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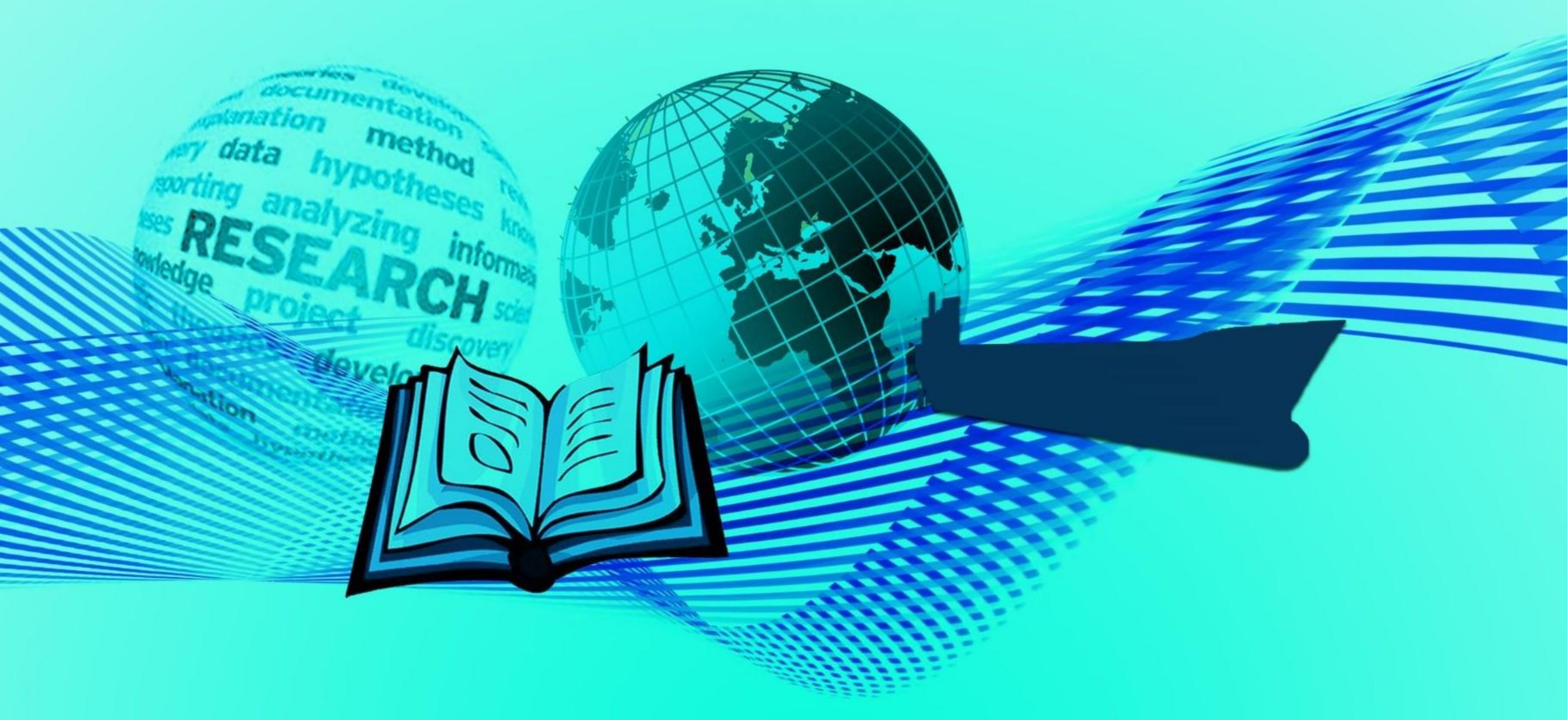

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IIRE Journal of Maritime Research and Development

Maritime sector has always been influencing the global economy. Shipping facilitates the bulk transportation of raw material, oil and gas products, food, and manufactured goods across international borders. Shipping is truly global in nature, and it can easily be said that without shipping, the intercontinental trade of commodities would come to a standstill.

Recognizing the importance of research in various aspects of maritime and logistic sector, IIRE through its Journal of Maritime Research and Development (IJMRD) encourages research work and provides a platform for publication of articles, manuscripts, technical notes, papers, *etc.* on a wide range of relevant topics listed below:

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BIG DATA AND PREDICTIVE ANALYSIS: A SUSTAINABLE STEP TOWARDS MODERNIZATION OF MARITIME INDUSTRY

Mr Punit Oza[1], Mr Chitta Dash[2], Mr Ng Yi Han[3], Mr Sanjeev Namath[4], Mr Jiten Mehra[5], Mr Ron Fong[6] & Mr Abdullah Siddique[7].

Abstract

The article concentrates on and emphasises major advancements in the marine industry, primarily those connected to digitalization of information processing across national and international waterways, as well as the sector's long-term development in the contemporary era. With the growing interconnection of marine logistics, information exchange across diverse stakeholders is important to ensure efficient supply chain processes and management. Electronic data interchange (EDI) has garnered considerable scholarly and commercial interest in the marine sector because potential it provides to greatly increase the quality of data exchange and hence promote supply chain convergence. This paper has been prepared after thoughtful consideration and discussion with some of the industry's most notable executives, as well as a thorough assessment and analysis of the industry's ongoing innovative endeavours.

