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# ISF Institution of Research and Education (IIRE)

## IIRE JOURNAL OF MARITIME RESEARCH AND DEVELOPMENT (IJMRD)

October 2022

# ISF Institute of Research and Education (IIRE)

## IIRE JOURNAL
## OF
## MARITIME RESEARCH AND DEVELOPMENT
## (IJMRD)

**October 2022**

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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:

- Development in Shipping
- Ship Operations and Management
- Risk Assessment and Risk Management in Maritime Sector
- Maritime Safety and Environmental Protection
- Technological Developments
- Maritime Education
- Human Resource in Maritime Sector
- Trade Liberalization and Shipping
- Freight Rates Fluctuations and Forecasting
- Commodity Markets and Shipping
- Shipping Investment and Finance
- Maritime Logistics
- Multimodal Transport
- Inland Waterways Transport
- Maritime Statistics
- Port Management, Port Pricing and Privatization
- Economic and Environmental Impact of Shipping and Ports
- Other Current Topics of Interest in Shipping

# Editorial Board

# *Editorial*

The shipping industry eagerly awaits the launch of SIRE 2.0, an enhanced and risk-based vessel inspection programme that will supersede the existing SIRE programme of the OCIMF. In an effort to be up to date with the requirements the highly operational industry in knee-jerk reaction is once again making the mistake of focusing all its attention on the seafarers at the sharp end of the ship operations without understanding the underpinning human factors approach that the inspection regime undertakes.

A core element of SIRE 2.0 takes a human-centered approach which will provide a defined process to uncover systemic issues that might lead to risks. The human-centered approach will take into consideration the physical, psychological, and social factors that affect human interaction with equipment, process and with other people. This is achieved by assessing Performance Influencing Factors (PIF). Inspectors will be prepared with a human response toolkit. For each question which is associated with Performance Influencing Factors, the inspector will be asked to provide objective responses to nine areas. These areas cover a variety of factors relating to human errors such as accessibility and usefulness of procedures, human-machine interfaces or the opportunity to learn or practice.

Two research papers in this issue are devoted to these very aspects of human factors integration in management systems that will strengthen the safety management and also much better equip the industry to face the new inspection regime.

Three more papers in the issue are continuing Conference proceedings of the highly scholarly and scientific “International Maritime Research Confluence” held by the Management of this Journal at Mumbai earlier this year and covers the balance 3 sessions on “Enhancing the stature of Maritime India”, “Big Data and Predictive Analysis” and “Additive Manufacturing for Sustainable Shipbuilding and Repairs”. These Conference Proceedings are peer-reviewed and ensures robust scholarly and actionable contents.

Happy reading!

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**IIRE Journal of Maritime Research and Development (IJMRD)**

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# HOW TO ENHANCE INDIA'S GLOBAL STATURE AS A MARITIME NATION

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## Abstract

The article targets towards extrapolating and highlighting the key issues discussed in the IMRC 2022 with esteemed figureheads of the commercial, insurance and maritime arbitration industry. The focus of the research is to provide solutions for increasing the shipping tonnage of maritime industry in India, provide feasible routes for creation and development of Indian Maritime Arbitration Association and considers ways to increase insurance capacity in India and the need for enhanced risk management in Indian ports and shipping.

***Keywords:*** Maritime, Insurance, Risk management, Controlled Tonnage, Arbitration, IMAA.

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## 1. INTRODUCTION

India is blessed with a rich maritime heritage, to shape Indian maritime sector into a robust engine of nations development we have given top priority to port-led development, India's immense potential of coastline strength needs to be harnessed to the fullest (Maritime India Vision 2030).

There have been discussions and deliberations about taking concrete measures to add pace to capacity building and enhancing efficiency of the sector with the favourable policies and reforms. India certainly needs to work towards ease of doing business, creating modern infrastructure of global standards to ensure modern multi-model connectivity and to strengthen its position in the global maritime scenario. There are over 150 initiatives across various maritime sub-sectors like boats, shipping, waterways etc. (Maritime India vision 2030). The paper explores possibility of 'Building Global Credibility for Indian Maritime Sector'. For achieving global credibility India needs to focus on four areas:

- Developing Indian Controlled Tonnage.
- Increase India's insurance capacity for the maritime sector.
- Set-up Indian Maritime Arbitration body for International maritime disputes.
- Establishing India as a hub for bunkering activities.

The emphasis now must be shifted to three key areas: capacity building, expertise, and quality improvement. In simple terms, capacity could never be capable of sustaining the industry until the requisite expertise of global ranking is fostered and employed, while guaranteeing better and improved quality product and services are delivered to the global maritime industry. Presently constituted, the aim is to expand controlled tonnage so that trade and logistics can be profitable and build a name for themselves in the global marine industry. Capacity, on the other hand, is not just limited to the number of shipments. There is also an urgent need for the development of state-of-the-art ports facilities capable of handling enormous cargo volume while also providing faster turnaround time. In short to enhance the efficiency of the ports.

## 2. DEVELOPING INDIAN CONTROLLED TONNAGE

India with its 7517 Km coastline is an important maritime nation. It is amongst the leading maritime nations of the world Rank 19 in 2021 with 26.40 million DWT. Since the independence India has not succeeded in growing tonnage under the Indian flag, in fact it has declined in real terms from 1.16 of the global fleet in 1970 to less than 0.8 in 2021. To influence international maritime decision making and to have a voice in IMO it is crucial to become large flag state and ship owing nation.

India has potential to develop International standard Maritime Clusters with immense strategic benefits including but not limited to reputation enhancement, knowledge hotspots and employment at all levels. India needs to work on to create a level playing field and for adding capacity by:

**2.1 Indian Flag Primary Register Tonnage:**

To compete globally and to create a level playing field for ship owners following steps are important. Shipowners Capital expenditures (Capex) towards fixed assets, i.e., the purchase and maintenance etc. of vessels, as shipping is a capital-intensive business and Capex is very high which leads to stress on free cash flows for running the business. Uncertainties and risky nature of shipping does not make things easy for shipowners hence they need support and encouragement and internationally comparable regulatory support, and tax regime, simple and convenient approval procedures, reasonable cost of borrowing finance, leasing, and insurance, availability of subsidiary schemes and soft loans. Tax relaxation on earning of officers and crew members sailing on Indian vessels.

In April 2015 GOI operationalized International Financial Services Centre (IFSC) at GIFT Multi Services SEZ. GIFT IFSC has constituted the Committee for Development of Avenues for Ship Acquisition, Financing and Leasing, and it has already started working on alternate financing and leasing structures.

Indian Merchant Shipping Act of 1958, for the first time, deals with registration of ships. Part V of Indian Merchant Shipping Act deals with exclusively with the registration of Indian ships. Ships are required to be registered only at ports designated as ports of registry. At present Mumbai, Calcutta, Madras, Cochin and Mormugao have been notified as ports of registry and principal officers of Mumbai, Calcutta & Madras and Surveyor in charge of Cochin and Mormugao have

been notified as Registrar of Indian ships. Certain formalities are required to be complied with before a ship is registered as an Indian ship, and these are laid down in the Merchant Shipping (Registration of ships) rules 1960 as amended from time to time.

### 2.2 Easy and Friendly Bareboat and/or Bareboat-cum-demise charters

Bareboat charter is the contract for the lease or sub lease of a vessel for a specified time for which the charterer has complete possession and control of the vessel, except for selling the vessel or keeping it for mortgage, charterer has right to appoint the required human resource to run the vessel for the duration of the charter. Charterer do not but excluding the right to sell or mortgage the vessel. India needs to formulate friendly and charter schemes of international standards, such as:

- Minimum 3 years BBC duration.
- Maximum 22 years age at the time of entry.
- Classed with Indian Register of Shipping or Dual Class, at despondent Owner's option.
- Indian Crew.
- Indian Flag or Dual Flag for ease of financing/mortgage.
- Similar benefits as that of Indian Flag Primary Register Tonnage for employment of tonnage.
- Simplified and international standards for formation of joint venture (JV) company, registration, and taxation.

### 2.3 Indian International Shipping Register (IISR)

It is a good time for this ground-breaking change to transform India's global position. Visibility, credibility, and strength of a maritime nation is directly proportional to the shipping tonnage it controls (a combination of its Primary or International Register). Increased tonnage along with good regulatory environment and world class infrastructure and port terminals together are important for India to gain an influential position at the IMO. India can consider building a maritime cluster around the tonnage to become a knowledge and innovation hotspot and generate employment. Global and economic conditions are volatile and currently it is an opportunity for the sector to act immediately to reap the benefits. To achieve this the following steps are recommended:

*2.3.1* In principle approval of establishing the IISR by MOS urgently: Develop SOPs for IISR with engaging top-notch Class-advisors. IISR shall have its management and SOPs on the lines of the best practices of the top 5 Shipping Registers. Process will include evaluation of the existing registries, their processes and identify the best practices.

*2.3.2* Ships registered under IISR shall be allowed to have a mixed nationality crew. Having more ships with half Indian crew is better from the employment perspective than having a few Indian National Flag ships with full Indian crew.

*2.3.3* Intense communication blitz through MEA and other international events showcasing realistic financial outcome.

*2.3.4* IISR must encourage more owners of different nationalities to register ships under the IISR.

*2.3.5* To register the ship under IISR, the Ship-owner shall be required to register a company in India. The process of establishing the company, operation, and taxation to be investigated and simplified (with the urgent cooperation with MCA). We may adopt the procedures established in the top 5 International Ship Registries- that have succeeded in getting GDP edge to their respective governments.

## 3. INDIA'S INSURANCE CAPACITY FOR THE MARITIME SECTOR

Shipping is an extremely capital intensive and cyclical sector. A shipowner assumes a significant level of risk. Aiming towards leasing assistance for shipowners may be a sensible course of action, but ship leasing is a commodity that is still in its early stages, and there is inherent risk attached with it. Regrettably, the ship financing sector has been converging rather than increasing, making fund accumulation a conspicuous concern that is, of course, intertwined with legacy. In India, marine insurance is one of the least known sectors of the shipping and port industries. A variety of issues are wreaking havoc on India's insurance industry. Some examples include a lack of an integrated strategy, extensive multi-broking, intermediaries' lack of experience and expertise, experts' lack of grasp of maritime law, and, most crucially, a refusal to recognise the linked nature of maritime contracts.

While insurance policies in maritime is substantially different from the traditional insurance market for motor vehicles, marine insurance is far more service oriented and requires immediate responses. If an event occurs, a Protection and Indemnity (P&I) club must place a guarantee on it before the asset may depart and carry on with its business arbitration and dispute resolutions.

Current state of Maritime Insurance in India is not very good. Cargo and Hull marine insurance a meagre 2% of market share in FY'18 (valued at about Rs. 158.5 cr. in FY'18), of India's non-life segment. The Loss ratio was as high as 75%. Quantitative terms for premium, growth was -1% to Rs. 2,800 cr. in FY'18. Reinsurance for Indian businesses outside India went from Rs. 6,723 cr. in FY2016 to Rs. 12,461 cr. in FY2017. While there is Marine Hull premium shift from foreign to Indian (21.89% in FY'15 to 54.27% in FY'17, there is no significant growth in marine cargo premiums.

Marine has a relatively limited portfolio for the insurance business, generating just 3000 crores of premium out of a total of 2 lakh crores in the country. Over a decade, the statistics for marine hull have slowly declined from 1100 crores in 2012-13 to an annual premium of 875 crores presently. Some maritime businesses have reported a decline in volume of trade, resulting a freeze in new shipbuilding in the industry. As a result, marine premium loss ratios have consistently exceeded 100 percent, approaching 150 percent at times during the last decade. According to the most recent statistics, the amount is about 96 percent, demonstrating how terrible the state of this portfolio is currently.

General Insurance companies develop their capacity based on the capital they deploy, the premium they generate, and the reinsurance support they have. Ports and terminals are properties that fall into 'Wet' properties because of their proximity to the ocean front and sometimes extending into the sea in the form of SPMs, jetties, breakwaters, and other structures and/or machineries or appurtenances. As most property treaties exclude wet properties, insurance companies tend to only retain that much of the risk that fits into their net retention.

The other aspect is high liability cover requirement by the ports. Inclusion of mechanical breakdown and consequential loss cover which otherwise falls into the category of 'Engineering Insurance', makes it more complicated.

Due to the above aspects, some insurance companies offer a package policy known as 'Port Package Insurance', it combines all these risks that a port is exposed to.

## 3.1 Capacity in the Indian Market

*3.1.1* Due to the treaty restrictions, the available capacity of insurers is only that much which is representative by their absolute net retention.

*3.1.2* GIC Re sometimes provides capacity by way of compulsory session and by way of facultative reinsurance. Due to the lack of underwriters and inexperience in the marketplace, foreign reinsurers with presence in India prefer such risks to be underwritten in London or other reinsurance Centre's in the world. This is the reason for cession of reinsurance premium to overseas reinsurance Centre's / reinsurers.

Marine Insurance is one of the less understood aspects of shipping and port industry, in India. Indian marine insurance has been plaguing, the factors can be listed as below:

*3.1.3* Lack of integrated approach

*a)* Excessive multi-broker/intermediaries.
*b)* Lack of experience and expertise.
*c)* Lack of understanding of maritime law.
*d)* Failure to comprehend interconnective nature of maritime contracts.
*e)* Maritime Insurance training is essential and building upon the knowledge and expertise via proper mandates is imperative.
*f)* Understanding and utilization of insurance provisions in all international cargo movements can only be achieved if EXIM cargo associations are given a set of guidelines to adhere to.
*g)* Currently 18% GST on Insurance makes competition more difficult for Indian Insurance Companies.

## 3.2 Steps to be taken

*3.2.1* Risk Evaluation

*a) Review of Existing Systems*

- Focus on quality and extent of risk exposure.
- Make independent and unbiased recommendations.

- Ensure that exposures (hardware + third party) are suitable and cost-effectively covered.
- Take into account the insurance capacity available within the country.
- Evaluate the need for obtaining cover from overseas underwriters and reinsurers and make plans to expand capacity in India to replace the same, over time.

*b) Identify the residual risk resting with ports*

- Includes a realistic evaluation of the extent and cover of Shipowners', Stevedores, and third-party port users' insurance cover.
- Evaluate possibility of applying the "co-assured" or jointly assured concept, to reduce liability and recovery under subrogation from the port(s).

*c) Identify the base exposure common to all ports (for economies of scale)*

- Identification and quantification of specific risks relating to individual ports.
- Identification of additional insurance capacity (both property and third-party liability) that India needs.

*d) Force Majeure Risks*

- Port projects (Greenfield in particular) are exposed to force majeure events, such as natural calamities, fire, other disruptions of operations.
- These risks are often mitigated through insurance contracts and specific provisions in concession agreements.
- Type of insurance cover with regards to the risk covered, and adequacy in event of catastrophic losses and disruption needs to be evaluated.
- Case in point, the present pandemic – A good opportunity for Indian insurers to gauge and prepare for the future.

As known, the premium of any insurance depends upon the disclosure of risk. The success of a claim is also inherently dependent upon the exact nature and quantum of the risk, truthfully declared.

Thereby, it is the paramount responsibility of the potential insured to disclose the insurable risks, in order to make the claims process smooth, and expedite compensation.

*3.2.2* Claims Status Evaluation

*a)* Basic purpose of taking cover is threatened when claims may be in dispute / outright rejected. All the client gets then is a false sense of security, until crisis happens or there is a need for a claim payment.

*b)* Auditing the processes being followed in each port is essential, alongside valuation/quantification of the risk and risk mitigation.

*c)* In addition, regular inspections and maintenance systems put in place (with recommendations for improvement and implementation) will lead to a reduction in the perception of risk, and thereby reduce the premium, which will help in convincing more companies to take cover.

*3.2.3* Developing a Gold Standard

*a)* Streamlining processes through development of a Gold Standard.

*b)* Prepared and implemented by the authoritative body.

*c)* Schedule of regular internal and independent external audits.

*d)* In the event of claims, insurance policy ensured to respond in time and pay-out of legitimate claims quickly.

*e)* Faster pay-outs of legitimate claims will provide stability to trade & commerce, following a loss.

*f)* Reduction in claims that do not get paid out for breach of terms and conditions, warranties or put on hold unduly by insurers.

*g)* Under the "Indian Port Association" umbrella, PSU Ports Management to form a code of practice including but not limited to:

- Maintenance of proper asset registration, annual/biannual valuation of assets to avoid condition of under-insurance.
- Evaluation of "Business Interruption" exposure by maintaining accounts to a good standard.
- Maintenance of machineries, equipment, immovable and movable assets with a high standard and proper recordkeeping.
- Measures and procedures put in place for loss prevention and loss minimisation.
- Maintaining claims record, keeping database of breached and unjustifiable claims.
- Periodic surveys and compliance of recommendations made.

- Private ports need to align to these measures, especially in respect to their sustainability audit (covering public ports).

### *3.2.4* Increasing Insurance Capacity

While the key improvements mentioned previously (A-C) are in progress, the below steps will aid in streamlining and growing the Indian Maritime & Port Insurance Capacity:

*a)* Establishing a Primary Insurance Pool with a CMD (from the industry) and an operational team.
*b)* Establishing a Stakeholders' Advisory Board with representatives from PSUs, Private Underwriters and Significant Clients.
*c)* Investigate and understand reasons why insurance capacity could not be increased (consulting with Indian insurance PSUs and Financial Institutions).
*d)* Carry out a study of Chinese Insurance model to keep most of the insurance & reinsurance premia within the country.

