has to

[13] Uday Kiran, P.S.S., 2025. Marine Insurance and India: Trends, Challenges and Opportunities. *Strategic Analysis*, pp.1-4.
[14] Pandey, S.K., 2023. A Thorough Analysis Of The Issues And Solutions Facing Maritime Security And Marine Insurance Laws In The Twenty-First Century. *Russian Law Journal*, *11*(5), pp.209-218.

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be reinsured by a domestic and international reinsurer consortium and could necessitate a PPP to take on the ultra-tail risk, perhaps arranged through a state-sponsored Indian Reinsurance Scheme to increase capacity.[15]

- Parametric Delay and Contingency Coverage: Customized policies for particular supply chain risk. For instance, a prominent Indian exporter may purchase a policy that reimburses a set amount of money if a particular port (e.g., Chabahar) is closed down by geopolitical means for longer than X days so that the exporter can get back surprise logistics expenses upfront.[16]

C. The Call for Cooperation: Creation of a New IRDAI, DG Shipping, Legal Professionals, and Tech Firms Involving Regulatory and Commercial Ecosystem

Only through a single regulatory and commercial ecosystem can the active risk model be implemented successfully.

- Regulatory Convergence for Innovation: The Insurance Regulatory and Development Authority of India (IRDAI) and DG Shipping have to collaborate in creating a Unified Maritime Technology Risk Sandbox. This enables insurers and tech companies to experiment with dynamic underwriting models and innovative policies (e.g., NFCC) in a restricted capacity without prompting full regulatory overhead immediately. DG Shipping supplies the technical safety requirements (e.g., compulsory patching procedures, AI validation norms), and IRDAI supplies the financial framework (e.g., solvency norms for NFCC).

- Mandating Data Standards: DG Shipping should work with the Indian Register of Shipping (IRS) to impose global technical standards (e.g., ISO 27001, industry best practices) on vessel OT/IT architecture and data transmission. Adhering to the imposed standards should become mandatory for securing H&M and P&I cover rendering the risk controllable and insurable.[17]

- Legal Reform Working Group: A working group with a sole mandate, made up of legal professionals, the Law Ministry, DG Shipping, and industry stakeholders should be tasked to:

1. Prepare a "Cyber-Marine Liability Act" which clarifies product liability, provides guidelines

[15] Singh, R.R., 2021. Maritime Insurance: Settlement of Claims. *Issue 4 Int'l JL Mgmt. & Human.*, *4*, p.1254.
[16] Kiran, R. and Krishna, B., 2007. The Law of Liability for Maritime Accidents in India. *J. Mar. L. & Com.*, *38*, p.39.
[17] Stein, D., 2024. Indian marine insurance: Insured duties from utmost good faith to fair presentation. *Lex Portus*, *10*, p.7.

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for coercing proprietary data during discovery and formulates a sound legal definition of algorithmic negligence.

2. Examine and modify the MIA 1963 to legitimate the provision for non-indemnity-based insurance (parametric models).

3. Create a definite national framework for Green Fuel Spills liability and compensation that adheres to the "polluter pays" principle but offers explicit, high-level caps for insurers.

VII. Conclusion and Policy Recommendations

A. Summary of Findings: Reiterating the Urgent Need for Modernization

India's existing maritime legal and insurance framework has been made functionally redundant by the New Trilemma Technology, Decarbonization, and Geopolitics. The Marine Insurance Act, 1963, and conventional P&I principles do not have the ability to deal with the systematic, intangible, and high-risk threats of algorithmic failure, cyber-attack, and contamination of new fuels.

The most fundamental concepts of causation, seaworthiness, and indemnity are being challenged directly. In the end, this obsolescence jeopardizes India's maritime competitiveness under MIV 2030 by creating a liability black hole for green and autonomous assets. A comprehensive transition to a data-driven, proactively managed risk environment driven by technological innovation and regulatory foresight is the answer, not cosmetic adjustments.

B. Recommendations for Stakeholders

The Ministry of Ports, Shipping, and Waterways (MoPSW) must give legislative reform top priority by drafting and enacting a Cyber-Marine Liability Act. The Indian Insurance Industry, i.e., GIC, private insurers, and the brokers, will have to fundamentally alter their methodology.[18] Parallelly, the Directorate General of Shipping (DG Shipping) would need to set up and enforce Technical and Safety Standards for Autonomous Operation and Cyber Security and work jointly with the Indian Register of Shipping (IRS) so compliance remains a strict requirement for the Certificate of Registry and insurance coverage of a ship. Additionally, DG Shipping has to formulate detailed Minimum Remote Manning (MRM) standards in order to help give the regulatory certainty required for P&I clubs to insure autonomous risk. On the fiscal side, the Insurance Regulatory and Development Authority of India (IRDAI) has to act proactively by introducing an IRDAI-DG Shipping Sandbox. Such a sandbox ought to expedite the testing and development of non-traditional financial instruments such as Parametric Insurance for delay

[18] Billah, M.M., 2016. *Effects of Insurance on Maritime Liability Law*. Springer International Pu.

and business interruption, as well as specialized, high-limit Novel Fuel Catastrophe Cover (NFCC).

The IRDAI needs to update its regulations to lawfully validate and recognize these non-indemnity-based policies. Last but not least, the Parliament of India ought to revisit the Rotterdam Rules with a view to ratification in order to update the liability regime for multimodal and electronic carriage contracts.

C. A Call for Action: Highlighting the Urgency of Taking Prompt Action to Ensure the Indian Maritime Environment Remains Resilient and Insurable

The cost of regulatory inertia is clear: more expensive capital for new vessels, reduced competitiveness in markets, and potential for devastating, uncompensated losses from environmental or cyber disasters. The government, regulators, and industry stakeholders in India must realize that the new currency of maritime commerce is risk management. By embracing data-driven underwriting to its benefit, instituting targeted legal reforms, and enabling unprecedented cooperation, India can leverage its exposure to the New Trilemma as a strategic advantage to establish itself as a robust and responsible global maritime power.

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