Keywords: Big data, Predictive analysis, Sustainable, Development, Modernization, Maritime, Information, Shipping, Artificial intelligence, Transport, Machine learning.

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1. INTRODUCTION

In today 's technological environment, the marine business is very competitive, and organisations are always making investments in technologies that may help them improve logistic profitability while lowering total costs. Therefore, the desire for sophisticated technology, such as marine big data, among corporate carriers as well as various end users has been expanding at an alarming rate.

The worldwide marine analytics sector is predicted to increase from $993.39 million in 2021 to $2,150.88 million by 2028, at a CAGR of 11.7 percent between 2028 and 2021 (The Insight Partners, 2021).

Before big data, corporations utilised conventional technology to evaluate enormous sets of data obtained from traditional channels such as storage facilities, supply hubs, and so on. Nonetheless, with the introduction of big data, it really has gotten simpler to execute statistics evaluation and analyses of unusual information in real clusters as well as batch mode with the help of big data collections from standard sources.

In the maritime sector, big data is being used to track sensors on vessels and do predictive analysis to reduce disruptions and increase efficiency. Big data findings forecast expensive difficulties throughout the ship's career, from development to operation to decommissioning. Hamburg Port (Germany), Cartagena Port (Columbia), Rotterdam Port (The Netherlands), and numerous Southeast Asian facilities are increasingly utilising big data analytics technologies for harbour and terminal operations (Business Wire, 2022).

Data that is available on the causes of ship accidents at sea, cargo losses inside or outside ports or storage facilities, and other delivery difficulties (for example, the explanations for harm to the products) may be discovered through data gathered through appropriate monitoring of dispatches over several years. This big data for the maritime sector may be utilised to make prospective judgments to foresee and avert expensive crises, as well as to provide more dependable cargo transportation solutions.

It is majorly agreed that big data can be useful in vessel engineering. Essentially, this would be accomplished by studying the findings of prior vessels' sensors. Data gathered and evaluated during the ship's lifespan will be beneficial for future ship building advancements. Existing datasets might be used to evaluate the prospective vessel model without having to build it physically. This is a huge benefit for the shipbuilding sector.

While we progress forward into an increasingly international economy, the necessity for goods transportation and associated logistical assistance will expand at an explosive rate. This expansion will raise the requirement to maximise time and profitability to have the most lucrative delivery procedures throughout time. The application of modern data processing methodologies will improve the efficiency of products delivery. Enhanced transportation operations will boost global trade.

Analytics may help ecommerce businesses enhance their sales efforts, but only if they can collect meaningful information and utilize it correctly. One method is to use predictive analytics with information from the digital storefront, but we could also incorporate predictive analytics in the transportation business. After all, logistic data could very well be utilised to increase the customer satisfaction, which can lead to increased sales. Instead of just responding to client activity, predictive analysis may be used to forecast and influence business demand. Big data, with little foresight, may enhance your shipping company's distribution network, improving your market position.

2. BIG DATA AND INFORMATION SHARING

Big Data improvements in marine shipping (both freight and passenger) are exhibited, mostly in harbour operations, climate forecasting, surveillance, and security. Movement and marine transportation have always been critical to financial, environmental, and societal growth. Traffic and freight quantities continue to rise as worldwide commerce and globalisation expand. As a result, several players (such as marine logistics businesses, shipping lines, distributors, and so on) are being obliged to embrace changes in the maritime shipping business and adopt more efficient methods by adopting technology capable of gathering and processing vast volumes of data (in a cost-effective way).

On a continuous routine, a vast volume of information is created in marine transport from many sources and in various forms. This comprises information such as traffic statistics, container information, weather data, and equipment records. Due to the sheer vastness of the marine transportation network, which encompasses the abovementioned entities, widescale management issues occur at the strategic, technical, and functional levels. Nowadays, Big Data analytics are being used in a variety of businesses (including the marine transport business) to improve the accuracy of decision-making methods.

2.1 Big Data in Maritime Industry

A wide variety of parties are involved in maritime transport, including terminal administrators, shipbuilders and ship owners, contractors, brokers, transportation and insurance firms, classification organisations, and so on. A huge number of stakeholders implies a wide range of business operations and concerns, including diverse data-related interests. As a result, there is no precise meaning of the phrase "Maritime Big Data." Depending on the aim, Maritime Big Data may contain information about ship efficiency, transport costs, meteorological conditions, labour expenses, oil prices, or even metal pricing. Furthermore, the quantity of electronic sensors in marine transport is rapidly growing. As a result, the development of Big Data in the marine environment is expanding, contributing to the abundance of information, and the statistics; come from a variety of sources. Aside from weather predictions and historical data, the most essential data assets in the case of voyage data are given by deck machinery, which is recorded by the Voyage Data Recorder (VDR), and by external surveillance, such as the Automatic Identification System (AIS). The primary goal of VDR is to give information for analysis in the event of an incident. As a result, VDR preserves all gathered data from a journey. Date and time, ship's whereabouts, speed, course, bridge audio, communication recording, wind velocity and flow, primary warnings on the bridge and rudder, engine instructions and answers, and other data are recorded by VDR. VDR gathers large amounts of data, allowing for in-depth analysis of the journey. Because VDR data is overwritten and updated with fresh data after a certain period, the data should be transmitted onshore or preserved and transferred manually or automatically claim that such data is still studied only in situations of catastrophes and is otherwise erased without deliberation (Marija Jovic, 2019).