In order that the market starts developing its capacity, the PSU ports need to create a pool on a contribution basis based on the following criteria:

*a)* *Type of Cargo Handled:* They retain certain part of the risk at the pool level, and they contribute to a pool which will entertain liability up to a certain amount.
*b)* *Turnage of Cargo Handled:* The next portion will be the available capacity of the Indian market. This will be fully retained in the market and will be fully administered by an Indian insurance company with assistance of nominated risk managers and loss adjusters. We call this to be 'Primary Layer'. This will be rated by Indian Insurers based on their losses.
*c)* *Revenue earned:* Over the primary layer, Indian reinsurers must ensure capacity deployment by pooling and that would add to the first layer above the primary or one can structure excess of loss reinsurance on a layer basis and price it appropriately so that ports pay higher premium for higher capacity requirement.
*d)* *Geographical location:* With better risk management and improved loss experience, the market retention can be increased.

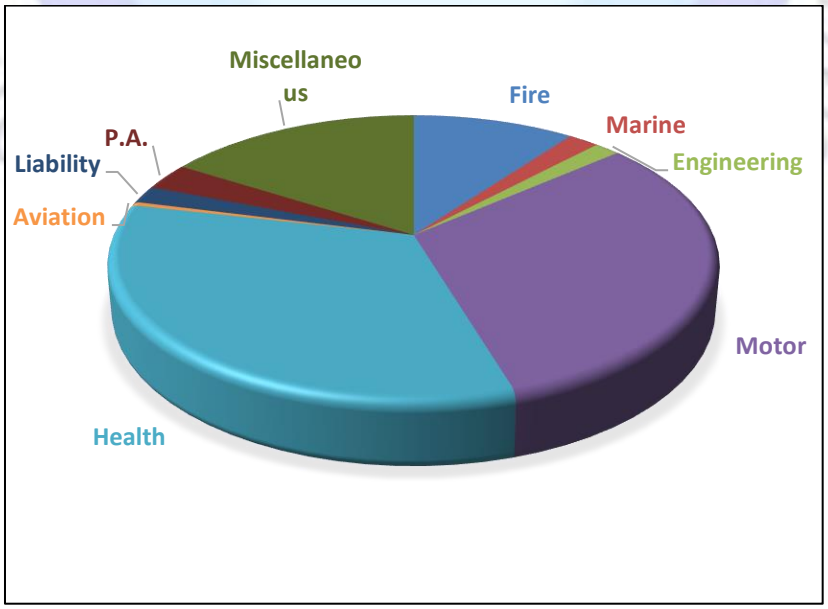
*Figure 1: Stake holders and insurance pool*

| STAKE HOLDERS ADVISORY BOARD (proposed to be newly appointed)<br>OBJECTIVE: TO ENSURE COMPLIANCE BY THE POOL | | | | | |
|---|---|---|---|---|---|
| PRIMARY INSURANCE POOL (proposed to be newly formed)<br>OBJECTIVE: MAXIMISE MARKET RETENTION | | | | | |
| NIA<br>**(LEAD)** | UII | OIC | GIC Re | INDIAN PRIVATE SECTOR (E.G.) | INDIAN PRIVATE SECTOR (E.G.) |
| NEW INDIA ASSURANCE | UNITED INDIA INSURANCE | ORIENTAL INSURANCE COMPANY | GENERAL INSURANCE CORPORATION | TaTa AIG | BAJAJ ALLIANZ |
| | | | | ICICI LAMBARD | HDFC |

e) *Result of JH-143 Survey and Past Loss Experience:* Increasing the Capacity in the Indian Market, by following steps:

- A large general insurance company, preferably a PSU with deep reserves and expansiveness to provide capacity, administer the programme and front the policies.
- A group of officers / executives who have the required experience and the expertise to handle the specialized class of insurance.
- Experienced international brokers to advise on technical matters, structure, and source reinsurance capacity.
- A group of reinsurers who will look at it on a long-term basis.

*Figure 2: Segment-Wise Gross Direct Premium Income by Non-life Insurers in India (April 2021 to February 2022)*




*Source: gicounsil.in*

Category of Marine includes Marine Cargo and Marine Hull, while category of Motor includes Motor OD and Motor TP and Miscellaneous includes Crop Insurance + Credit Guarantee + All other miscellaneous.

In the year 2021 to Feb 2022 total premium registered growth of 11.05 percent from previous year. In the year 2020- 2021 it was 179237.93 and increased to was 199043.4 crores**.**

*Table 1: Marine Sector gross direct premium in India (2020 to 2022 February)*

| Year | Marine Cargo | Marine Hull | Marine Total |
|---|---|---|---|
| 2021-22* | 2906.43 | 936.31 | 3842.74 |
| 2020-2021 | 2263.76 | 952.92 | 3216.68 |
| % Growth | 28.389 | -1.743 | 19.463 |

Source: gicounsil.in

*Note (*): Not including the entire year*

## 4. INDIA'S INSURANCE CAPACITY FOR THE MARITIME SECTOR

Maritime arbitration is an efficient and effective method of resolving maritime disputes. Maritime disputes are technical, commercial, and global in nature and is required to be accepted by stake holders involve in maritime international trade.

India has a long tradition of arbitration, such as the settlement of differences by tribunals agreed-upon by the involved parties. In current times the maritime trade globally is governed by some regulatory bodies.

Maritime law or admiralty law addresses nautical and private issues and disputes. These laws are basically consisting of domestic law about shipping/maritime activities, and private international law governing the relationships between private parties functioning on ocean-going ships.

## 3.3 Current Status of Legal / Alternate Dispute Resolution in India

### *3.3.1* Maritime Arbitrations

*a)* London presently the leading arbitration centre for commercial disputes.

*b)* Maritime Arbitrations are a significant contributing element to this.

*c)* Dedicated bodies for maritime alternate dispute resolutions like LMAA in the UK, TOMAC in Japan, etc.

*d)* Meantime in India, best we have at present is 'Rules for Maritime Arbitration' in the ICA, set up in 1965. Similarly, we have the 'Maritime Arbitration Rules' in IDAC.

*e)* As per LCIA data in 2015, from a total of 449 appointments of arbitrators, no Indian Arbitrators were chosen.

*f)* With most Indian arbitrators in Singapore, of 126 arbitrations in 2015 from SIAC data, only 3% were Indian appointments.

### *3.3.2* Indian Maritime Arbitration Body

Maritime Industry is Multi-Modal, Multi-Contract, Multi-Jurisdiction and Multi-Nationality. The industry needs a dispute resolution system that is private, cost-effective, time efficient and enforceable. India needs to Work towards establishing an international Maritime

Dispute Resolution Centre. India has benefit of language and education which can be leveraged the industry's desire to participate in making India a world leader in alternate dispute resolution. India can effectively conduct Online hearings, integrate the use of AI in litigation and ADR.

Arbitrations India must also have its own maritime arbitration centre which is claimable because India's EXIM trade where about 85 billion dollars a year are spent on foreign freight by foreign flag vessel requires to be serviced in India. It simply cannot struggle around different arbitration centres from Hong Kong to London to Singapore or elsewhere and must create its own centre.

The distribution of seats in arbitration is done via charter party which takes respective decisions in the interest of Indian cargo and then drives the arbitration process by its commands on which arbitral tribunal individuals are going to be assigned to.

### 3.4 Identifying London Maritime Arbitration Association (LMAA) procedures

Party autonomy is key to Arbitration success. Adoption of LMAA rules with logical changes may make the process simpler and practical, without having to reinvent the wheel.

Similar to LMAA and Tokyo Maritime Arbitration Commission (TOMAC), the IMAA shall be independent, with no compulsory appointments from PSUs, government, or industry associations. IMAA to have its own governing body.

- Establishing a Panel and List of commercially minded individuals as Maritime Arbitrators, as well as lawyers with Maritime Law knowledge and experience.
- Support from policy makers to promote IMAA (e.g., make IMAA clause compulsory for PSU maritime trades.
- Awards by IMAA enforceable by Indian court of law. IMAA to also provide Mediation, Med-Arb, Arb- Med services.

### 3.5 Existing Panels

The Society for affordable redressal of disputes (SAROD-Ports) has been formed by the Indian Ports Association (IPA) in association with Indian Private Ports & Terminals (IPPTA) under the Societies Registration Act, 1860. The Society has been registered in Delhi on 30.01.2020 and shall be functioning as per the Rules and Regulations framed and amended from time to time. The purpose of SAROD-Ports is to take care of the pending or future disputes between the ports and the concessionaires. The objectives of SAROD-Ports to achieve dispute resolution timely, cost effectively, while continue to enrich the dispute resolution mechanism with the help of experts.

Include existing segment specific panels (e.g., SAROD-Ports) under the IIMA umbrella to serve the parties desiring to base their dispute resolution clause upon them.

### 3.6 IMAA Alternate Dispute Resolution: *The key point in ADR is Enforceability of awards*

Courts must be supportive of the IMAA's rulings, and refuse to entertain appeals against an award, except in cases of public policy, or in the case of a proven bias from one or more involved arbitrators. Parties who engage in arbitration must comply with the decisions of the arbitrator, and the award thereby issued.

Once the IMAA has been established, discourage the mushrooming of Maritime Arbitration centres or associations. A way to achieve this is by maintaining an open fair list and panel of the arbitrators involved.

### 3.7 Support needed from

- MOS – for a strong follow up through one of its departments / divisions.
- Ministry of Law & Justice – to enact certain regulations that encourages the courts to allow / upheld the decisions made through the body conceptualized.
- Ministry of Corporate affairs agree to give a nod.
- Ministry of Commerce and Industry to concur.

## ABBREVIATIONS

| | |
|---|---|
| ADR | Alternative Dispute Resolution |
| BBC | Bare Boat Charter |
| CAPEX & OPEX | Capital expenditure, and Operating Expenses |
| GIFT | Gujarat International Finance Tec-City |
| GOI | Government of India |
| IFSC | International Financial Services Centre |
| IMAA | Indian Maritime Arbitration Association |
| IISR | Indian International Shipping Register |
| IPA | Indian Ports Association |
| IPPTA | Indian Private Ports & Terminals |
| JV | Joint Venture |
| LMAA | London Maritime Arbitration Association |
| OD | Own Damage |
| SOP | Standard Operating Procedure |
| TP | Third Party |
| TOMAC | Tokyo Maritime Arbitration Commission |

## REFERENCES

AMSS. (n.d.). *Association of Maritime Safety and Security*. Retrieved from http://www.safetysea.org/

General Insurance Council. (2022). *Industry Performance* . Retrieved from Segmentwise Report: https://www.gicouncil.in/statistics/industry-statistics/segment-wise-report-on-homepage/

Govt of India. (2021). Maritime India Vision 2030[11]. *Ministry of Ports, Shipping & Waterways*. Retrieved from https://shipmin.gov.in/sites/default/files/MIV%202030%20Presentation_compressed.pdf

Jiang, Z. (2011). Maritime Arbitration: Law and Practice in the People's Republic of China. *Faculty of Law, Lund University*, 60-72. Retrieved from https://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=1976812&fileOId=1977171

Makkar, J. (2019). *Indian Shipping and Ports - Initial thoughts & Recommendations.* Mumbai Port Trust.

Makkar, J. (2020, April). A Critical Review of the Indian Ports and Shipping Sector. *IIRE Journal of Maritime Research and Development*, *4*(1), 18-30.

Makkar, J. S. (2022, February). *Jagmeet Singh Makkar's Post*. Retrieved from LinkedIn: https://www.linkedin.com/posts/jagmeet-singh-makkar-13385a30_greetings-on-behalf-of-skillsplus-we-wish-activity-6882367300935278592-VOrc#:~:text=1.%20Developing%20Indian%20Controlled%20Tonnage%3B

Unison. (n.d.). *Ports & Terminals*. Retrieved from Unison Unparalleled Insurance Solutions: https://unisoninsurance.net/ports-terminals.php

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

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## 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.

## REFERENCES

Baker, J. (2020, Feb 04). *Predictive analytics: the new hot ticket in shipping?* Retrieved from Ship Technology: https://www.ship-technology.com/features/predictive-analytics-new-hot-ticket-shipping/

Business Wire. (2022, February 28). *Global Maritime Analytics Market Analysis/Forecast Report 2021-2028 - Increasing Demand for Enhanced Maritime Operations Through Data Analytics & Developing Regions to Drive Future Growth*. Retrieved from Business Wire: shorturl.at/puHW6

DHL/Cisco. (2015, April 15). *Internet of Things will deliver $ 1.9 trillion boost to supply chain and logistics operations*. Retrieved from Deutsche Post DHL Group:

https://www.dpdhl.com/en/media-relations/press-releases/2015/dhl-and-cisco-trend-report-internet-of-things.html

DNV GL. (2018, April 30). *Annual Report 2017*. Retrieved from DNV GL: https://issuu.com/dnvgl/docs/180430133227-c8c508c4e8d34efabdfd167ac385a6d6

IBM/Maersk. (2017, March 05). *Maersk and IBM Unveil First Industry-Wide Cross-Border Supply Chain Solution on Blockchain*. Retrieved from IBM Newsroom: https://newsroom.ibm.com/2017-03-05-Maersk-and-IBM-Unveil-First-Industry-Wide-Cross-Border-Supply-Chain-Solution-on-Blockchain

Latifov, K. (2019). A critical evaluation of potential outcomes of using modern. *The Maritime Comomns: Digital Repository of the World Maritime University*, 12-62. Retrieved from https://commons.wmu.se/cgi/viewcontent.cgi?article=2222&context=all_dissertations

Marija Jovic, E. T. (2019). Big Data Management in Maritime Transport. 123-141.

Ministry of Ports, S. a. (2021, Febraury 19). *Maritime India Vision 2030*. Retrieved from Sargamala: https://sagarmala.gov.in/sites/default/files/MIV%202030%20Report.pdf

Shipware. (2021, June 14). *How Predictive Analytics Is Changing the Way Shipping Works*. Retrieved from Shipware: https://shipware.com/blog/how-predictive-analytics-is-changing-the-way-shipping-works/

The Insight Partners. (2021, December). *Maritime Analytics Market Forecast to 2028 - COVID-19 Impact and Global Analysis By Application*. Retrieved from ResearcH and Markets: https://shrt.cx/mpxC6I

The World Bank. (2017). *Logistics Performance Index*. Retrieved from The World Bank Organization: https://lpi.worldbank.org/domestic/performance/2016/C/AFG#chartarea

Wärtsilä. (2017). *Wärtsilä: Eniram*. Retrieved from https://www.wartsila.com/insights/article/becoming-part-ofw%C3%A4rtsil%C3%A4-eniram

WCN Editorial. (2017, September 27). *ITS and Advent move to streamline appointment process in Long Beach*. Retrieved from World Cargo News: https://www.worldcargonews.com/news/news/its-and-advent-move-to-streamline-appointment-process-in-long-beach-26956

Yifan Zhang, J. L. (2020, June). Energy-Efficient Cyclical Trajectory Design for UAV-Aided Maritime Data Collection in Wind. *GLOBECOM 2020*. doi:https://doi.org/10.1109/GLOBECOM42002.2020.9322588

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# DEMYSTIFYING HUMAN FACTORS & INTEGRATING IN MANAGEMENT SYSTEMS

Dr Suresh Bhardwaj[1]

Abstract

Human factors are the physical, psychological, and social characteristics that affect human interaction with equipment, systems, processes and other individuals. It is the people on our ships who actually make safety work. However human error still occurs in the interactions with conditions, systems, and other people. By addressing these interactions, we can reduce human error, thereby reducing incidents and improving reliability and productivity.

***Keywords:*** Human factors, human error, human element.

## 1. INTRODUCTION

Often incidents are attributed to human involvement. This gives the impression that people cause incidents. A human-centred approach recognises that human error, actions, and decisions are often the result of the way the workplace is set up; how work, equipment and safeguards are designed, and how leaders influence the work culture. By making human factors' assessment fundamental to the work processes, it can systematically address the issues and latent conditions that influence errors, actions and decisions that cause risk or lead to harm.

Human Factors thus needs to be an integral part of any organization's strategy and a key enabler to further reduce safety, environment, security and health impacts within the maritime industry. That means that it must be part of any management system. This paper aims to 'demystify' human factors and help those involved gain confidence by successfully incorporating human factors in their management systems.

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## 2. HOW DO HUMAN FACTORS RELATE TO INCIDENTS?

Safety is usually defined as 'freedom from incidents and accidents. So, is it then a "dynamic non-event," noted more in its absence than its presence? If the measurement of safety is that nothing happens, then how do we understand how systems operate - to produce nothing?

In other words, since accidents are only probabilistic outcomes, it is a challenge to say for sure that the absence of accidents is by good design or by lucky chance! (Rasmussen, J. 2000).

The starting point for safety management traditionally is that either something has gone wrong or that something has been identified as a risk. The generic mechanism is the Causality Credo—a predominant belief that adverse outcomes (accidents, incidents) happen because something goes wrong, hence that they have causes that can be found and treated.

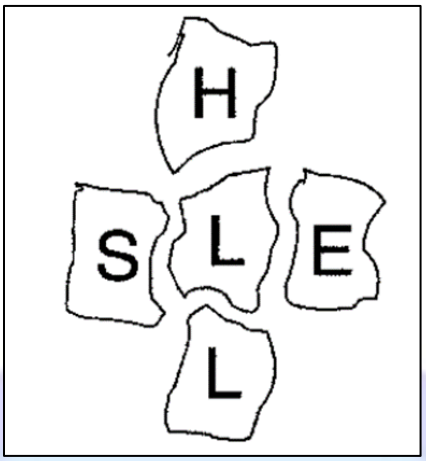
It is presumed that things go wrong because of identifiable failures or malfunctions of specific components: technology, procedures, the human workers and the organisations in which they are embedded. Humans—acting alone or collectively—are therefore viewed predominantly as a liability or hazard, principally because they are the most variable of these components.

However, in contemporary safety science, the concept of unsafe acts shifted from being synonymous with human error to the notion of deviation from the expected performance, and considers the contributing factors that lead to the performance deviation, in as much as considering failures of barriers or defences at all stages of the accident development as well as 'latent conditions' or dormant conditions that are present within the system well before there is any recognizable accident sequence (DOE, 2012).

Furthermore, today's work environment on board the ships being very complex, SHEL Model: Liveware – L, Hardware – H, Software – S, Environment - E. is commonly depicted graphically to display not only the four components of work environment but also the relationships, or interfaces, between the liveware and all the other components.

A mismatch can be a source of human error and identification of a mismatch may be the identification of a safety deficiency in the system (IMO, 2000).

*Figure 1: SHEL Mode*




Investigations thus require delving into the basic organizational processes: designing, constructing, operating, maintaining, communicating, selecting, and training, supervising, and managing that contain the kinds of latent conditions most likely to constitute a threat to the safety of the system. The investigation focuses on understanding the context of decisions - and explaining the event 'why people did what they did', and this provides a much better understanding and thence the ability to develop solutions that improve operations.

## 2.1 Why understanding human performance matters:

People interact with each other, plants, and process as part of a complex system. Human beings are essential in maintaining our barriers and safeguards. They can, and often do, "save the day". But we also know that people will make mistakes. Their actions are rarely malicious and usually make sense to them at the time. We know that mistakes are typically due to underlying conditions and systems. Understanding why mistakes happen can help us prevent or cope with them. Investigation is central to understanding why people did what they did. We use what we learn from investigation to design plants, tools, and activities to reduce mistakes and better manage risk. Finally, we know that leaders help shape the conditions that influence what people do. It matters how leaders respond when things go wrong (Conklin, 2019).

### *2.1.1 What are 'Human Factors'?*

'Human Factors' are simply those things that can influence what people do. They may include factors relating to the job people do (e.g., time available or control panel design) personnel factors

(e.g., fatigue, capability) and organizational factors (roles, manning levels). This list of factors is often referred to as “Performance Shaping Factors”.

The goal of human factors (HF) in investigation is to understand what influenced the behaviours that were causal or contributory to the incident. Plants, tools, and activities can be designed to reduce mistakes and manage risk better.

### *2.1.2 Performance Influencing Factors (PIFs)*

Performance Influencing Factors (PIFs) are the characteristics of the job, the individual and the organisation that influence human performance. Optimising PIFs will reduce the likelihood of all types of human failure.

Job factors:

- Clarity of signs, signals, instructions, and other information.
- System/equipment interface (labelling, alarms, error avoidance/ tolerance).
- Difficulty/complexity of task.
- Routine or unusual.
- Divided attention.
- Procedures inadequate or inappropriate.
- Preparation for task (e.g., permits, risk assessments, checking).
- Time available/required.
- Tools appropriate for task.
- Communication, with colleagues, supervise on, contractor, other.
- Working environment (noise, heat, space, lighting, ventilation).

Person factors:

- Physical capability and condition.
- Fatigue (acute from temporary situation, or chronic).
- Stress/morale.
- Work overload/underload.
- Competence to deal with circumstances.
- Motivation vs. other priorities.

Organisation factors:

- Work pressures e.g., production vs. safety.
- Level and nature of supervision / leadership.
- Communication.
- Manning levels.
- Peer pressure.
- Clarity of roles and responsibilities.
- Consequences of failure to follow rules/procedures.
- Effectiveness of organisational learning (learning from experiences).
- Organisational or safety culture, e.g., everyone breaks the rules.

Human performance isn't about apportioning blame. It's about identifying potential flaws in the systems that people are a part of (i.e., equipment, process, environment). Incidents can be avoided with a better understanding of the conditions that lead to the error. Human performance helps to recognise these flaws and takes steps to address them.

## 3. FROM PREVENTIVE TO PRODUCTIVE SAFETY

### 3.1 From Safety-I to Safety-II

In Safety-I, the starting point for safety management is either that something has gone wrong or that something has been identified as a risk. The generic mechanism of Safety-I is the Causality Credo—a predominant belief that adverse outcomes (accidents, incidents) happen because something goes wrong, hence that they have causes that can be found and treated.

In the normal course of work, seafarers perform safely because they are able to adjust their work so that it matches the conditions. Seafaring and ship operations by its very nature is made intractable by the bull-headed approach in this worst-case scenario of globalization. Given the uncertainty, intractability, and complexity of work, the surprise is not that things occasionally go wrong but that they go right so often. Yet as we have seen, when we try to manage safety, we focus on the few cases that go wrong rather than the many that go right. But attending to rare cases

of failure attributed to ‘human error’ does not explain why human performance practically always goes right and how it helps to meet goals of safe voyages. Focusing on the lack of safety does not show us which direction to take to improve safety.

The solution to this is surprisingly simple: instead of only looking at the few cases where things go wrong, we should look at the many cases where things go right and try to understand how that happens. We should acknowledge that things go right because seafarers are able to adjust their work to conditions rather than because they ‘work as imagined’. Resilience engineering acknowledges that acceptable outcomes and adverse outcomes have a common basis, namely everyday performance adjustments.

Safety-II is the system’s ability to function as required under varying conditions, so that the number of intended and acceptable outcomes (in other words, everyday activities) is as high as possible. The basis for safety and safety management must therefore be an understanding of why things go right, which means an understanding of everyday activities.

### 3.2 ‘Work-As-Imagined’ and ‘Work-As-Done’

It is an unspoken assumption that work can be completely analysed and prescribed and that Work-As-Imagined therefore will correspond to Work-As-Done. But Work-As-Imagined is an idealized view of the formal task environment that disregards how task performance must be adjusted to match the constantly changing conditions of work and of the world. Work-As-Imagined describes what should happen under normal working conditions. Work-As-Done, on the other hand, describes what actually happens, how work unfolds over time in complex contexts.

But the more intractable environments that we have today means that Work-As-Done differs significantly from Work-As-Imagined. Since Work-As-Done by definition reflects the reality that people have to deal with, the unavoidable conclusion is that our notions about Work-As-Imagined are inadequate if not directly wrong.

This constitutes a challenge to the models and methods that comprise the mainstream of safety engineering and human factors. It also challenges traditional managerial authority and how safety is managed in the shipping industry - through procedures and systems defined and controlled by the company. In the shipping industry this kind of control from the company is yet more

accentuated because of the stringent mandatory regulations and far-reaching implications if the shore -management is seen to be in any fault.

A practical implication of this is that we can only improve safety if we get out from behind our desk, out of meetings, and into operational environments and with operational people. Today's work environments require that we look at everyday work or Work-As-Done rather than Work-As-Imagined, hence at systems that are real rather than ideal.

Such systems perform reliably because people are flexible and adaptive, rather than because the systems have been perfectly thought out and designed or because people do precisely what has been prescribed. Humans are therefore no longer a liability and performance variability is not a threat.

On the contrary, the variability of everyday performance is necessary for the system to function and is the reason for both acceptable and adverse outcomes. Because all outcomes depend on performance variability, failures cannot be prevented by eliminating it; in other words, safety cannot be managed by imposing constraints on normal work (Hollnagel, 2015).

The way we think of safety must correspond to Work- As-Done and not rely on Work-As-Imagined.

### 3.3 The Manifestations of Safety-II: Things that go right

In Safety – II, safety is defined by what happens when it is present, rather than by what happens when it is absent, and is thus directly related to the high frequency, acceptable outcomes. In other words, the more of these manifestations there are, the higher the level of safety is and vice versa.

Even though things go right all the time, we fail to notice this because we become used to it. Psychologically, we take it for granted. But since everyday performance is unexceptional, it can be explained in relatively simple terms.

For instance, everyday performance can be described as performance adjustments that serve to create or maintain required working conditions, that compensate for a lack of time, materials, information, etc., and that try to avoid conditions that are known to be harmful to work. And because everyday performance variability is ubiquitous, it is easier to monitor and manage.

*Figure 2: Event Probability and Safety Focus (Kurzweil, 2018)*

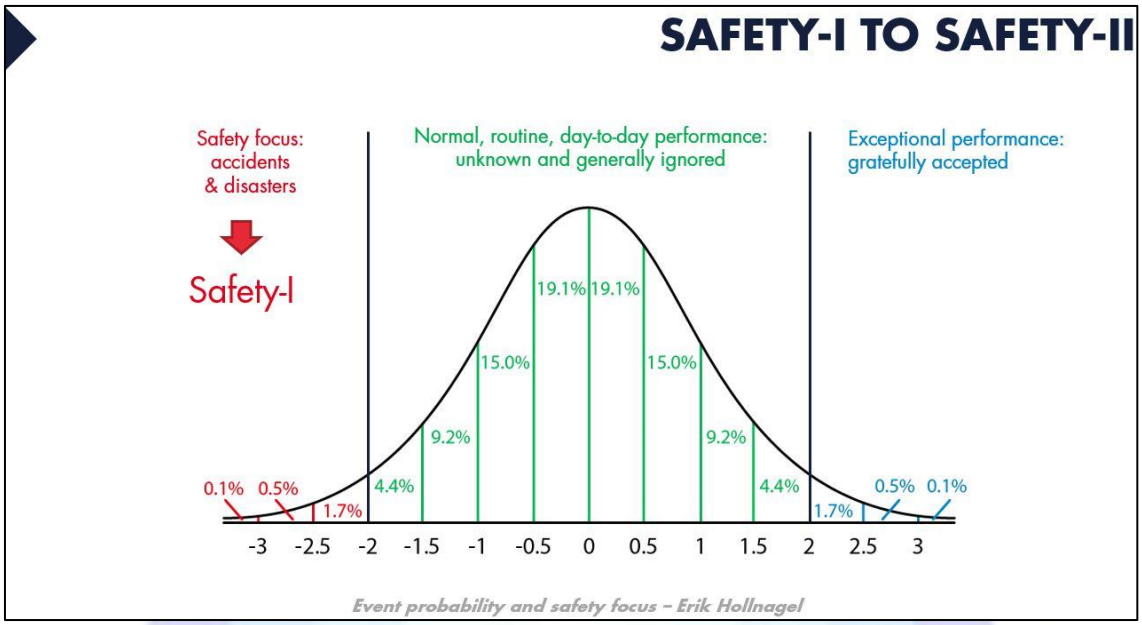



*Figure 3: Difference between Safety-I and Safety-II (Kurzweil, 2018)*

| | Safety-I | Safety-II |
|---|---|---|
| **Definition of safety** | That as few things as possible go wrong. | That as many things as possible go right. |
| **Safety management principle** | Reactive, respond when something happens or is categorised as an unacceptable risk. | Proactive, continuously trying to anticipate developments and events. |
| **View of the human factor in safety management** | Humans are predominantly seen as a liability or hazard. | Humans are seen as a resource necessary for system flexibility and resilience. |
| **Accident investigation** | Accidents are caused by failures and malfunctions. The purpose of an investigation is to identify the causes. | Things basically happen in the same way, regardless of the outcome. The purpose of an investigation is to understand how things usually go right as a basis for explaining how things occasionally go wrong. |
| **Risk assessment** | Accidents are caused by failures and malfunctions. The purpose of an investigation is to identify causes and contributory factors. | To understand the conditions where performance variability can become difficult or impossible to monitor and control. |

What seafarers do in everyday work situations is usually a combination of Safety-I and Safety-II. The specific balance depends on many things, such as the nature of the work, the experience of the people, the organisational climate, management and time pressures, and other characteristics. Everybody knows that prevention is better than cure, but the conditions may not always allow prevention to play its proper role. It is a different matter when it comes to the ranks of policymakers, and management and regulatory activities. Here the Safety-I view dominates.

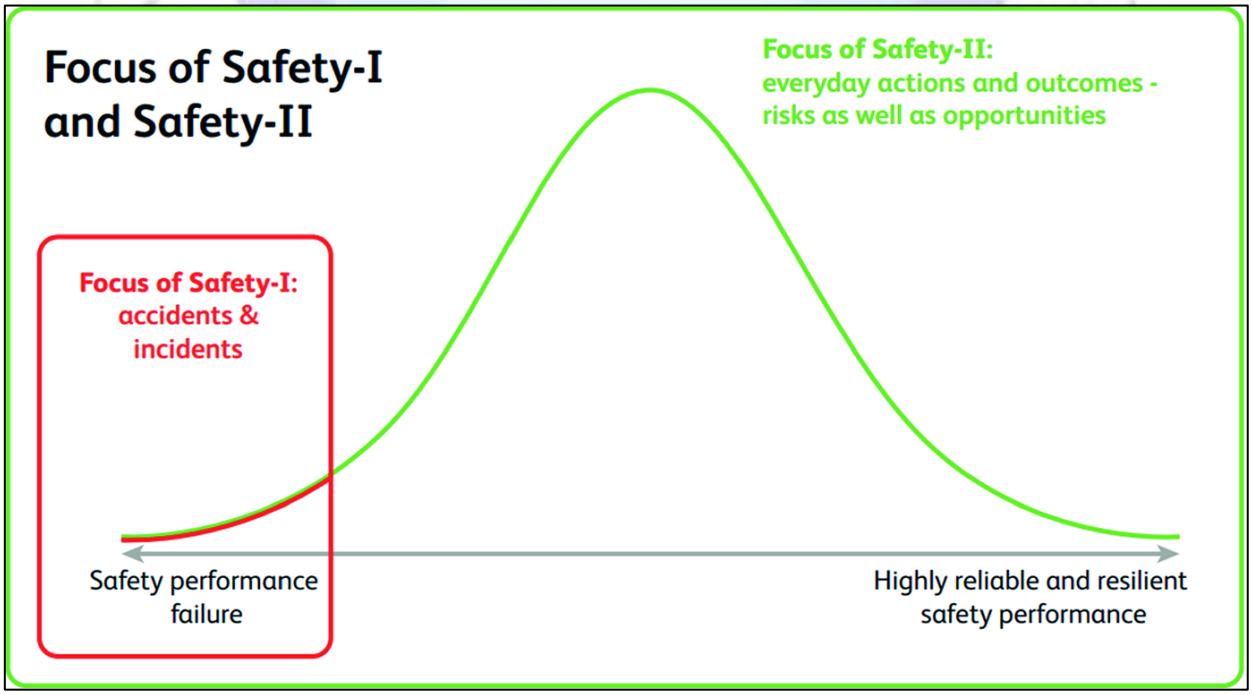
One reason is that the primary objective of policymakers, managers and regulators historically has been to make sure that there are no accidents. Another reason is that these levels are removed in time and space from the actual operation of the systems and services, and therefore have limited opportunity to observe or experience how work actually is done. A third reason is that it is much simpler to count the few events that fail than the many that do not—in other words an efficiency-thoroughness trade-off.

It is important to emphasise that Safety-I and Safety-II represent two complementary views of safety rather than two incompatible or conflicting approaches. Many of the existing practices can therefore continue to be used, although possibly with a different emphasis.

## 4. SAFETY-II IS THE HUMAN FACTORS APPROACH

It is necessary to understand how such everyday activities go well—how they succeed—in order to understand how they might fail. From a Safety-II view, they do not fail because of some kind of error or malfunction, but because of unexpected combinations of everyday performance variability.

*Figure 4: Focus of Safety-I and Safety-II (Kurzweil, 2018)*



Safety-II focuses on events in the middle of the distribution. These are 'difficult' to see, but only because we habitually ignore them in our daily activities. The 'logic' seems to be that if something works, then why spend more time on it? But the fact of the matter is that they usually do not work in the way that we assume, and that Work-As-Done may be significantly different from Work-As-Imagined. The events in the middle can be understood and explained in terms of the mutual performance adjustments that provide the basis for everyday work.

Because they are frequent, because they are small scale, and because we can understand why and how they happen, they are easy to monitor and manage. Interventions are focused and limited in scope (because the subject matter is uncomplicated), and it is therefore also easier—although not necessarily straightforward— to anticipate what both the main and the side effects may be.

In other words, it is our people on the ships, in the operations and support teams who make safety work. However, human error still occurs in the interactions with conditions, systems, and other people. By addressing these interactions, we not only reduce human error but also improve reliability and productivity.

Human Factors addresses the interaction of people with other people, with facilities and with management systems in the workplace. These factors have been shown to have an impact on human performance and safe operations. Human Factors is the application of what we know about human capabilities and limitations in order to maximize overall system performance. By giving careful consideration to the interactions between humans and technological and organizational elements of a system it is possible to significantly increase the system's productivity and reliability.

Human Factors is about making it easy for people to do things right and hard to do things wrong.

- Fit the task, equipment, environment to the capabilities and limitations of Person.
- Not try to adapt or fit the person to the task.
- Ultimately, our goal is to make the human interaction with systems one that:
- Enhances performance.
- Increases safety.
- Increases user satisfaction.

Human factors involve the study of factors and development of tools that facilitate the achievement of these goals.

## 4.1 Areas where Human Factors have key role

- Design of tools, equipment and user interfaces in a way that augments the user's work performance.
- Human and organizational factors in risk assessments and emergency preparedness planning.
- Human behaviour and cognition in accident causation.
- Efficient decision making and teamwork in stressful or critical situations.
- Safety culture and safety behaviour improvement programs.