Nevertheless, the AIS's expanding popularity has resulted in the network being overburdened in some of the world's most crowded waterways as of lately. Considering the potential risk that this overload poses to the AIS's primary goal of accident prevention, the International Association of

Maritime Aids to Route planning and Lighthouse Administrators and a variety of local maritime organizations have begun development on the VHF Data Exchange System (VDES). Rather than being a development of AIS, VDES is a connectivity platform that encompasses many communications subsystems, one of which is the AIS. A key component of VDES is the development of newer methods that provide faster data frequencies than those utilised for AIS. The VDES promotes e-Navigation and has the potential to significantly improve the supply of marine data services such as marine risk monitoring, broad information transfers at high transmission rates, locating, shipping transport planning, satellite connectivity, and so on (Marija Jovic, 2019).

2.2 Complexity of Big Data

To realise the advantages of big data, highly skilled personnel and analytical systems are required. Although advances in ICT will lead to improvements in data collecting, new ideas such as big data are also likely to expand the volume of information and the degree of complexity in evaluation, rendering conventional data processing programmes outdated. Because big data in marine transportation can come from a wide range of sources, including voyage information, equipment records, fully automated identification system (AIS) data, weather and corporate data, and other information, computation becomes more complicated, necessitating the acclimation of organisational mechanisms and capabilities.

As per the World Bank Logistics Performance Index (2016), modern ICT advances outstrip the capabilities of majority of the current labour (The World Bank, 2017). Big data monitoring will thus necessitate highly skilled personnel to separate critical information from noise, as well as strong analytics platforms capable of processing enormous volumes of information and activities supplied by a variety of sensors and other equipment.

Obtaining a comparative edge through a sustainable digital revolution plan necessitates not only technical skills, but also a corporate environment that encourages creativity and a shift in value system. This entails evaluating techniques and practices on a small scale and extensively evaluating them in order to determine what works. Firms should also strengthen their relationships with scientific disciplines and colleges in order to better recruit workers and create innovations. Corporations should engage in communication with the government domain to identify and promote skillsets that need to be taught or created when it comes to educating and skills training people in maritime, transportation, and ports. The marine industry has a huge number of feasibly networked goods and equipment, which provides a significant opportunity for the application of the Internet of Things (IoT). As per DHL/Cisco, the use of IoT in transport and logistics is expected to produce USD 1.9 trillion in worldwide value over the next decade (DHL/Cisco, 2015).

Nonetheless, the Internet of Things continues to face challenges in terms of worldwide standardisation, despite the fact that several industry-led efforts have recently begun to expand the usage of Electronic Product Codes (EPC) and Radio Frequency Identification (RFID). In terms of digitalization in particular, linking "things" is a means to a goal that adds no worth without the resultant discoveries. To generate understanding of the data provided by interlinked devices, analytics and accompanying apps (such as visualisations) are required. This necessitates organisational change. Nowadays, the extent of digitization within marine businesses is limited. Having considered the degree of print and telephone use in shipping transactions, for example, basic digitized trading appears to be a long-term business goal.

The OECD ICT dataset, in specific, reveals significant technological adoption discrepancies between major and minor businesses. For instance, despite the fact that the expenses of implementing fundamental digital technologies have dropped considerably, small businesses with 10 to 49 staff are just half as likely as large businesses to have a company webpage. A few impediments to widespread usage of reliable information exist. In many circumstances, organisations are opaque about where data is held and who has authority to it. As shown in a DNV GL report, data owners in maritime firms are frequently unaware of the sources, background, and regulatory or contractual duties of the data with which they are working. Furthermore, they discovered information reliability difficulties in all 30 pilot programmes when big data was employed in assessment. The acquired data was frequently derived not from the sensors mounted on the equipment, but from how they have been programmed or labelled (DNV GL, 2018).

2.3 Improving modes and streams of Information Exchange

International Journal of Logistic Research and Application's Simple marine logistics framework, which indicates that an overseas delivery from point A to point B requires 3 concurrent motions: cargo (middle), cash (left), and information circulation (right). The relevant records and documentation necessary at each level are listed in yellow boxes. The money flow is depicted in the form of agreement components, assurances, and documents pertaining to shipping pay-out and coverage. "Data" are represented as information streams on arrows connecting two separate nodes. Based on the scope of segmentation, a single delivery may need approval from up to 30 different companies and up to 200 interactions. Furthermore, the picture depicts two aspects of digitalisation: the very first, the procedure of dematerialisation and incorporates the following data, and secondly, communication pathways and network streams via which electronic materials and information travel back and forth (IBM/Maersk, 2017).