## 4.2 Human Centred Design

### *4.2.1 User Centred Design*

A 'user-centred design' approach requires that the design of equipment and systems is based on understanding the needs and characteristics of its users. To make this happen, the design process needs to involve stakeholders in a continual process of identifying user requirements for tasks, testing the design, and iterating. This draws on all the available data on the purposes, needs, capabilities and limitations of humans.

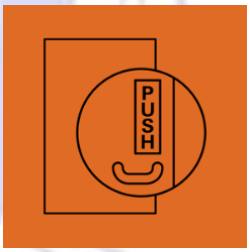
Involving users too late in the design process can be costly. Once a system is in development, correcting a problem where the design does not meet the needs of the users can cost an estimated ten times more than fixing it during design, but once a system is being used, it can cost 100 times more.

### *4.2.2 Principles of Workplace design*

Four principles govern the workplace design. They may seem like common sense, but can be overlooked:

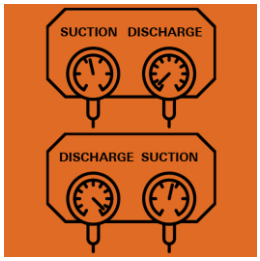
- Importance. Locate components that are essential to a safe and efficient operation in the most accessible positions. ‘Accessible’ refers not just to ease of reach, but also to visibility and audibility.
- Frequency of use. Make components that are used frequently the most accessible.
- Function. Locate components with closely related functions close to each other.
- Sequence of use. Locate components that are often used in sequence close to each other and in a layout consistent with the sequence of operation.
    - Access – When providing physical access, the design accommodates for neutral postures and provides space for the person to perform the work. The design also accounts for their clothing, or any protective covering worn by the worker and any equipment carried by the employee.

    - Shortcuts – If equipment is perceived by users to be too complex, or it requires more effort to operate or maintain than they believe is necessary, they may look for a 'shortcut', which could be perceived as being safe when it isn’t.
    - Expectations - If the equipment is not designed to operate as per the users’ cultural and stereotypical expectations, the chance for human error is significantly increased.
    - Simplicity – Reducing the number of activities the operator has to complete to lower the complexity of the task can reduce the chance for human error.




    - \Consistency – Humans expect consistency in the design and arrangement of their workplace. If a part of the workplace appears in more than one location in their work environment, operators will likely expect it to work the same way at every location.

      For example, if buttons are laid out in a particular way on one area of a control desk, but the same buttons have a different layout in another area of the desk, there is a risk of errors occurring.
    - Efficiency – If the design is felt to be inefficient by the user they may modify it, which will often solve the initial problem but may introduce other problems that may be as bad, or worse.



### 4.3 Closed-loop design and feedback

Humans perform best in a closed-loop design cycle. We are constantly working through this cycle of:

- Sensing information.
- Processing that information.
- Responding with action.
- Seeking feedback to decide if our action has had the result we were after – so we sense and process information again.

In this way the cycle continues. There should be no break in the cycle, especially between the action taken and the feedback provided. With our feedback systems we aim to show a person what the result of their action has been, not that they have triggered an action.

For example, an operator may trigger the opening of a valve. The feedback system may show that the operator has asked for the valve to be opened, but what if there is a fault and the valve jams shut? If the system only shows that the open command was given, it gives the operator a false impression

In another example, a technician may be required to provide a constant flow of fluid to test a new system, by controlling a valve. If there is no feedback system to show them the effect of the valve on flow, they cannot maintain the required rate.

In an ideal world, every product and system that is designed for use by humans would be developed with human factors in mind.

- A user centred approach to design can be a cost-effective way to make sure the characteristics and needs of the users have been addressed and the system is *usable.*
- By following the design principles and ensuring that our products and systems have the right design characteristics, we can make sure that human factors have always been incorporated into our designs.
- Proper user centred design can mitigate the opportunity for errors independent of competency and training, thereby relying on administrative controls for avoiding performance risks.

## 5. ERGONOMICS

Ergonomics is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimise human well-being and overall system performance. Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and systems in order to make them compatible with the needs, abilities and limitations of people. (IEA)

### 5.1 Why ergonomics?

It is a subject that continually incorporates information and technologies from other domains if they contribute to understanding and improving human performance.

It creates an awareness in industry of the importance of human factors when planning work and that the overall purpose of ergonomics is to increase the efficiency of human activity. (Murrell).

Source: Murrell, KHF (1965), *Ergonomics*. Chapman and Hall.

- Physical ergonomics is concerned with working postures, materials handling, repetitive movements, work related musculo-skeletal disorders, workplace layout, safety and health.
- Cognitive ergonomics is concerned with mental workload, decision-making, skilled performance, human-computer interaction, human reliability, work stress and training.
- Organisational ergonomics is concerned with communication, crew resource management, work design, design of working times, teamwork, participatory design, community ergonomics, cooperative work, new work paradigms, virtual organisations, telework, and quality management.

### 5.2 Workload, Stress, and Fatigue

#### *5.2.1 What is Workload?*

Workload generally refers to the quantity of work people are expected to complete, but workload isn't just about the sheer amount of work. It may also refer to:

- How difficult the work is.
- How much the amount of workload varies (e.g., busy, and quiet periods).
- The extent to which staff have control over their workload and the way they choose to carry out their work.
- The novelty/variety of the work to those staff carrying it out.
- The length of time for which staff work at an intense rate without breaks.

Physical workload

Physical workload means the demands created by working in a particular posture (e.g., sitting, standing, or reaching at a workstation); manual labour (such as walking, using hand tools, carrying loads); or working in particular environmental conditions (e.g., extremes of temperature and humidity, or poor lighting).

Mental workload

Workload can also refer to the mental demands created by gathering sources of information and then processing the information, often against time pressure. Mental workload can be considerably increased by the feeling of additional pressure resulting from knowing the potential consequences of an error. It's unrealistic to expect that people will maintain high levels of concentration and vigilance for long periods of time. The intensity of the mental workload will reduce the time people are able to concentrate for.

### 5.3 Signs of Stress

Work that isn't challenging enough can cause boredom, so a healthy level of pressure is useful, but too much pressure can lead to stress. It's important to be aware of signs of stress, both in yourself and in others, as it can seriously impair ability to function.

**Physical signs** of stress include:

- Difficulty sleeping.
- Indigestion and abdominal pain.
- Headaches.

- Increased smoking or alcohol consumption.

**Behavioural signs** of stress include:

- Difficulty concentrating/lapses in attention.
- Emotional outbursts or becoming withdrawn.
- Frequent errors, even with simple tasks.

**Emotional signs** of stress include:

- Feelings of depression or anxiety.
- Decrease in self-confidence.
- Feelings of anger or resentment.

## 5.4 Fatigue

Fatigue is different to stress and is the state of tiredness that can be associated with long hours of work, prolonged periods without sleep or with working when people would normally be resting. Fatigue can also be experienced due to sleep disorders such as:

- Obstructive sleep apnea (person stops breathing periodically during the night).
- Narcolepsy (the brain's inability to control its sleep/wakefulness cycles).

Other health conditions that create fatigue as a symptom include:

- An underactive thyroid.
- Diabetes.
- Depression.

### *5.4.1 Effects of fatigue*

A person experiencing fatigue might be more likely to make errors and take risks and be less able to respond to unusual or emergency events.

Whether a person is experiencing fatigue can only be determined by an individualised assessment, but even under ideal conditions, night-time alertness will generally be less than daytime alertness.

Long working hours and long journeys to and from work can also lead to fatigue.

### *5.4.2 Fatigue risk factors*

The three most important risk factors are:

- Insufficient or poor-quality sleep.
- Too much time awake and.
- Circadian rhythms (i.e., People are more prone to fatigue at certain times of the day).

### *5.4.3 Sleep debt*

Acute fatigue will be experienced after an episode of sleep loss. Ongoing sleep disruption or lack of adequate sleep can lead to sleep debt and cumulative fatigue.

This means it's important that people have enough time between shifts to sleep properly.

## 5.5 Summary

- Workload can refer to both the physical and mental strain that workplaces on a person.
- A workload that is too high can lead to stress, which can manifest itself in a number of ways, including emotional problems, physical discomfort, and lack of attention at work.
- Fatigue is different to stress in that it's caused by long working hours and/or insufficient or inadequate sleep.
- It can lead to problems with attention or even falling asleep while working.

# 6. SITUATION AWARENESS

Situation awareness is being aware of what's happening around you, actively predicting what can happen next, and realizing whether anyone or anything is a threat to your health and safety.

Although situation awareness is down to the people working in the environment, there are steps you can take to set work up in a way that makes good situation awareness easier to achieve.

- *Good briefings*

All teams are provided with proper briefings on the work they're about to carry out and the possible risks it poses. Letting them know the types of problem they need to look out for makes them more attuned to signs of danger.

Team members regularly communicate with each other to keep everyone briefed on the current situation.

- *Rested and fit for duty*

It is obviously important that all staff are physically and mentally fit for work. Stress, physical discomfort, fatigue, and drug/alcohol impairment can all dramatically reduce people's situation awareness.

- *Minimize distractions*

Work processes can be set up to allow people to focus their attention more fully on certain tasks.

For example, letting colleagues know not to disturb someone performing those tasks and making sure that people aren't asked to be responsible for other areas at the same time.

- *Maintain accurate understanding of the situation*

Having technology, prompts, logs, and registers gives people a clear picture of the plant and the tasks and helps them to recognise changes when they emerge.

Be aware that, as situations evolve and change (e.g., due to unexpected equipment, staffing or environmental conditions), the risk may need to be reassessed.

- *Skills*

Skills that build situation awareness include team communication, problem solving and techniques recognising hazards and changes when they emerge etc.

People need to learn and practice these skills to achieve a high level of situation awareness. Adding checking behaviours into working practices may help people to systemically scan their environment for indications of danger.

### 6.1 Summary

- Situation awareness is about noticing, understanding, and forecasting the factors in your working environment that could pose a risk to you, your colleagues or the site.
- Situation awareness is a skill that can be learned and improved but also enhanced with proper design.
- Steps can be taken by managers to improve the situation awareness of their teams. These include checking whether staff are fit to work, providing proper briefings and setting work up in a way that minimizes distractions and encourages safety checking habits.

## 7. BEHAVIOUR BASED SAFETY

Behaviour-Based Safety (BBS) is a process used as part of a human performance programme. BBS is the process that focuses on peer-to-peer behavioural observations, respectfully discussing with the observed individuals what influenced their behaviour and analysing data collected during those observations to improve both personal and process safety performance.

- *Where does it come from?*

BBS is based on extensive behavioural science research. It helps improve safety performance in an operation by targeting and enabling risk-reducing behaviours.

- *How do we use it?*

BBS is one of the tools used in our human performance programme. This programme seeks to enhance risk management by looking at the human behaviour elements of people interacting with plant and complex work systems, as well as the importance of leadership and culture.

- *How does it work?*

BBS is primarily used to improve safety performance through positive feedback in areas that are targeted as ripe for improvement.

Observations in the field can also provide leading indicators for safety.

### 7.1 Summary

- BBS is the process we use to focus on observing workforce behaviour.
- Once behaviour has been observed, there is a discussion on what contributed to the incident.
- The data collected in those observations is analysed to improve both personal and process safety information.
- BBS is not a replacement for reporting hazards or near misses, removing those hazards or completing field safety audits.

## 8. CREW RESOURCE MANAGEMENT (BRM ERRM)

Crew resource management (CRM) refers to a training and development approach to developing non-technical skills, with the aim of reducing the potential for, and impact of errors that could have catastrophic consequences.

### 8.1 What are non-technical skills?

**Non-technical skills** are skills that complement the technical skills required for the safe and efficient execution of operator tasks. These non-technical skills include communication, decision making, leadership, teamwork, situation awareness (the ability to maintain awareness and anticipate risks in a dynamically changing situation), and personal resources including an ability to recognise the signs of stress and fatigue.

## 8.2 So, what are the skills that CRM aims to improve?

### *8.2.1 Situation awareness*

This includes:

- Gathering information.
- Understanding information and risk status.
- Anticipating future state/developments.

### *8.2.2 Decision-making*

This includes:

- Identifying and assessing options.
- Selecting an option and communicating it.
- Implementing and reviewing decisions.

### *8.2.3 Communication*

This includes:

- Briefing and giving feedback.
- Listening.
- Asking questions.
- Being assertive.

### *8.2.4 Teamwork*

This includes:

- Understanding your own role within the team.
- Co-ordinating tasks with team members/other shifts.
- Considering and helping others.
- Resolving conflicts.

*8.2.5 Leadership*

This includes:

- Planning and directing.
- Maintaining standards.
- Supporting team members.

*8.2.6 Performance Shaping Factors – stress and fatigue*

This includes:

- Identifying signs of stress and fatigue.
- Coping with the effect of stress and fatigue.

**8.3 Summary**

- CRM is a set of training procedures, that can help us to avoid human error in situations where errors could have a high negative impact.
- CRM focuses on improving non-technical skills and behaviour.
- Many companies currently use CRM training in simulated environments.
- CRM can be used to improve a number of situations and activities but is most useful when multiple operators are working together.

**9. CONCLUSIONS**

The *new SIRE 2.0 regime by OCIMF* is expected to become operational in late 2022. Much of SIRE2 deals with process and focuses on human performance. The SIRE2 changes will involve a lot of additional work and a significant amount of learning for inspectors, crews, and Operators.

Mapping the SIRE2 questions to the TMSA3 elements is a very welcome inclusion. This will permit Operators to analyse the detailed reports now that the measuring tool (SIRE2) is formally linked to the management tool (TMSA3). Analysis of report results can be made together with associated TMSA3 elements and to the SMS as well. This will identify hot spots, TMSA and SMS

shortcomings, and initiate prompt remedial action. Doing this in real time will deliver a dynamic and detailed sitrep across the entire fleet and initiate appropriate actions without delay.

‘’However, a Human Factors element cannot be implemented overnight – it takes time for companies to become familiar with the concepts and understand how to apply them practically.’’, commented OCIMF Managing Director Rob Drysdale.

Company and their technical teams need to ensure safety by achieving TMSA3 compliance. Continuous improvement of Ship Management Systems is supported through developed phased improvements, determined from self-assessment and audit results. So, to improve, companies need to perform regular self-assessment reviews and compare results against TMSA key performance indicators. Companies must then align their policies and procedures with industry best practices thus achieve performance improvement alongside high standards of safety and pollution prevention.

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## REFERENCES

Conklin, Todd. (2019). 5 Principles of Human Performance; USA.

DOE (2012). US Department of Energy: Accident and Operational Safety Analysis Handbook. Washington D.C.

Hollnagel E., Wears R.L. and Braithwaite J. (2015). From Safety-I to Safety-II: A White Paper. The Resilient Health Care Net: Published simultaneously by the University of Southern Denmark, University of Florida, USA, and Macquarie University, Australia.

IMO (2000). International Maritime Organization: Resolution A.884(21). London.

Kurzweil, L., Rehor, V (2018). SAFETY II and other recent trends in SMS. Magazine of Aviation Development 6(3):6-11, 2018, ISSN: 1805-7578 DOI: 10.14311/MAD.2018.03.01

Rasmussen, J. & Svedung, I. (2000). Proactive risk management in a dynamic society. Karlstad, Sweden: Swedish Rescue Services Agency.

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# ADDITIVE MANUFACTURING (AM) FOR SUSTAINABLE SHIPBUILDING, OPERATIONS AND REPAIRS

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## Abstract

The session on the Additive manufacturing, its application and future impact it will have on the shipbuilding and repairs was deliberated by following four panel members: Mr. Syed Abdi, Mr. Sujoy Seal, Mr. Aditya Chandavarkar, Dr K. Sastry and moderated by Capt. S. Kishore, and Mr Ulhas Kalghatgi acting as an assimilator. After the initial introduction, the moderator made opening remarks on the state of Indian Shipbuilding and its presence in this industry being negligible, except for defence projects and the silver lining was two shipyards; M/s Cochin Shipyard in Kochi, and Chowgule shipyard in Goa, who have orders to deliver autonomous ships. The session commenced with the poser, why Indian shipbuilding has not grown at all? And what role Additive Manufacturing will have in shipbuilding in future? Will it be a solution provider in the longer run? The all-pervading issues which plague Indian shipbuilding industry are the familiar ones known to everyone and the morning session on Maritime Commerce and Economy highlighted the problems facing the Indian Maritime Industry.

***Keywords:*** AM, Additive manufacturing, Shipbuilding, Operations, Reconstruction, Maritime.

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## 1. CURRENT INDIAN SHIPBUILDING SCENARIO

India with a long coastline of 7517 kilometres is one of the largest maritime nations in the world. The Indian maritime sector with 13 major ports (12 state owned and 1 private) and about 205 notified minor and intermediate ports is responsible of 95% of the trade by volume (according to the Ministry of Shipping). The expansions of international trade have been much advantageous to a developing country like India. The reduction of trade barriers has encouraged India to focus on building infrastructure like roads, ports, waterways along with the development of product storage and the shipment capacity (Dr. A Mourougane, 2020).

### 1.1 Challenges to Indian Shipbuilding Industry

India has sufficient demand for the shipbuilding, drydocking, repairs industry as there is more than 90% of Indian seaborne trade with the foreign fleet owned by the foreign companies in spite of the competition by far bigger shipyards of China, Japan, South Korea. Some challenges experienced by Indian players in the shipbuilding industry are:

- Prohibitive cost of capital and tax burdens.
- Improper logistics, lack of supply chain management, planning, coordination etc. shortage of both men and material.
- Non-performing shipyards are declared under IBC by NCLT due to several factors, further COVID having a multiplier effect.
- Lack of ancillary support (Jaison, 2021).