Although virtualized systems might be an efficient approach to make this data easily accessible, this poses the question of database rights and ownership. Data ownership essentially determines who creates, updates, distributes, and controls information exchange. As numerous parties in the distribution chain build data services as component of their economic strategy, the issue of the monetary worth of this data arises. The diversity of preceding contracts required between many distribution chain stakeholders, i.e., a sufficient description of data protection, establishing income or risk sharing methodologies for information stipulation and utilisation, various stages of direct connections and authorization systems, as well as the safety and anonymity of inter-firm (or public-private) information transmission, all condition effective supply chain cooperation. Organizations should be convinced that responsibility, expenses, verification, and data access are safely and appropriately controlled in an attempt to harmonise competing objectives in the distribution network before agreeing to exchange the information required to make similar systems operate. This means that individuals must believe they are receiving a reasonable number of advantages from networks or information systems in relation to the data they provide. As previously said, communication networks are becoming commodities offered by several rivals. As a result, in order to garner approval for this paradigm, public, cooperative venues would need to suitably reward its participants.

Furthermore, governmental, and administrative changes will be required to accommodate the use of innovative technologies while also ensuring that emergent revenue streams can deliver the intended advantages. As many systems emerge to address supply chain synchronization and transparency, it is critical to observe which software platform will eventually prevail. Authorities should be mindful that network models based on monopoly or oligopoly pose dangers like as lock-in, limited improvement, and vehemently anti-competitive attitudes. The notion of global standard protocols has the ability to overcome the challenge of lock-in. Furthermore, this would need a strong effort and broad collaborative activity from both the business and governmental domains, which would include an inquiry and memorandum of understanding on best practises, distribution, and global execution. This implies that, in the absence of a level competing environment and standardised regulations, interoperability stays a joint responsibility problem, as interacting with rivals and the government sectors necessitates extra work on the part of businesses. Relevant players must also decide over whether collaboration procedures should be assisted or steered by public (or public-private) efforts that seek to be impartial in the discussion. Governments or supranational agencies, in exchange, should assess the requirement and advantages of supporting such an interchange.

3. PREDICTIVE ANALYSIS AND WHAT IT MEANS FOR MARITIME INDUSTRY

To begin, let us define predictive analytics, which allows businesses to effectively estimate parts of consumer sales, shipping costs, and transportation based on current and historical data. Outside elements such as climate, recent affairs, and economy may also be considered. Exterior variables can improve forecasting precision. Data analytics, when combined, may assist an ecommerce or logistic organisation in identifying trends to better prepare for consumer sales and all components of their international logistic chain.

Forecasting the coming years in marine is not a novel notion. Terminal operators have done predictions for as long as there have been port facilities. Nonetheless, technology like as radio-frequency identification (RFID) and differential global positioning systems (DGPS) have aided in the collecting of increasingly precise real-time data. This allows for a highly accurate projection of when shipment will be ready for pickup. Advantageous financial circumstances have resulted in a rise in cargo transportation demand.

The application of big data statistics for predictive analytics is rising in the transportation and ecommerce industries. According to an MHI Industry research, the use of predictive analytics by distribution network specialists has grown dramatically.

According to the research, this utilisation increased by 76% between 2017 and 2019, particularly application in stock management to reduce cycle times and enhance client satisfaction. According to research by the Council of Supply Chain Management Professionals, 93 percent of shippers believe it is critical to employ data-driven information processing in the supply chain (Shipware, 2021).

Electronics and predictive analytics technological advancements, ranging from information storage to parallel processing, new forecasting systems, algorithmic innovations, and data visualisation, are equally important. All of this has helped to make predictive analytics more pragmatic and attainable. Several causes have contributed to the urgency to improve cargo throughput at ports.

3.1 Case Study of The Port of Long Beach, California

The neighbouring ports of Los Angeles and Long Beach in Southern Californian Shores are the busiest in the United States. Traffic may be a concern with such a large volume of goods to manage, with queues of ships at anchor waiting for room to berth.

"As vessel call sizes proceed to climb, US ports, along with many others around the world, are trying to maintain or ideally enhance terminal efficiency," explains Allen Thomas, chief strategy officer of Advent Intermodal Solutions. "We just cannot achieve that without the assistance of emerging technologies."

The International Transportation Service (ITS) and Advent notably debuted a predictive visibility strategy at ITS's Long Beach transportation hub. The firms have spent the last two years developing a data sharing system that allows transporters, beneficial cargo owners (BCOs), and motor carriers to determine when freight will be unloaded five days prior to arrival of vessels. The essence of this is an addition of Advent's eModal service, a digital interface that terminal clients are presently using to handle truck scheduling. The ITS terminal operating system can provide eModal with an estimate of when a cargo will be ready for pickup. With this date and time set, the platform can automatically schedule truckers depending on their requirements (Baker, 2020).

"This primarily provides huge advantage for the trucking industry (particularly the dispatcher/scheduler) by eliminating the requirement for them to repeatedly keep checking back in eModal to confirm containers availability and then create a booking," Thomas explains. "This overall phase is removed, saving around 20 minutes each container on average while confirming availability periods five days ahead of time" (in turn being profitable for both trucking business and terminal labour planning) (Baker, 2020).

According to a recent World Cargo News story, ITS CEO Sean Lindsay stated that in the first week of using the eModal technology, the business had 150 booking requests, which increased to over 600 in two fortnights. Furthermore, the Port of Los Angeles just announced a novel information exchange platform that digitises marine transportation data, allowing BCOs and supply chain operators to access it. The site, which was initially introduced at a few ports as part of a test programme, have been widened to cover all marine transport companies and port administration by mid-2018 (WCN Editorial, 2017).

In the foreseeable future, estimated container availability periods might be distributed over the platform to other supply chain elements. Terminals would be able to detect equipment and labour requirements, truckers would be able to organise assignment schedules, and BCOs would be able to organize their facilities for distribution.

3.2 Methods of Predictive Analysis

Machine learning is frequently used in predictive analytics, which is then applied to logistic information or other data that has to be optimised. Data is essential since it is hard to obtain useful analyses to be proactive going ahead without high-quality data. A predictive analytics framework may be used for a variety of software kinds. Transportation management systems, audit recovery tools, warehouse administration programmes, and contracting/procurement software might all be part of the system.

The primary objective is to utilise clean information to build a model or framework for predicting particular outcomes or events. It entails recognising patterns that may be updated when fresh data becomes accessible.

Applying a predictive analytics system, parcel audit recovery solution is a simple approach to reduce expenses. The programme employs artificial intelligence that has been fine-tuned over time to detect anomalies in carrier bills precisely and automatically. Parcel audit recovery, which runs in the background, may detect carrier faults, and automatically reimburse the client. This might indicate that the carrier paid the wrong accessorial fee or supplied a product late while it claimed for guaranteed on-time delivery.

Integrating a system like package audit recovery with a shipping or transportation administration platform is a one-two punch for lowering carrier and operational expenses while maintaining service quality. Predictive analytics may be used by a transportation system to select the optimal level shipping method based on package or freight size, pricing, carrier preferences, scheduling, and many other criteria. On the back end, the audit recovery service ensures that the shipper is paying the appropriate price for the consented services. The service is free at the outset, while takes a percentage of the recovered savings with no exertion on your side (Shipware, 2021).

4. BIG DATA ANALYSIS AND NOVEL SOLUTIONS

Considering the huge scale of infrastructure and organizational challenges, the marine sector has become one of the oldest and most conventional businesses that still relies on intuition rather than facts. Nowadays, the maritime sector has become more technologically advanced, and competitive rivalry in this domain has prompted the implementation of fully automated control systems on vessels, which accumulate, analyse, and process numerous information in order to produce more efficient vessels, optimised data management, and ecologically friendly engines.

Big Data Analysis approaches are used to discover trends that can assist further to improve and understand the vessel's operation and when combined with Artificial Intelligence and Machine Learning, aid in vessel management to get the most out of it. Wärtsilä, a prominent engine manufacturing company, is a fantastic illustration of current Big Data Analysis. Wärtsilä motors profit from Eniram, a big data analytic solution designed to significantly improve ship operations, journey routing, and energy efficiency through modelling of shallow water characteristics, sensor utilisation, real-time and prior data (Wärtsilä, 2017).

According to Solnik, IT divisions use AI to anticipate and overcome difficulties before they transpire, and as per to Min, there's already advancements in developing artificial intelligence-based predictive analytics technology for vessels that will greatly alleviate the work and effort of technicians while also allowing corporations and seafarers to experience safer seas and much more dependable machinery and equipment.

4.1 Artificial Intelligence

Artificial intelligence has been characterised in a variety of ways and degrees, but when these classifications are combined, we may confidently conclude that AI is supposed to reason and behave in both sentient and intellectual ways. Maritime places a greater emphasis on the logic of AI, as a computation of emotional responses is not very interesting in this business; in fact, shipping companies would prefer to exclude all human-related operations if they had such an economically viable prospect.

AI is predicted eventually to someday let vessels cruise with minimum human interaction and manage dangerous and catastrophic circumstances by itself, eliminating reliance on interpersonal interactions and interference, which may frequently result in misinterpretation, lack of expertise, and environmental awareness.

In the eyes of academics, perfect AI was and still is a hypothetical concept, and many have been doubtful about the actual prospects of producing an AI that is clever enough to greatly outperform living beings in non-repetitive jobs that demand high intellect. Part of the explanation was the 1997 chess game among IBM 's Deep Blue and the world champion Gary Kasparov in which Deep Blue has used brute force, computation of all the potential solutions and results occasionally even with 20 steps forward and selecting the step that brings the computer in a stronger position out of every one of its variations. This may be analogous to grabbing a 4-pin lock and attempting all the configurations from 0000 to 9999, in other terms, while this earned Deep Blue a historical triumph against Kasparov, it would not be a particularly clever or efficient manner of playing Chess. Deep blue's edge was the rapidity with which it would carry out these computations and return to the subsequent stage, something living beings could never replicate (Latifov, 2019).

4.2 Machine Learning

The most basic method to describe Machine Learning is "trial and failure." It’s the manner of machines altering and adjusting their behaviours to acquire more accurate, persistent and so in the end flawless through simulation. Machine Learning technologies is dependent on extremely continuous and abundant data, making data acquisition a critical component in attaining effective results. Machine Learning is particularly remarkable because everyone can connect to it and it is very near to the kid 's maturation cycle, however unlike people, machines can recreate a situation billions of times in a small period of time and identify the best solution to the challenge in a rapid and repeatable fashion.