As we bring our focus to supply chain management, we explore the primary characteristics of a good supply chain can be listed as:

- Deliverance of high-quality customer responses.
- Converting the inputs to outputs efficiently.
- Utilization of Assets optimally.

The above characteristics are also true for a spare parts supply chain. The main aim of any spare parts supply chain is to respond to customer requests satisfactorily while reducing the operating costs.

Any unpredictability in demand is one of the major issues in such a supply chain. In uncertain situations, to be able to keep up customer requests may mean having higher inventory in more locations. Organizations also need to provide support for previous and current generations of the products. This increases the inventory by many folds. Additionally, the after-sales supply chain requires competent workforce. With these challenges, supply chain managers face difficulty in delivering a high customer service while maintaining low costs. According to a study in 2009, the USA military held a stock of spare parts inventory worth USD 94 billion (Thompson, et al., 2016). These numbers are eye-catching and present an opportunity to optimize the spare parts supply chain.

A study was carried out on the present status of the supply chain management in India and some salient features are listed here:

- The facilities at Indian shipyards are moderate. These facilities combined with the upcoming developments can meet about 10% of the global ship repairs market in the coming few years.
- In India, steel is primarily used for commercial shipbuilding and repair. Quality imported steel and equipment is not commercially competitive.
- Digitized warehouse management is being enabled in most shipyards in India. However, many technologies such as blockchain, internet of things, digital warehousing is not very popular.
- India is unable to produce quality steel for ship repairs at a competitive price.

Considering the challenges and hurdles discussed, the following focus areas identified by a study can be looked into as future policy initiatives and solutions to enhance the shipbuilding and ship repair industry in India (Jaison, 2021):

- Set up an independent and empowered body for navigating the commercial shipbuilding, ship repair industry and ship recycling industry.
- Look into measures to increase availability of cost-effective shipbuilding steel in India.
- Incentivize indigenous production of spare parts equipment to be installed on new ships and replaced on existing ships during repairs. In addition, this will also require a strong technical support at all Indian ports.
- Introduce new technologies for advanced shipbuilding and repair.

## 2. EXPLORING NEW TECHNOLOGIES – ADDITIVE MANUFACTURING

In the past, manufacturing businesses in the past have used subtractive manufacturing processes which include cutting, drilling, molds, etc. to manufacture equipment. While subtractive process has been extremely popular, new additive style technologies are gradually replacing them. Additive manufacturing is a computer-controlled process of manufacturing a three-dimensional object by compiling layer upon layer of material on a build platform until the final product is finished. The layers can then be set and hardened using lasers or heat. Additive manufacturing has evolved significantly and is a group of technologies (Ziółkowski & Dyl , 2020):

- Binder Jetting.
- Directed Energy Deposition (DED).
- Material Extrusion.
- Powder Bed Fusion (PBF).
- Sheet Lamination.
- Vat Polymerization.
- Material Jetting.

AM can play a huge role in ship repairs and logistics support. Compared to the invention of new technologies and equipment, the lifecycle of a ship long. As such, ship repairs demand a complicated supply chain management and inventory management. Ship repair industry is also complex due to the breakdowns that happen during sailing and while the geographic distance from any repair centre is high. AM offers solutions to manufacture a spare part on demand in just in time

The advantages of additive manufacturing can be concisely summarized as:

### 2.1 Modern manufacturing:

- Many materials on one printer.
- Fast iterations of prototyping.
- Monolith manufacturing.
- Industry 4.0 implementation.

### 2.2 Cost reduction

- Only one production machine required.
- Weight reduction.
- Ships can be enabled with AM machines to reduce downtime on yards.

### 2.3 Less space

- Less material needed on stock.
- Reduction of warehouse space.
- Production on demand.

### 2.4 Environmentally friendly

- No need for global delivery.
- Less machines involved in the process.
- Waste minimization.
- Low power consumption.

### 2.5 Time saving

- Part optimization leads to faster repairs.
- Shorter periods on shipyards.
- Reduction in delivery times.

The panel members did sound optimistic that AM can address few of the hurdles but not definitely all of them. AM cannot be a silver bullet to shipbuilding but may be a game changer in future. It is not panacea for all the ills looming in front of the shipyard. There was a consensus as to how the application of AM can be explored and exploited to gain advantage of the technology, because it is going to stay and gain acceptance from the stakeholders. It is a tool in future. AM can be defined as the process in which a part/component is made, by adding material layer by layer and there is no removal of the material, thus minimising any wastage.

AM has three distinct features; it is a tool to customize. It is a pull technology and not push technology.

- Part to part replacement.
- A service provider in digital manufacturing.
- A big solution provider, e. g. a failed component can be made with minimum loss of time and at a fraction of the cost, eliminating all the intermediaries.

The common applications are:

- To begin with small components like pump impellers, fuel nozzles could be made gradually moving on to bigger components. GE engines are fitted with nozzles using AM technology.
- There are occasions when ships are held up due to shortage of spares, or spare part not being received awaiting customs clearance, or not being able to connect to the ship at the first available port. Such bottle necks can be avoided, using AM.
- Critical components used in cranes; ship synchro lift can be made using AM. In fact, one of the panel members cited a case where for want of a critical part, synchro lift could not be commissioned delaying further activities.
- India having positioned itself in the software industry can leverage its potential to become a digital hub for manufacturing and provide the knowhow to the other players who are keen to use AM technology. Moreover, it is not capital intensive.
- Application in manufacturing refurbished parts.
- Oil and gas sectors and offshore industries have shown acceptance to AM.

These are the some of the applications but there is no end to it.

## 3. CHALLENGES

Decision makers are often skeptic regarding additive manufacturing as against to industrial manufacturing as AM is a relatively young technology. AM is reduced to only a bullet point in futuristic plans rather than any immediate strategies to adopt it. Decision makers are also inclined to rely on traditional methods which are tried and tested for many years since they need to consider

safety at sea and possible financial implications of incidents at sea. However, many large organizations are gaining interest and looking into AM as a potential spare parts supply chain to be managed via AM. In addition, the involvement of classification societies in the development of 3D printing in the maritime industry demonstrates the desire to standardize AM and to enable the easy and safe manufacturing of parts by these methods.

Additive manufacturing is still a new group of technologies, but it has the potential to compete with traditional techniques. With more research and study, we can establish the best practices, reliability factors, initiation methods, potential defects for AM. AM in ship repair industry can generate solutions for many of the current issues relating to supply chain, storage space, wait times, costs, optimizing deign, etc. AM also enables parts containing many elements to be bult as a monolith which can highly optimize the parts. The risk of failure which comes with connections, assemblies, etc. can be reduced. AM can also allow for repairs to be carried out on board; thus, reducing the downtime on yards. With short training initiatives for the ship crew, onboard repairs for specific parts can be easily implemented.

## 4. CONCLUSIONS

Despite capturing the imagination of the industry, as regards the potential which AM has, the challenges which need to be addressed are:

- Scaling, i.e., making of bigger components.
- Making of complex parts.
- Regulatory issues and approval from classification societies and flag administration.
- IMO needs to be taken on board, though it has selectively accepted smaller components made by AM.

To sum up, Additive manufacturing has the potential to:

- Create a revolution in making custom made spare parts to begin with and then scale up further in ship building.
- Reduce cost in ship building, e. g. there are direct and indirect costs. In case of series of ships being built by a shipyard, it invariably happens that parts are replaced from those in

stock. When the last of the ship is nearing completion, usually the vessel is short of a machinery component and at this point of time sourcing from OEM is likely to delay the delivery of ship. This is where AM can be used to make a part and commission the machinery.

- Add value to the manufacturing.
- Replicate the parts whether made in Korea, India or elsewhere.
- Adopt distributed manufacturing, i.e., make parts where needed, unlike digital warehousing, where data is stored in the cloud, which can be shared at cost. Thus, IPR can be protected.
- Change the business model.
- Bring about changes in shipping industry in the next 10-20 years horizon.

To gain confidence amongst the stakeholders, regarding AM technology, few ship owners are insisting the OEM to manufacture 10-20% of parts using AM and place it on-board at the time of delivery. It is still a long way to go before AM can gain its full potential, lot of research needs to be done, classification societies need to develop rules, procedures and guidance notes for its surveyors and the industry, but the industry has started warming up to and accepting new technologies for innovation and leaner systems.

## REFERENCES

Dr. A Mourougane. (2020). Present Scenario of Ship Building Industry in Indian. *Journal of Development Economics and Managaement Research Studies*, 29-38.

Jaison, M. (2021). Current Trends in Supply Chain Management of Building in India - An Overview. *Industrial Engineering Journal*, 7.

Jaison, M. (2021). Towards Greater Shipbuilding Supply Chain Surplus in India - A Review. *Industrial Engineering Journal*, 9-10.

Thompson, M. K., Moroni, G., Vaneker, T., Fadel, G., Campbell, R. I., Gibson, I., . . . Martina, F. (2016). Design for Additive Manufacturing: Trends, Opportunities, Considerations, and Constraints. *CIRP Annals - Manufacturing Technology*, 737-760.

Ziółkowski, M., & Dyl , T. (2020). Possible Applications of Additive Manufacturing Technologies in Shipbuilding: A Review. *MDPI*, 30-34.

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# DISTRIBUTED LEADERSHIP AND EMERGENCY RESPONSE: A STUDY ON SEAFARERS

Ms. Delna Shroff[1]

Abstract

Merchant shipping is an occupation with a high rate of fatal injuries caused by accidents and maritime disasters. The importance of safety leadership has been emphasized in many studies carried out within the maritime industry. However, there is a tendency for most research to focus on holders of formal positions. A lot of previous work on leadership has been carried out on the assumption that leadership rests with a single leader. The current study adopts a practice-based perspective to explore distributed leadership among seafarers. A mixed design is applied to explore the seafarer's implicit understanding of distributed leadership through semi-structured interviews. A simulation is then developed and used to analyse the relationship between distributed leadership and the emergency response of the bridge team members.

***Keywords:*** Distributed leadership, practice, maritime, emergency response, safety, bridge operations.

## 1. INTRODUCTION

Accidents at sea can have devastating effects on the lives of those who are involved. Human error has been frequently linked as the main contributing factor to maritime casualties (Amir et al., 2014). The most significant problems affecting maritime safety include collision/contact, grounding, foundering, fire, capsizing and sinking. A maritime accident results in the loss of human lives, loss of property and pollution. Between 2003 and 2012, the industry's fatal accident rate was twelve times higher than that of the general workforce (S. E. Roberts, 2014). Maritime safety legislation and norms have seen significant advances, but accidents still occur.

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Inadequate leadership was found to be a significant contributory factor in ninety-four marine navigational mishaps in the U.K. in research conducted in 2013 (Sydnes, 2013). A human factor, particularly leadership, has been implicated in numerous maritime disasters (Kim et al., 2016). A recent study highlighted the lack of leadership as a contributory factor in many maritime accidents. There was a lack of leadership behind the decision-making failures, poor judgment, and improper management of the crisis, all falling under the leader competency problems (Vineet Kaur Sandhu, 2021). Another recent study by Kim T (2021) found a lack of empirically proven models for describing and measuring safety leadership in day-to-day operations (Tae-eun Kim, 2020).

It is evident from accident reports that leadership onboard the ship is very critical. Several studies have pointed out the role of human and organizational factors in maritime safety (Chauvin, 2013; Hetherington et al., 2006; Schröder-Hinrichs, 2010). The role of those factors is a central issue in collisions. In a study by Chauvin (2013), the analysis showed that most collisions were due to decision errors. At the leadership level, the investigation revealed the systematic planning of inappropriate operations and non-compliance with the Safety Management System (Christine Chauvin, 2013). This study also stresses the necessity to investigate the master’s decisions in critical conditions. These decisions concern bridge manning and vessel speed.

While several leadership studies have been carried out in the past, there is a tendency for most research to focus on holders of formal positions. The shipping industry's long-standing authoritarian leadership style has been one of the main obstacles to leadership growth. On board, a strict vertical structure is in place, with the ship's Master wielding unquestionable authority and dominion. Hierarchical authority alone should not determine his ability to govern. The international maritime industry is unique, making it challenging to apply leadership development concepts from other sectors (Katherine Devitt, 2010). The unit of analysis in most studies has been the 'individual'. This is more so in the case of the maritime industry, where there is an undue focus on leadership styles as antecedents of safety behaviours (Clarke, 2012). Further, most studies measured leadership through generic scales, providing a quantitative assessment of the leader's behaviour.

Making a shift from attributes and behaviours of individual leaders to a more practice-based perspective whereby leadership is conceived of as a collective social process emerging through the interactions of multiple actors seems to be the need of the hour (Bolden, 2011). Isolated

discussions about single actors (mainly the ship Master) and single causes in a system, no matter how important they are, will not lead to sustainable system improvements.

The proposed study adopts a mixed design to explore the practice of distributed leadership among seafarers. The follower forms an integral part of the dynamic leadership system. This study aims to investigate the phenomena of distributed leadership, its characteristics, and the role of distributed leadership in the maritime environment. Distributed leadership's popularity is increasing; however, there is little scientific information about its nature and impact in any organizational environment (Alan Bryman, 1996).

Adopting a distributed leadership model, leadership practice centres on what people do and how and why they do it. It is a product of the interactions of leaders, followers, and their situations. Recent research by Leithwood et al. (2007) has shown that different patterns of distributed leadership are critical in achieving organizational improvement and change. Their work reinforces the importance of planning, aligned, distributed leadership practice that is purposeful and focused. Research into shared leadership is just the beginning, and many more questions will be answered in this area in the future.

The researcher chose this study as leadership within the maritime context is a complex phenomenon that cannot be understood using a single qualitative or quantitative design alone. Hence there was a need to look at this phenomenon more holistically. Distributed leadership practice is unique in that it is a result of concerted action. It offers a way of rethinking the nature of leadership. While prior research has focused on transactional or transformational leadership styles, there is a need to examine leadership activity as a unit of analysis. The focus is on developing a maritime-specific framework for distributed leadership practice.

## 2. LITERATURE REVIEW

It is difficult to define what is meant by the phrase "Distributed Leadership (DL)." This phrase has been conceptualized and interpreted in various ways (Kenneth Leithwood A. H., 2007). The notions of shared, collaborative, democratic, and participative leadership are all examples of distributed leadership. Distributed leadership has a wide range of literature supporting it. Three essential elements related to the concept of distributed leadership are noteworthy:

- Leadership is seen as emerging in a network of people who interact.
- There is openness to the boundaries of leadership. This suggests that multiple people can contribute as there are no fixed limits.
- Different levels of expertise are distributed among many people.

According to traditional leadership theory, only one individual has the authority and influence to lead an organization's activities (Burke 2010). Distributed leadership theory, on the other hand, holds that any organization can benefit from the leadership abilities of many people. The crucial thing is how leadership is empowered, coordinated, and supported since that is the key to success. Distributed leadership implies that multiple individuals at different levels within an organization are involved in decision-making instead of a single leader at the top (Kenneth Leithwood B. M., 2009).

## 2.1 Distributed Leadership

The essence of the concept of distributed leadership is that leadership does not rest with a single person alone. It is a fluid or emergent property rather than a fixed phenomenon (Spillane, 2006). There seem to be standard theoretical bases among distributed leadership and its related concepts, including shared, democratic, and emergent leadership, but different countries and sectors apply many of these concepts. Distributed leadership as an idea has seen rapid growth in interest since the year 2000.

Distributed leadership is distributing leadership practices (Malloy, 2017). In this leadership style, the leader and followers interact (Spillane, 2006). Instead of focusing on position, individual expertise is essential in distributed leadership (Malloy, 2017). This type of leadership focuses on collective work and collective learning by working on goals through communication and interaction (Halverson, 2007). Teachers collaborate and thereby develop expertise. Leadership resides with everyone at every level and not just the individual at the top (Daniel Goleman, 2002).

## 2.2 Theoretical Roots

In the Handbook of Social Psychology, an Australian psychologist Gibb coined the term "distributed leadership" in 1954. He looked at several facets of influence processes to better understand how formal and informal organizations work together. A distinction was drawn

between "focused leadership" and "distributed leadership" in an attempt to find a means to measure these patterns of effect. When we say that a leadership activity was focused, we mean that only one person was involved. The word "distributed" connoted the idea that power would be spread among a large number of people. Distributed leadership emerged as a more contemporary notion in the late 1990s and early 2000s, referring to a network of leadership activities and interactions that spans people and contexts.

Spillane et al.'s (2001, 2004) study is the most widely used modern research on distributed leadership practice. This study, which lasted almost four years, examined leadership practices in great depth. The social backdrop and the interrelationships among individuals involved are essential to understanding leadership behaviour. Spillane's work suggests that one must understand how leadership practice is divided among leaders, their followers, and the context in which they find themselves. There were a lot of different leaders involved in this study, which was conducted in elementary schools. The conclusion that was drawn was that looking at the school as a whole was critical to understanding the practice of leadership and developing one's leadership skills. Leaders' interactions were characterized by their interdependence. Reciprocal, pooling, and sequential interdependencies were all found to exist. When two or more leaders work individually but they are mutually supporting one another, then leadership practice can be said to be reciprocal. Pooled interdependency is when two individuals pool their information through formal and informal meetings. At times two or more leaders perform actions in a definite sequence. To bring about a leadership routine, it is important that individuals are interdependent, and tasks are arranged in a sequence.