Machine learning will be the subsequent major step following big data analytics; it is used to synthesize the statistical information and begin operating while optimising via trial and failure. The input from these activities is likewise logged and saved in a directory to be evaluated afterwards, and the pattern continues until the machine discovers a way to adapt its operations to each event. As previously stated, Eniram, a Big Data Analysis-based mechanism, also employs Machine Learning to handle critical functions such as energy, journey, and ship efficiency, and assists Wärtsilä in troubleshooting engineering errors that can be used to cultivate stronger, more dependable, and consistent future technologies.

4.3 Unmanned Aerial Vehicle Surveillance and Data Collection

New intelligence and automated systems for maritime experimentation and development are radically altering maritime research and the communication system. More automated procedures can improve the efficacy with which the marine network is managed, while the coordinated employment of diverse unmanned vehicles contributes to minimize risk and operational expenses. Unmanned aerial vehicle (UAV) has recently found widespread use in wireless communication networks as a portable host unit, relaying, or storing enormous data. Furthermore, because of its great mobility, UAVs are a versatile and cost-effective instrument that may be used for a wide range of marine tasks such as monitoring, evacuation, and gathering required information. Numerous telemetry actions can be performed and conducted for maritime surveillance, investigation, and exploitation based on the assumption of fast and in real-time information gathering from nautical buoys. Such marine information gathering may be conducted by satellites, vessels, and aircrafts, but satellite transmission is often expensive and limited by network capacity, whilst piloted ships/aircrafts suffer significant workforce and operational costs with possible danger. Considering the circumstances, it seems highly promising to use a fixed-wing UAV which can resist severe conditions over the water surface as an efficient data collector. Because of its great agility and versatility, the UAV may fly near to the buoys and take use of the strong connectivity channel to gather enormous amounts of information electronically and rapidly.

While fixed-wing UAVs may often be fuel-powered and handle a bigger burden than rotational wing UAVs, one of the main constraints for long-distance and long-endurance missions at sea is restricted resource aboard. Furthermore, the environmental drag induced by marine conditions, which influences the UAV's trajectory and consequently limits the UAV's flying radius, cannot be overlooked. UAVs are deployed to locate for and retrieve information from buoys using optimum navigation system for quality-of-service, however the weather impact and the UAV's power usage are not expressly taken into account. The fuel usage designs of fixed wing or rotational wing devices are suggested for energy-efficient transmission prototype, relying upon which UAV's path is concurrently optimised with air to land interactions across multiple settings comprising information gathering. Nonconvex challenges are often handled poorly using versions of the successive convex approximation (SCA) approach. Regrettably, these SCA-based systems rely significantly on trajectory calibration and do not directly account for weather effects. Furthermore, for fixed-wing UAVs which should sustain forward propulsion in order to stay airborne, the computational intricacy and consequent trajectory difficulty became too expensive for the job of gathering enormous volumes of information from scattered buoys.

To confront the aforementioned obstacles, Institute of Electrical and Electronics Engineers' communication society advocates for an innovative cyclical velocity vector structural model that can manage arbitrary information volumes effectively while accounting for the significant naval air currents impact, and which reduces the UAV's power usage by collectively optimising its flight path and the transmission rate organising among the buoys. The suggested UAV path, in particular, consists of numerous cyclical laps, each accountable for gathering only a set of information and so needing less operation period in each lap, resulting in a considerable reduction in algorithmic burden. Furthermore, it is demonstrated that the gust that impedes the UAV's forward propulsion, when correctly exploited, is not always detrimental to the data gathering mission and fuel conservation. The optimised cyclical 8- curve trajectory, in example, may proactively harness the wind and achieve reduced power usage as opposed to the situation without wind, and it may even surpass the conventional spherical flight path (Yifan Zhang, 2020).

5. MARITIME INDIA VISION 2030

MIV 2030 is a comprehensive exercise and strategy for organisations in the Indian seafaring industry to work together to expand the business and make it internationally competitive. After comprehensive engagements with public and commercial sector players, the Maritime India Vision 2030 (MIV 2030) was developed. At the outset of the activity, 14 thrust area groups from diverse marine sectors were formed to examine and identify initiatives and objectives that would be addressed as a component of the Maritime India Vision 2030. The Indian seaport business has been working hard to reduce emissions and pollution. The MIV 2030 has established specific objectives for harbours to aspire for in order to attain ecological and sustainable facilities construction, as well as port administration and maintenance (Ministry of Ports, 2021).

Port-related activities concentrate on increasing capacity, improving operational efficiency, port-driven industrialisation, and developing secure and sustainable world-class terminals to meet escalating trade volume demands while lowering logistical costs through improved evacuation and cost-effective operations. Shipping-related efforts are aimed at expanding industries like as vessel manufacturing, recycling, and repair, as well as increasing India's international standing as a nautical force. Several measures have also been established to increase the volume of Indian flagged vessels, the quantity of Indian mariners via excellent maritime education and training, and the expansion of fledgling industries such as cruise tourism in the nation. Inland waterways have been quickly expanding in the nation, and MIV 2030 expands on this trend by increasing the multi-modality and proportion of inland waterway-borne cargo and passenger traffic in the sub-continent.

5.1 MIV 2030's 10 Key Highlighted Themes

MIV 2030 identifies ten major areas that are critical for India to maintain its position at the vanguard of the international shipping industry (Ministry of Ports, 2021):

5.1.1 Create world-class harbour infrastructure.

MIV 2030 has highlighted four main measures: brownfield storage enhancement, the construction of best-in-class mega ports, the establishment of a transhipment centre in Southern India, and facilities modernisation.

5.1.2 Increase the effectiveness and cost competitiveness of E2E operations.

To be internationally relevant, Indian Ports needs to increase automation and technology adoption to boost efficiency, as well as develop auxiliary services (e.g., PGA nodal offices) inside port facilities to reduce evacuation duration. MIV 2030 proposes important initiatives to increase competitiveness and effectiveness, such as improved operating efficiency, faster evacuation, reduced costs, coastal shipping encouragement, and port land industrialization.

5.1.3 Improve Regulatory and Administrative Frameworks to Empower All Stakeholders.

Major solutions proposed to improve effectiveness include the development of a National Logistics Portal (Maritime), the modernization of operational activities among marine partners, digital-led smart ports, and system-driven terminal operation assessment.

5.1.4 Strengthen Policy and Institutional Framework to Support all Stakeholders.

MIV 2030 has highlighted critical reforms for enhancing administrative mechanisms, amending current legislation, reinforcing MCA, and encouraging PPP, financial assistance, and fiscal resilience to facilitate the sector's ultimate sustainable growth.

5.1.5 Increase international participation in vessel construction, maintenance, and disposal.

MIV 2030 has recognised national demand disbursement for vessel construction, the growth of popular platforms for the ancillary and marine concept ecological system, the formation of vessel restoration clusters, and the promotion of waste to wealth through greater scrap utilisation in the steel industry as key measures to rise the country's market position.

5.1.6 Improve Freight and Passenger Transportation on Inland Waterways.

Port architecture and fairway enhancement have been suggested as key solutions to improve passenger and container transportation; financial and administrative measures to support IW ship operators and freight owners; and encouragement of Ro-Ro and ferry operations in India.

5.1.7 Strengthen the Ocean, Coast, and River Cruise Industries.

Port infrastructure spending; theme-based shoreline and island circuits; cruise education academies; islands ecological development; and design and implementation of ferry and river cruise terminals on National Waterways are among the intervention programmes suggested for the growth of the cruise sector.

5.1.8 Improve India's International Status and Marine Collaboration.

While numerous attempts are being made to improve and strengthen interconnection (ferry, cruise, cargo) with neighbouring nations such as Bangladesh, Sri Lanka, and the Maldives, especially in the fields of maritime collaboration could be discussed, such as stabilising permanent representation at the IMO, prevalent norms, and encouraging "Resolve in India." Additionally, significant attempts to encourage partnership with sophisticated maritime nations (such as the United Kingdom, the United States, the Netherlands, and others) are essential.

5.1.9 Be the global leader in the secure, sustainable, and environmentally friendly maritime sector.

To minimise ecological damage, Indian ports have launched a number of measures, including encouraging solar and wind energy incorporation, the Swachh Bharat Abhiyan, the Swachh Sagar site for trash disposal, and so on. In addition, to provide a safer working condition, Indian ports are working to implement a variety of precautionary measures to avoid accidents and mishaps. MIV 2030 has pinpointed key approaches such as maximising the use of renewable energy, reducing air emissions, optimising water usage, strengthening solid waste management, a zero-accident safety programme, and a centralised monitoring framework to further propel India to the forefront of safe, sustainable, and green harbours.

5.1.10 Develop a best-in-class seafaring economy through world-class education, innovation, and training.

Key actions have been suggested for boosting research and innovation, improving education and training, developing a suitable environment for seafarers, and port-led efficient expansion.

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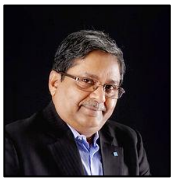