Spillane's theory of distributed leadership emphasizes how the social context is an important component in understanding how leaders think and act. The tasks, people, actions, and interactions evolve together as contributing factors to distributed leadership within the academic context (James P. Spillane, 2001).

### 2.3 Leithwood et al.'s Framework of Distributed Leadership

When Leithwood and his colleagues conceptualized the leadership distribution they were looking at, they didn't just focus on an idealized image and practice of distributed leadership. Instead, they looked at a more general theoretical framework for studying the distribution of leadership in organizations. There is a wide range of leadership functions' alignment and beliefs connected with

different types of alignment, such as a plan-full alignment, an anarchic misalignment, and spontaneous misalignment (Kenneth Leithwood A. H., 2007).

- Planful alignment: Gronn's "institutionalized practice" is a good analogue for this arrangement. Members of the organization have carefully considered the duties and responsibilities of people in positions of authority in this setup. Leaders have agreed on the best ways to carry out certain practices and responsibilities of leadership. Trust in the motives of one's leadership colleagues, well-grounded beliefs in the capabilities of one's leadership colleagues, and collaboration rather than rivalry as the best method to enhance productivity within the organization are all likely to be connected with planful alignment.
- Spontaneous alignment: There is a lack of preparation regarding the distribution of leadership roles and responsibilities in this type of distribution—unintentional and instinctive decision-making results in aligning roles and responsibilities among persons. There is little evidence that this type of alignment significantly impacts short-term productivity compared to planful alignment.
- Spontaneous misalignment: Unpredictable distribution of power is the norm. This type of (mis)alignment is ineffective for both short-term and long-term productivity. Organizational productivity suffers in the short and long term.
- Anarchic misalignment: In this distribution method, some or all organizational leaders actively resist or reject the influence of others. As a result, employees worked independently, competed for limited resources, and shared corporate objectives.

Short-term good organizational change can be achieved through both planned and random alignment patterns, according to Leithwood and colleagues (2007). Furthermore, planful alignment significantly impacts long-term organizational productivity more than other alignment patterns. The study indicated that spontaneous misalignment and anarchic alignment might severely impact organizational change and development. Distributed leadership needs to be better understood, according to the study's conclusions. Without this knowledge, it would be impossible to predict a significant link between DL and performance outcomes (2009). For leadership to be effectively distributed, two critical factors must be met: To begin, leadership should be distributed among those who already have or can acquire the necessary skills and knowledge to do the job at hand. The second prerequisite is that excellent organization and planning are required to spread leadership practice.

Leithwood et al. (2007) carried out early work in distributed leadership. They suggested that planful and spontaneous distribution configurations strongly predicted positive organizational change. Furthermore, planful alignment seemed more likely to contribute significantly than other alignment patterns to long-term organizational productivity. The research found that spontaneous misalignment and anarchic alignment were likely to affect short- and long-term organizational change and development negatively.

The work by Leithwood and colleagues cited above also suggests that the distribution of leadership may not necessarily be effective. What is more important is understanding how the distribution of leadership activity takes place.

A growing number of research studies are examining the effects of distributed leadership on classroom instruction and student achievement. There is now more information available on the types, effects, and nature of distributed leadership practice due to the conceptual, theoretical, and practical work being done in this area. Their approach emphasizes the importance of strategic planning and alignment with a clear end goal.

Research on distributed leadership and organizational development is encouraging but not conclusive. Distributed leadership practice has some challenges, but more research is needed to understand these issues (Harris, 2009) better.

### 2.4 Authoritarian Leadership

To paraphrase (Yukl, 2006), leadership involves encouraging people to recognize and agree on what needs to be done and how it should be done while supporting individual and group efforts to achieve common goals.

In their study (Zhen Wang, 2019), referenced authoritarian leadership. An autocratic leader exercises total authority and control over subordinates and expect complete submission from those under their command (Cheng, 2000) & (Scandura, 2008). Authoritarian leaders want their followers to accept and respect their subordinates' rigid and centralized hierarchy (HSIAO, 1990).

Studying the influence of authoritarian leadership on subordinate task performance was the focus of (Zhen Wang, 2019). According to the research, leader-member exchanges negatively impact subordinates' work performance. Members' reliance on the leader shields them from the adverse

effects of authoritarian leadership. Authoritarian leadership has a more substantial impact on leader-member exchange when there is lesser dependence on the leader.

Çelik (Çelik, 2017) examined the relationship between employee motivation and leadership. He referred to empirical studies from different firms and sectors. There was a reference to a study by Mine Turker on maritime employees. The results showed that employees identified their leader as more authoritarian in approach. A negative correlation was found between other leadership styles and employee motivation. The supportive leadership style was found to have the lowest correlation with employee motivation. It was expected that a chain of command should be established as maritime employees spend a lot of time with their senior managers and associates. For this reason, the authority will create a firm structure for following set rules.

Comperatore (Carlos A Comperatore, 2005) states that authoritarian leadership is one of the stressors that are prevalent in the maritime environment. This stressor combines with other stressors such as extreme temperatures, long working hours, mental and physical workload, isolation, and other stressors. This system of stressors affects the ability of crew members to remain alert and perform.

Surugiu and Dragomir (Dragomir, 2010) conducted a study to improve the training strategy for seafarers. They hold that there is a lack of orientation toward developing a training strategy based on leadership. Maritime leadership training should encourage seafarers to take extra responsibilities when given the opportunity. There needs to be a climate of trust and confidence on board. There is a lack of effective communication among authoritarian commanders, and a lack of communication contributes to many accidents.

## 2.5 Emergency Response

Life is in danger when an emergency occurs suddenly and unexpectedly. When disaster strikes, it might be anything from an earthquake to a terrorist attack to releasing dangerous materials (Schmidt, 2000). Even the most severe disasters usually result in the loss of life or property. Each step of emergency management is distinct, yet they frequently overlap in execution.

The response is the second part of emergency management. During and immediately following an emergency, this phase calls for action to be taken. As soon as things have calmed down, we may say that the response phase is over. Put your plans into action in this phase.

*Emergency Response: An operational definition:*

O'Toole (O'Toole, 2002) conducted an employee safety perception survey. Injury data was collected. This preliminary study showed that positive employee perceptions were positively related to a reduction in injuries. The study showed that emergency response was one of the crucial factors influencing employee perceptions. These perceptions influenced decisions related to at-risk behaviours on the job.

One definition of ''emergency response" is the coordinated effort by many entities to mitigate (Rhona Flin, 1996) the effects of a potentially life-threatening crisis that happens abruptly and unexpectedly (Goetsch, 2005). Emergency response is also defined as measures taken in an emergency to preserve lives and prevent additional property damage. Analysing emergency reactions at a team level is an attempt undertaken in the current study. The team's ability to respond to an emergency was observed and rated.

## 2.6 Workload, Power Distance and Safety Performance

*Workload:*

The concept of workload is discussed in transportation (Lützhöft, 2011), nuclear power operations (Sheridan, 1981), air traffic control (Shayne Loft, 2007), driving, and many others. De Zwart et al. (1995), for example, have a general awareness of physical workload, but the concept of mental workload needs further definition. Mental processing power or resources and task requirements are thought to have an inverse connection.

According to research, many maritime mishaps are partly caused by a person's mental workload. There is still a lot of work to be done in the field of mental workload. However, each method has its pros and downsides (Vidulich, 2006).

*Mental Workload:*

The cognitive burden is founded on the premise that as the complexity of an activity increases, so does the quantity of cognitive resources necessary to meet those demands (Wickens, 2008) & (Baddeley, 1992). According to research, performance improves for light to medium workloads but degrades as the workload increases (Staal, 2004). If you're engaged in an activity or work that

requires you to be in a specific location, you're more likely to be prone to distractions. A linear relationship between job load and performance has been seen (Marshall, 2002).

It is possible to think of workload as a multi-dimensional notion that considers time, mental tasks, physical tasks, and pressures. One of the most critical aspects of one's mental workload is how hard one works to meet the expectations of one's job.

Smith and Smith (2017) studied rail industry workers' workloads. Some of these risk factors included an unhealthy lifestyle, working shifts, and little control or support. They conducted a poll. A high workload level was also found to be connected to exhaustion, which in turn was linked to a higher likelihood of mishaps and a slower response time.

Hockey et al. (2003) examined the literature on safety in three main areas: critical themes of accidents, the role of human error, and intervention to improve security. Twenty studies were reviewed on the following areas: across the following areas: fatigue, stress, health, situation awareness, teamwork, decision-making, communication, automation, and safety culture. The results showed the relative contributions of individual and organizational factors in shipping accidents and also identified the methodological concerns with past research. It was concluded that monitoring and modification of human factors issues could improve safety performance in the maritime context.

Hockey et al. (2003) conducted an experimental study to analyze the mental demands of collision avoidance in a simulation. The findings revealed that high levels of a collision threat were related to an increase in mental workload and an impairment in performance on a secondary task. This study highlights the potential consequences of monitoring equipment simultaneously. In concert with a single job, this impairment could have severe consequences in a real-life situation.

With advanced technologies being introduced in the shipping industry, including Portable Pilotage Units, Remote Pilotage, advanced techniques of maintaining situational awareness, and autonomous Shipping, there is a strong need to understand mental workload during bridge operations and cooperation with shore personnel. An analysis of the mental workload of Captains, Pilots, and Tug Masters was carried out with the help of SWAT, ISA, analysis of communication, and collecting simultaneous electro-dermal activity of team members. The findings revealed that the EDA measure of workload is superior to the paper-based techniques. A lot of research has been done on individual workload in the past few years.

Work on measuring workload in a team setting is gaining attention. There is a tendency to measure team workload using a combination of individual workload measurements. For example, a researcher may collect workload ratings from each team member and create a team average from these ratings. The applicability of individual workload measures to a team setting is being debated; however, well-accepted standards of team workload are currently unavailable.

### 2.7 Power Distance:

According to Mauk Mulder (1977), a social psychologist, the degree of power disparity between a less powerful one and a more powerful other is characterized as the degree to which the two individuals belong to the same social system (whether it is loosely or firmly knit). Power distance has been extended by Hofstede (1997) to include a more comprehensive cultural idea. According to his definition, a country's lower-ranking citizens expect and accept that power is dispersed unequally.

Individuals, groups, organizations, and nations are differentiated based on the degree to which inequality is accepted either as inescapable or as functional. This value is termed power distance. Power is essential to all relationships; it is inherent in hierarchical organizations. Hence it is necessary to understand the concept of power distance. Daniels (2014), in a review of value taxonomies and elements of power distance, identified areas where additional research is required on power distance. The study outlined a plan for future research on this subject.

Hofstede (1980, 2001) refers to power distance as the extent societies accept inequalities. With the work context, it can be regarded as the perceived difference, i.e., inequality in the amount of power a supervisor has compared to that of a subordinate. The extent of this inequality is valued by both the supervisor and the subordinate and further reinforced by the social and national environment (Hofstede, 2001).

Power distance influences levels of participative decision-making, centralization, and formal hierarchy within organizations (Hofstede, 2001). In a culture with high power distance, individuals who possess more power are perceived as superiors, not accessible, paternalistic, and are expected to adopt an autocratic style of leadership (Hofstede, 1980). As these individuals are perceived as superior, others with less power accept their hierarchical position. They tend to trust their leaders and do not question their judgment (Kirkman, Chen, Farh, Chen, & Lowe, 2009).

They are generally docile, loyal, and obey their leaders (Bochner & Hesketh, 1994). High power distance is linked to more task orientation and fewer people exposure. High power distance cultures emphasize structure for task completion and maintain the social space in hierarchical relationships (Bochner & Hesketh, 1994). A higher value is placed on status, power, and prestige (Jaw, Ling, Wang, & Chang, 2007; Schwartz, 1999). In contrast, low power distance manifests itself, for example, as decentralized organizations, participative decision making, and consultative leadership (Hofstede, 1980).

Taras, Kirkman, and Steel's (2010) conducted a meta-Analysis. They found that power distance positively correlated with absenteeism, sensitivity to others, job satisfaction, perceived organizational justice, continuance commitment, normative commitment, trust, conformity, perceptions of directive leadership, openness to experience, and religiosity at the individual level. The results showed that power distance was negatively associated with emotional displays, feedback-seeking, exchange ideology, avoiding unethical behaviour, team commitment, teamwork preference, employee self-esteem, and perceptions of participative leadership. At the group level, power distance was positively correlated with group cooperation and negatively correlated with group performance. At the country level, power distance is positively associated with conformity, the importance of family values, agreeableness, neuroticism, and corruption and negatively correlated with life satisfaction, extraversion, openness to experience, wealth, human rights, gender role equality, and income equality.

Wang, Mao, Wu, and Liu (2012) examined (in part) how power distance moderates the relation between abusive supervision and justice.

Khatri et al. (2003) reviewed the literature on power distance orientation and its influence on different organizational behaviours. They concluded that people in high-power distance contexts are reluctant to participate in decisions over time. They become passive followers. As a result, decisions are taken by a few leaders autocratically. Communication also suffers. Tough decisions are made and implemented faster, and the quality of decisions is poorer. This is because of a lack of input from team members, poor communication, and poor information sharing.

A subordinate may regard their participation in decision-making as an indication of their superior's incapacity in a high-power distance cultural situation. This means bosses may make decisions without consulting or involving subordinates (Francesco and Chen, 2000). Because of the

potential for embarrassment, associates are reluctant to voice their opinions publicly. When people behave in this way, major communication breakdowns occur. Senior management and lower-level staff become estranged from each other over time. Senior management loses touch with the work being done at the bottom of the organization's structure, which causes employees at those levels to become unsure of what they may anticipate from their superiors (Mintzberg, 1993). Informal communication is absent in companies and cultures with a significant degree of power distance. Authority and decision-making are retained in the hands of a few people at the top (Hofstede, 2001).

According to Sinha and Tripathi (1994), authoritarian decision-making can be seen in most Indian companies. A more significant power disparity hinders the communication between superiors and subordinates. Because of this chasm in communication, it isn't easy to make informed decisions (Mintzberg, 1993; Khatri, 1996).

The study by Lu et al. (2016) looked at the impact of country culture on container shipping human errors. They discovered that aspects of national culture such as power distance, avoidance of ambiguity, collectivism, and a focus on the long term had a favourable impact on people's safety behaviour.

In a study by Robert et al. (2000), it was found that management practices relating to empowerment correlated negatively with job satisfaction found that management practices described to empowerment were negatively related to job satisfaction in high power distance national cultures and positive in countries low in this dimension. Thus, high power distance cultures are more likely to accept management decisions and leave it to the management to lay down procedures and safe work rules. Moreover, high power distance cultures are more likely to agree with some behavioural detection and monitoring levels when compared to cultures low in this dimension.

## 2.8 Research Objectives

- To explore how leadership manifests itself among seafarers aboard merchant ships.
- To examine the strength and direction of the relationship between planfully aligned leadership (one form of distributed leadership) and emergency response of the team members during navigation.

- To investigate the contribution of demographic measures, workload, and power distance in predicting the emergency response of team members during navigation.

### 2.9 Research Questions

The current research seeks to address the following research questions:

- *How does leadership manifest itself among seafarers* aboard merchant ships?
- What is the strength and direction of the relationship between planfully aligned leadership and emergency response among team members?
- Is planfully aligned leadership a better predictor of emergency response among team members than authoritarian leadership?
- What is the strength and direction of the relationship between planfully aligned leadership and emergency response, after controlling for demographic measures? What is the contribution of the demographic measures such as age and contract period in this relationship?
- What is the strength and direction of the relationship between planfully aligned leadership and emergency response after controlling for the workload on team members? What is the contribution of workload in this relationship?
- What is the strength and direction of the relationship between planfully aligned leadership and emergency response after controlling for power distance that prevails between the formal leader and team members? What is the contribution of power distance in this relationship?

## 3. RESEARCH METHODOLOGY

The research methods chosen for this study are referred to as mixed methods (Tashakkori & Teddlie, 1998) or ‘‘triangulation”.

### 3.1 Research Phases

The study was conducted in four phases.

*Phase 1:* The first phase was the qualitative phase. The purpose of this phase was to gain insights into the seafarers' implicit understanding of leadership, explore how leadership emerges among the team members within the maritime context.

*Sample:* The sample for this phase was sailing officers, both Deck and Engine Officers. 24 officers were interviewed to gain insights into how leadership emerges onboard the ship. The mean age of the sample was 34.6 years, and SD was 9.49. They were selected from six different ship management companies. The inclusion criteria for sample selection were officers of Indian nationality who had served at least two contracts with their present company. The samples for the qualitative phase were officers from both operational and management levels. They were on shore leave.

*Procedure:* Semi-structured interviews were conducted with the respondents to gain insights into their implicit understanding of leadership. An interview guide was developed, and five officers were interviewed during a pilot run.

Following this, the interview questions were slightly modified. The researcher adopted the Critical Incident Technique (CIT) because it enabled participants to describe memories of a specific incident clearly.

*Measure used: Interview Guide*

An interview guide was prepared after speaking to four experts/Programme Heads in the maritime field, reviewing the literature on distributed leadership, and analysing the pilot study results.

The interview guide consisted of three sections. The first section of the interview comprised generic questions related to leadership. The purpose was to build rapport and provide a context for more detailed questions. Once the connection was established, and the respondent was comfortable sharing, the researcher proceeded to the questions on distributed leadership.

The distributed leadership segment consisted of 10 questions; each key question was followed by probing questions. The third segment of the interview guide comprised queries related to safety culture. The focus was on understanding the meaning of safety culture and its relation to leadership. How does leadership relate to safety culture, and how does culture translate into safe behaviours? The researcher reassured the respondents of complete confidentiality and anonymity in certain conversation sections, where respondents had to describe a critical incident.