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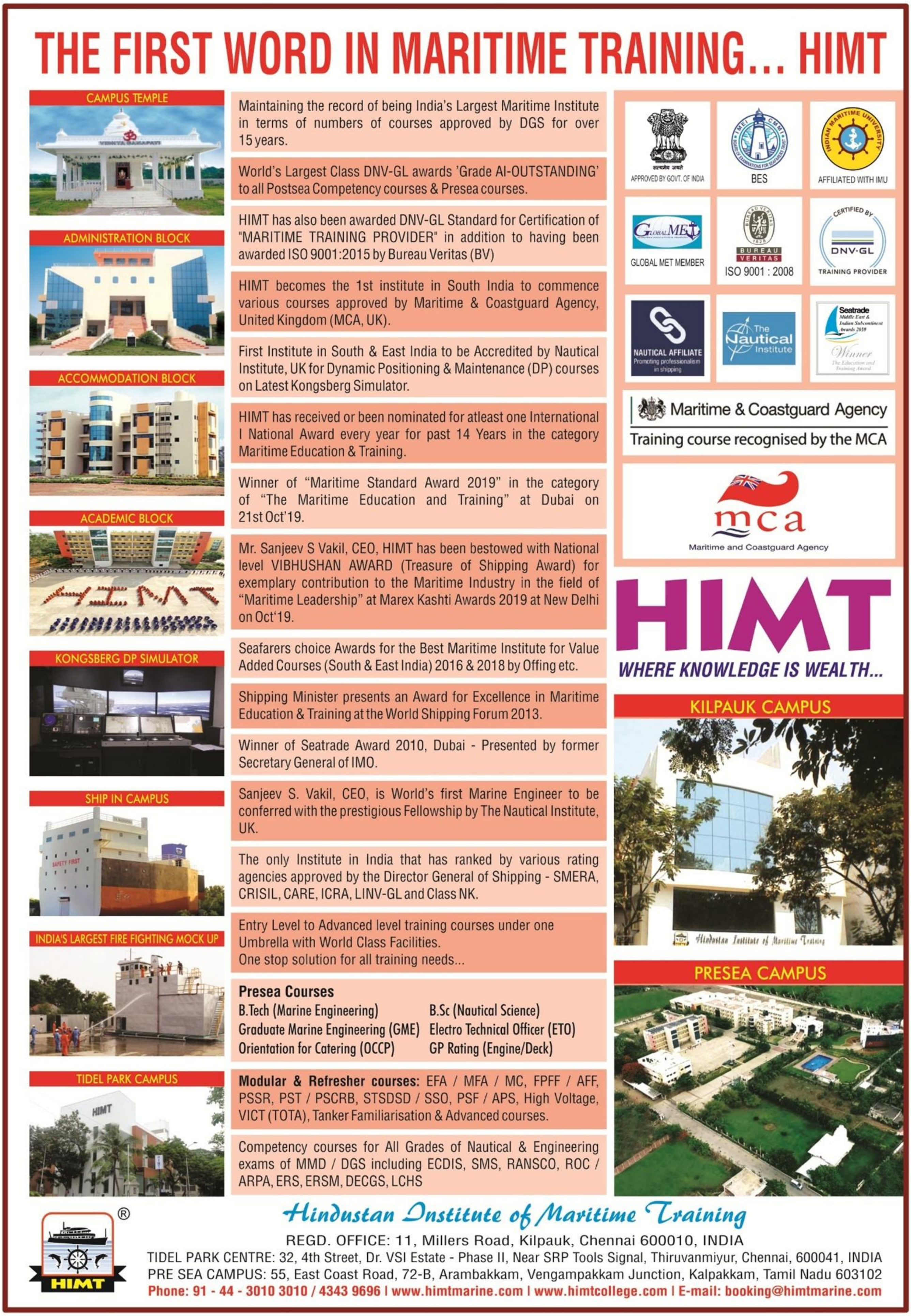

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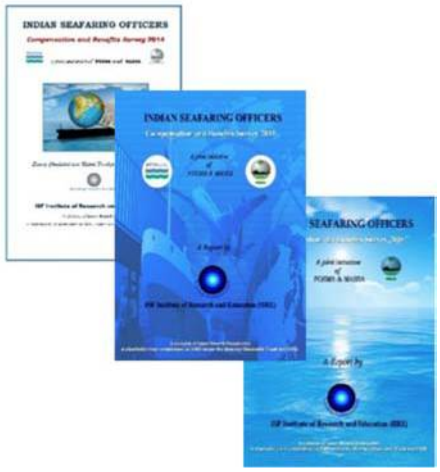

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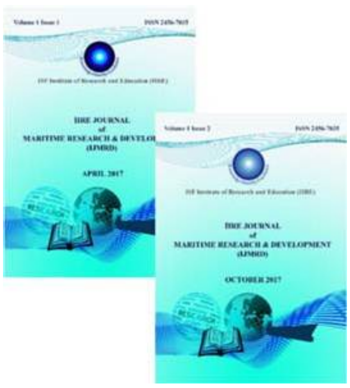

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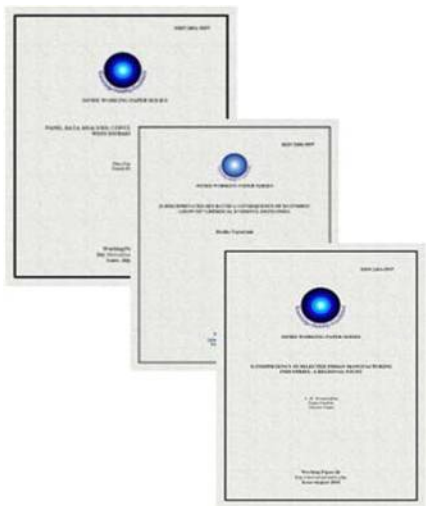

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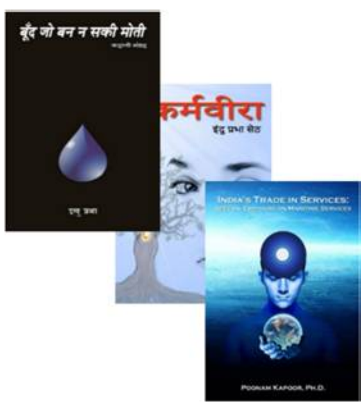

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