*Phase 2:* The second phase was a quantitative phase. The purpose of this phase was to further support the prevalence of planfully aligned leadership within the maritime context and measure planfully aligned leadership and the three dimensions objectively.

*Sample:* 216 sailing officers from both the operational and management levels were involved in this phase. Convenience sampling was used. The mean age of the participants was 30.7 years (SD = 5.39). The inclusion criteria for this phase were the same as that for the first phase.

*Procedure:* A survey-based rating scale was administered online to measure planfully aligned leadership among seafarers aboard merchant ships. The survey questionnaire was uploaded on an online platform, and the link was sent out to all the sailing officers. A list of sailing officers' details which included their emails, sailing background, and contact numbers (who met the inclusion criteria) was sent to the researcher by two training coordinators every week. The training coordinators were based at the Training Centre located in Mumbai. Every Monday, the researcher sent out an email to all the potential respondents with a briefing note and a link to the survey. Respondents were required to answer two sections of the survey instrument. Only the completed questionnaires (both sections) were considered for the current study. A total number of 301 respondents filled out the questionnaire. However, only 216 responses (71.8%) were considered for further analysis. Those responses were statistically analysed, and open-ended responses were coded.

*Measure used: Survey Instrument*

The survey instrument comprised two sections. The first section began with two open-ended questions followed by one closed-ended question. Questions were built from the salient themes that emerged from the qualitative data analysis and used the theory of distributed leadership as a conceptual underpinning to measure planfully aligned leadership. The purpose of these questions was to:

- Explore shipboard situations which required the immediate supervisor to lead.
- Gain an insight into the behaviours/actions taken by the immediate supervisor.
- Gain an understanding of how leadership emerged within the given context.
- Gain an understanding of what was perceived as effective/ineffective behaviours.

The second part of the survey encompassed a measure of planfully aligned leadership. Items for this scale were adapted from the ‘‘Core Practices” or ‘‘Basics” of successful school leadership (Leithwood et al., 2006). These practices were created from empirical studies carried out within the educational context. They were also validated by comparing them with behaviours associated with the instructional leadership model (Hallinger, 2003) and with practices of leaders which support student achievement. These behaviours fall into four categories which are mentioned below:

- Setting Direction.
- Developing People.
- Redesigning the Organization.
- Managing the Instructional (teaching and learning) Programme.

These practices have been implemented successfully within the educational context. Some practices have models of transformational leadership as their source, studies carried out by Burns (1978), and other empirical work by many other researchers. The survey was intended to generalize the findings which were obtained in the initial qualitative phase which focused only on 24 sailing officers.

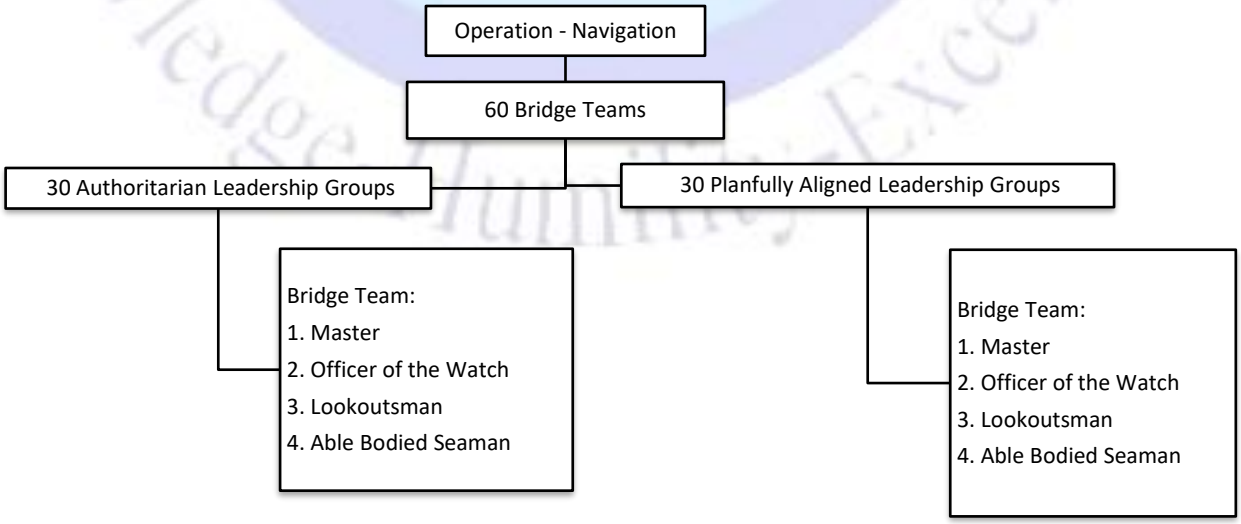
*Phase 3:* In the third phase, an experimental design was utilized to investigate the relationship between one form of distributed leadership, i.e., planfully aligned leadership, and the emergency response of the team members during a single shipboard operation. A simulation was designed and conducted to examine how planfully aligned leadership predicts emergency response, to study the team members' behaviours within their working environment, and thereby make observations of team performance in a complex maritime environment. The classic authoritarian style of leadership and planfully aligned leadership were compared and studied in a simulation. An event-based checklist was used to calculate the scores.

*Sample:* The study participants of this phase were sailing officers, both operational and management level officers. The sample was sailing officers comprising the Master, Chief Officer, and Second Officer. The Bridge Team consisted of the formal leader (Ship Master), Officer of the Watch (OOW), Lookouts man, and an Able-Bodied Seaman (AB). 30 planfully aligned leadership groups and 30 authoritarian leadership groups participated in the simulation exercise. The inclusion criteria for this phase were the same as that for the first and second phase.

*Procedure:* The study employed a between-groups, independent measures design. The experiment was conducted with different subjects in every group. As a result of a random allocation process, each participant was randomly allocated to one of 60 groups. The number of people on each bridge team remained unchanged; a typical bridge team included four people.

*Figure 1: 360-degree Full Mission Navigation*

*Figure 2: Bridge Team Composition*



*Procedure:*

*Table 1: Procedure (Phase 3)*

| Day 1 | Day 2 | | |
|---|---|---|---|
| | **Step 1** | **Step 2** | **Step 3** |
| **Familiarization** | **Briefing the Team** | **Briefing the Master** | **Simulation** |
| Each bridge team was guided to the Navigation Simulator on their respective day.<br><br>The simulator operator was instructed to carry out a familiarization session.<br><br>He provided an overview of the bridge equipment and gave a transit demonstration of the geographic area used for the simulation exercise. The demonstration took approximately 45 minutes. The 60 teams were randomly distributed between two groups, i.e. 30 teams functioned under planfully aligned leadership and 30 teams were under authoritarian leadership. | The group participants assembled in the meeting room in the morning on the day the simulation was conducted.<br><br>The bridge team was shown the particulars of the voyage on a projector screen.<br><br>The simulator operator (coached by the researcher) briefed the team members about their respective roles in the exercise.<br><br>The bridge team was then guided to the simulator, but the Master was requested to stay back for further instructions. | The researcher instructed the Master to conduct a briefing with his team (using a script).<br><br>The Master was given 15 minutes to read the script and familiarise himself with his approach.<br><br>The Master was then asked if he had any doubts about his role. They were clarified before he entered the bridge in case there were doubts. Once the Master stated that he was comfortable playing his role, the Master (as instructed in the script) then entered the simulator, briefed the bridge team.<br><br>The Master of the authoritarian leadership group laid down the expectations as per the script and did not allow any questioning or clarification of doubts.<br><br>The Master of the planfully aligned leadership group set the direction, built trust (as per the script). | The exercise began. The Master had the con, and after about 15 minutes, he handed over the conn to the Officer of the Watch (Chief Officer / Second Officer).<br><br>The Master remained on the bridge and was overseeing the operation.<br><br>The lookout man performed his role as a lookout.<br><br>The AB was at the helm and steered the vessel.<br><br>The Master (in the authoritarian leadership group) demonstrated an authoritarian leadership style.<br><br>The Master (in the planfully aligned leadership group) demonstrated the dimensions of planfully aligned leadership.<br><br>Every Master was given a *small card* with simple script statements/actions which he had to say/do at specific intervals in the exercise. |

*Measure Used: Event-Based Approach to Training and Assessment:*

Event-based training approach is widely used to evaluate individual and team performance (Fowlkes et al., 1994; Dwyer et al., 1997; Fowlkes & Burke 2005a; Fowlkes & Burke 2005b; Rosen et al., 2008). Event-Based Approach to Training (EBAT) is a methodology used to assess individual and team performance (Rosen et al., 2008). In this approach, critical events are inserted into appropriate contextualized scenarios. The scenario has a definite timeline; this helps the assessor understand what behaviours should occur and approximately when they should occur. Behavioural assessments are carried out in real-time. The checklist is used by observers to identify whether or not suitable responses to each important event were witnessed. The experiences are designed to elicit a specific set of responses. It is necessary to be able to observe and measure the behavioural responses.

### 3.2 Creating a Scenario Script:

Two nautical faculties/subject matter experts assisted in the creation of a scenario screenplay for the current investigation. A scenario script is a blueprint for the simulation's course of events and a means of keeping track of the many players involved. A well-written script makes certain that important events occur at the appropriate times. It also normalizes the simulation's non-critical noise.

In the current study, a script was created. The scenarios were identical for both the authoritarian and the planfully aligned leadership groups. 10 critical events (triggers) were introduced at definite intervals in the simulation. Images 5 and 6 show the route marked with the critical events which would be introduced at definite intervals in the simulation. Initially, about 10 minutes were given to the participants to get accustomed to the route. Gradually each critical event was introduced. Events ranged from simple situations to more critical ones, which required the team to respond.

The route was selected for this simulation keeping in mind the actual situation that exists when ships transit that area. Many factors of the environment, like weather, wind, traffic, etc., were taken into consideration and defined in advance. The participants' competency levels were also considered making sure the difficulty level of the exercise is neither too high nor too low and be carried out comfortably by the ranks involved. One faculty along with the researcher worked out the sequence of the critical events ranging from simple to more complex. Initially, a few trials

were carried out till all technical glitches were sorted, and the time intervals after which every critical event could be introduced were fixed.

The participants were observed from a one-way mirror/screen in the control room. All communication was also heard via speakers in the control room. The researcher and the simulator assessor independently monitored the scenario. The two observers, the simulator assessor, and the researcher entered their scores on two separate score sheets and made notes in the column named 'Comments' as they observed.

### 3.3 Evaluation:

After the debrief, a link was emailed to the participants in their emails to check the effect of fatigue and boredom. They provided their ratings on a brief scale using a 7-point rating scale. They were then briefed and sent another link and immediately guided to fill up their responses on three short scales to measure Power distance, Workload, and Distributed Leadership about the simulation they had just experienced. The participants immediately received the three links for the scales, and they filled up their ratings online. The participants were thanked for their time.

*Other measures used in Phase 3:*

*Disengagement Scale*

Multidimensional State Bored Scale (MSBS) of Disengagement modified by Shelley et al. (2013). The Disengagement subscale of the MSBS was used to examine the impact of participant weariness and boredom on their replies. There are three parts to it. Item 17 and item 28 (the Disengagement subscale items) of the MSBS scale were deleted since they were deemed unnecessary for the current investigation.

*NASA Task Load Index*

Individual workload is assessed by the NASA-Task Load Index (NASA-TLX), a multidimensional rating system. Mental, physical, temporal, performance, effort, and frustration are the six components that make up the six dimensions of mental and physical demand (F). An adaptation of the tool was made, and the workload was measured in terms of four dimensions: mental demand (How cognitively demanding was the task?), temporal demand (How hurried or rapid was the task?), and effort (How hard did you have to work to attain your level of

performance?). and frustration (to what degree were you aggravated, anxious, and angry at the time?

*Power distance Orientation Scale*

Individual-level investigations (Brockner et al., 2001; Earley 1999, Kim and Leung 2007) have led us to assess power distance direction (Earley and Erez, 1997). The original eight-item scale was deleted since five of the items did not apply to the current study.

- Research Variables.
- Operational Definitions of Study Variables.
- Independent Variable.

Planful Alignment: Distributed leadership implies that multiple individuals at different levels within an organization are involved in decision-making instead of a single leader at the top (Leithwood et al., 2009). Three dimensions were identified as subthemes under planfully aligned leadership:

1. Setting Direction: Leading a team to a shared understanding of the actions and goals of the group is an important factor that can promote a feeling of purpose or vision (Hallinger & Heck 2002).
2. Developing People: Individual assistance and intellectual stimulation, as well as setting an example for others, are all part of the process of cultivating others' potential and increasing their sense of purpose and commitment to the team (Leithwood & Jantzi, 2006).
3. Building Trust: Here trust is invested in role and status with a presumption of competence until proved otherwise (Bottery, 2002).

- Dependent Variable

Emergency Response: Emergency response is the action made during an emergency to avoid further damage.

- Control Variables

*Age:* Age here refers to the number of completed years of chronological age.

*Work Experience:* Work experience here refers to years of the contract period for onboarding the ship.

*Power Distance Orientation:* The degree to which a person accepts the unequal allocation of power in institutions and organizations is known as power distance. The term ‘‘associate’s orientation’’ refers to a construct at the level of a person.

*Workload:* Hart and Staveland (1988) describe workload as ‘‘the perceived relationship between the amount of mental processing capability or resources and the amount required by the task.’’

*Phase 4:* In the fourth phase, the qualitative phase, the participants who had participated in the simulation were selected randomly and contacted online. The fourth phase included semi-structured interviews to acquire more data that bolstered conclusions and provided a more thorough understanding of planfully aligned leadership.

*Sample:* The technique used for selecting participants was random sampling. A total of 14 officers were interviewed to gain a deeper understanding of the phenomenon as it unfolded in the simulator. The mean age of the sample was 34.6 years, and SD was 9.49. They were randomly selected from both planfully aligned and authoritarian leadership groups. The inclusion criteria for this phase were the same as that for the first phase.

The sample for this qualitative phase were Chief Officers, Second Officers, and Masters who played the role of Able Bodied Seaman in the simulation. Masters who played the role of Master in the simulation were excluded from this phase as the purpose was to understand the team members' experiences and how they responded to the emergency in the presence of the formal leader (the Ship Master).

Third officers were excluded from this phase as their competency level was lower than the other ranks, and the difficulty level of the exercise required a higher competency level.

*Procedure:* Seven interviews were conducted face to face in a separate room after the simulation. Seven interviews were conducted virtually as Mumbai was under lockdown due to the Covid -19 pandemic, and the training centre shut down for an extended period. All interviews were recorded with prior consent, and transcripts were prepared.

*Methods* triangulation was used for the analysis of the data. Methods triangulation is checking the consistency of findings using different data-collection methods. The reason for doing this was that using more than one method would help the researcher obtain more reliable data. It would

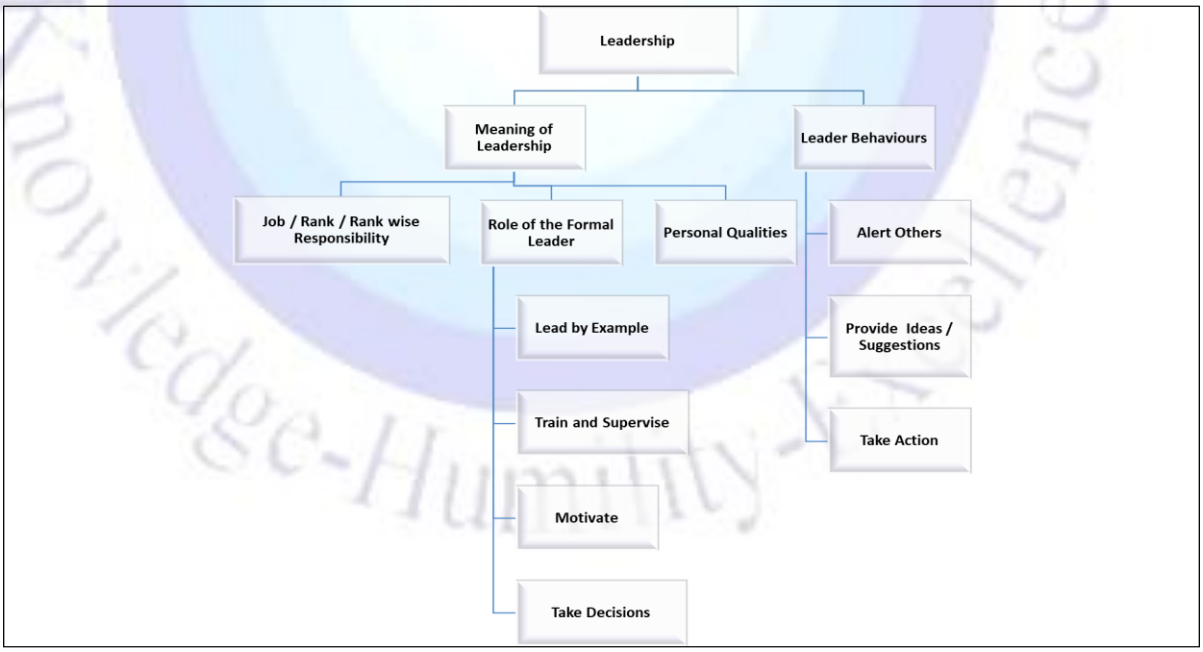
also offer a more holistic understanding of the phenomenon under study and its relationships with other concepts.

## 4. RESULTS

### 4.1 Phase 1

**Thematic analysis of the interview transcripts revealed two themes – *the seafarer's implicit understanding of leadership* and *typical leader behaviours.* Leadership was understood as a *'job/rank/rank wise responsibility'*, as a *'role performed by the formal leader'*, and as *'personal qualities'* possessed by the formal leader. Figure 2 indicates the seafarer's implicit understanding of leadership.**

*Figure 3: Seafarers' Implicit Understanding of Leadership*




*Leadership comes with the Job/Rank*

Within the maritime field, a unitary view of the leader seems to persist. Among the community of seafarers, leadership is strongly associated with one's rank on board the ship, it is perceived as a

part of an officer's job/job responsibility. Many of the respondents' understanding of leadership is that it comes with the job; when one takes charge, other crew members look up to you and follow. Some instances are presented below.

The Master associate's leadership with the rank of being a Captain. He says,

*This leadership that we are talking about is leading the ship because this is more of a job; it's a job. So, the moment I started this career, the thought process was that I had to become a ship's Captain. The Captain of the ship was the driving force, and we knew that the Captain is the overall in charge of a vessel, so that's how this …*

A Chief Officer (C/O) also considers leadership a requirement of one's job. To carry out various job responsibilities, he requires leadership to manage team members. He shares,

*Firstly, because my job requires me to have leadership qualities, maintain my people under me, delegate tasks, make sure they are doing the tasks, make sure that they are in a happy condition while doing the task, perform well, and so on…. it requires me to have that leadership, and I enjoy it…*

*Leadership as a Role to be Performed*

Some respondents perceive leadership as a 'role' that the formal leader performs. Leadership is perceived in terms of the 'role' that a person in authority performs – trainer, motivator, being a role model for others.

A Fourth Engineer shares,

*After coming to the merchant navy, I have seen my seniors. When I stepped into the leadership role in the specific college event I mentioned, I was looking at my friends. For me, they were always friends rather than a leader. When I came on board, I saw this particular ranking like Master, Chief Engineer in the engine side per se.*

*Leadership in terms of personal qualities*

A few respondents spoke of leadership in certain 'qualities' or personality traits that a leader possesses.

A 4/E states,

*As you mentioned, in the vertical line of leadership, some people have a personality for it, and I am not against it. Some people don't have a personality, so I was the latter type.*

C/O shares,

*In the maritime context, leadership means that I'm a better leader as a Chief Officer than as a Master. That's what I feel. My boys also feel that way …so I told you a leader is not just rank-wise; it is the qualities that a person has within himself…*

*Leader Behaviours*

A lot of the respondents, both operational and management level officers, revealed experiences where officers displayed behaviours that were critical to the outcome. Three prominent leader behaviours were identified– *alerting the team member/s, sharing ideas/suggestions with the crew member, and taking action.*

- *Alerting the team member/s:* This behaviour involves all team members reporting, checking, and questioning ambiguous situations. Positive reporting of actions completed and verbal alerts /challenges to actions that might have been missed or decisions that are not understood are essential to safe operations. The absence of such communication can lead to the breakdown of even the most experienced bridge team.

  For instance, a Master shares an incident where the 3/O alerted him in time about the rescue boat not being secured:

  *We had a near miss on one of our ships where I was the chief officer, and we were supposed to lower the rescue boat. The 3/O was supposed to go in to lower the boat. So, I told him that you familiarise himself with the hooking arrangement because hooking arrangement is very critical. Once you go down, you will be injured if you don't hook it correctly and if the boat falls. Then, just before the entire operation, I went with him on the rescue boat, and I showed him the hook; see, this is the hook, you have to dismantle it from here, and this is where you have to lock it. So, I was about to unhook it. The third officer now, a young guy, his first contract, said, if you unhook, we will fall now. I told him that the boat was secured. He said, No Sir, the boat is not secured; a team member has removed the securing arrangement.*

*Somebody had removed it; so, luckily, in this case, the third officer's presence of mind saved us from an incident. Otherwise, we were down; both of us were down.*

- *Providing ideas/suggestions:* Team members are engaged in problem-solving. A good team member should anticipate dangerous situations, recognize the development of an error chain, and offer suggestions for resolving the problem. If there is any ambiguity or element of doubt, team members should communicate and provide ideas and alternative solutions.

  A 4/E, for instance, suggested an idea promptly that aided the change over from diesel oil to heavy oil. He shared,

  *OK. So, this is about the specific set of generators on my last ship. While doing maintenance, typically engine runs on heavy fuel oil, which is very hot. So, during major maintenance, you change it over to diesel oil. If it cools down, everything is stuck in the lines. So, all three would not start on diesel oil in this particular set of engines. It wouldn't start. We tried, and Chief Engineer was there, Second Engineer was there. I had an idea to drain the lines in this instance, so we opened up the lines and put a bucket there. The second engineer was there; he cracked open the valve and flushed it till all the diesel oil was gone, and the heavy oil came into play…idea was mine.*

- *Taking action:* **An essential aspect of Bridge Resource Management on board is to recognize the development of an error chain and take appropriate action to break the error chain sequence.**

  A 3/O shares an incident where he noticed a fishing boat only five cables away and took prompt action. He shares,

  *I was on watch; I was an independent watchkeeper. So, I told the Able-Bodied Seaman (AB) that you keep a good watch. I told the AB to go down and have some tea; by the time he opened the door, some reflection was observed. There was a fishing boat around five cables only; I took the proper action, took the wheel in hand steering, and altered the course. Then I called the engine room; I informed them that I would give a general alteration; please reduce the revolution per minute (RPM) if any load comes on the engine. So, I told them that everything was prepared, and I altered the course.*

  A Master shared an incident where the C/O fell unconscious and the second officer, who is a rank below him, took charge of the situation. He shares,

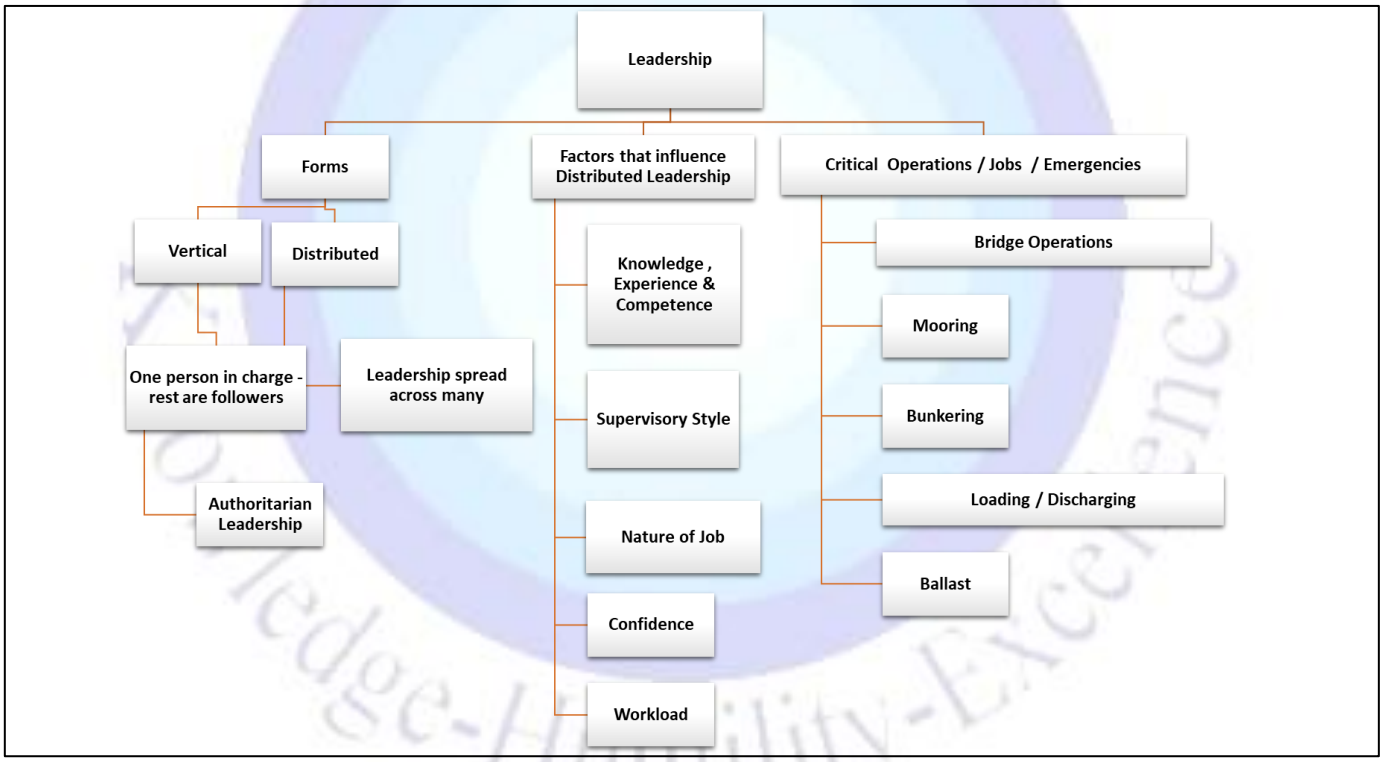
  *I had an injury in a hold where, if a person fell from a certain height, he had to be transported from the cargo hold to the deck. Unfortunately, I had a C/O who fell unconscious after seeing*

*blood, so I saw my 2/O just taking charge and bringing him out. As I said, he was a well-performing guy. Everybody respected him, and he took over.*

*Forms of Leadership and Factors that influence its emergence*

Three main themes that emerged from the data were prominent *forms of leadership, factors that affect/influence distributed leadership*, and *critical operations* that call for leadership to be displayed. Analysis of the interview transcripts revealed two forms of leadership that occur in tandem within the shipboard environment – *Vertical and Distributed*. Figure 3 depicts the forms of leadership and the factors that influence its emergence.

*Figure 4: Forms of Leadership and factors that influence its emergence*




*Vertical leadership:*

Analysis of the responses showed that vertical leadership is prevalent primarily because of the ship's hierarchical structure. The crew is organized hierarchically from Master downwards. Some of the responses suggesting the vertical hierarchical structure onboard the ship is mentioned below.

A Master emphasizes the hierarchical structure on board. He shares,

*There is a hierarchy; I mean, it cannot be informal. Somebody is senior to somebody; somebody's junior to someone. All the time you're on board, everyone is aware of who's who, so it can never be an equal playing ground….*

A C/E speaks of the authority vested in a single person. He shares,

*Leadership is leadership, you know; your authority has to be there. For a country, you need a leader; for a ship, you also need a leader. So, there's a Captain and I don't see any difference.*

While it is seen from the above instances that vertical leadership exists, a style of leadership that was considered rigid and not very effective by most respondents was the authoritarian style of leadership. This was quite evident from some of the responses below:

A C/O shared that the rigid approach is not effective when leading people. The essence lies in being more aware of people's needs and being diplomatic. He shares,

*When I started, I used to be very hard in approaching people. I can understand that it does not work with humans; you have to be soft, you have to be diplomatic, and you still need to be very assertive. Just believing that since I have been given the responsibility and other people have been theoretically told to obey my orders, I used to take it very literally, but it didn't work. So, I needed to change myself and become more aware of people's needs, especially those under me, which seems to be working. It is working, and I am still improving.*

A 3/O also shares his experience when being rude or arrogant was ineffective. He states,

*I have experienced that being arrogant or rude cannot make much difference, guiding someone, and not being rude help…*

*Distributed Leadership: A Few Critical Incidents*

All members of a team are encouraged to improve their leadership skills in a dispersed leadership paradigm. Everyone in the group has some level of leadership potential, and this is seen as a given. Leadership capacity and capability are not fixed, but they may be expanded. It is up to those in formal leadership roles to make sure that informal leaders can lead at the right moments and are supported in their efforts to make changes or innovate (Harris and Muijs, 2004). Below are some examples of leadership behaviours.

A Master shares an incident about a second officer who took charge. He shares,

*I once had an injury in a hold where if a person fell from a certain height, he had to be transported from the cargo hold to the deck. Unfortunately, I had a C/O who fell unconscious after seeing the blood. I saw my 2/O just taking charge and bringing him out.*

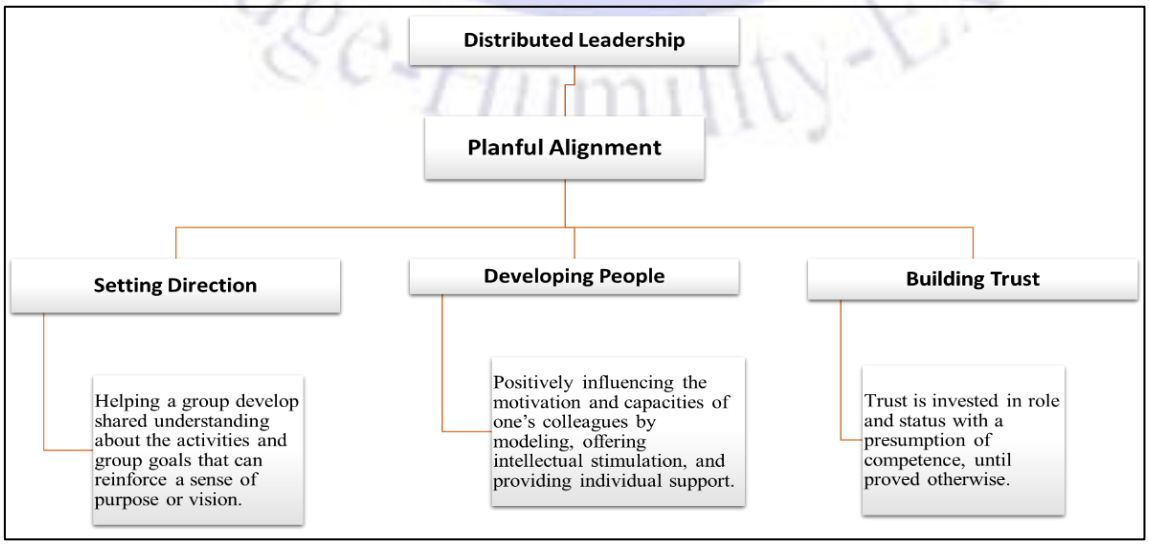
Distributed leadership does not imply that the formal leadership structures within organizations are removed or redundant.

*Planful Alignment*

Analysis of the transcripts revealed a configuration of distributed leadership where tasks or functions of ship officers were laid out and responsibilities were assigned to team members to carry out leadership functions. This form of leadership was called planful alignment.

Figure 4 depicts a framework of distributed leadership in the marine domain. Planful alignment was shown to be a common arrangement among sailors, according to the study. Organizational members have given careful consideration to the roles and responsibilities of people in positions of authority in this set-up. This agreement was reached among the sources of leadership about which source best carries out leadership practices or functions. Trust in one's leadership colleagues' motives, well-founded assumptions about one's leadership colleagues' capabilities, and a preference for cooperation over the competition as a way to increase productivity are some of the shared values and beliefs that seem likely to be associated with planful alignment.

*Figure 5: Framework of Distributed Leadership*



Three sub-themes under the central theme 'Planfully aligned leadership' were identified: *Setting Direction, Developing People, and Building Trust.*

- *Setting Direction:* To motivate their subordinates, leaders must use a series of techniques known as setting direction (Fullan, 2003). Settling down on a course of action is all about creating a common goal and expressing that goal to students. Educational leaders help to build shared meanings and understandings to support the school's goal because individuals usually respond based on how they perceive things. The validity and effectiveness of a school are bolstered when students' experiences, learning, and schooling are communicated to members of the community. (Liethwood and Riehl, 2003). Leaders that are adept at focusing attention on the most important components of the school's vision can convey the notion clearly and persuasively (Leithwood & Riehl, 2003).

  A Master shares how he initially sets the direction through meetings and conducting drills. This helps the team develop a shared vision and communicate the direction. He shares,
  *See, there are times when we carry out meetings and a few drills; I get people to start up, and when I find they can manage, I take a step back, and then I let them lead. Because they are the future, I've had chief officers; at times, I've had second officers, even third officers…*

  A Master shares,
  *I observed that if you keep encouraging him, keep prodding him in the correct direction the behaviour changes. Still, the other problem in shipping is the paucity of time and multitasking, which you do quite a few times.*

- *Developing People:* Developing People was the second subtheme of planful alignment. This is another component of planful alignment noted in most of the responses. Developing people comprises providing individualized support and consideration, offering intellectual stimulation, and modelling appropriate values and practices (Leithwood & Seashore-Louis, 2012).
- Effective leaders promote the learning and growth of professionals. Effective leaders lead by example and others emulate their behaviour. Leaders strengthen peoples' beliefs about their abilities and capacity to bring about change (Leithwood and Riehl, 2003). Instances of developing people were identified in the transcripts.

A Chief Officer shares how his Master used to teach him to pick up the next rank's (Chief Officer's) job. He says,

*One Captain, he was teaching me literally; you come, sit down, I'll teach you how to when I was a 2/O. He used to teach me, saying, I know that you are 2/O now; you will be C/O tomorrow. He used to call me and say, come sit down. Then for half an hour or forty-five minutes, he would teach me something.*

- *Building Trust:* The third subtheme of planful alignment is Building Trust. A third component that was explored is termed 'building trust' for the current study. This is also similar to building a collaborative culture. Drawing from education, effective school leaders help develop school cultures that encourage caring and building trust among team members. The shipboard environment sets the atmosphere and the context in which work is carried out.

  A 3/O speaks of when his chief officer trusted him to perform ballasting and deballasting. He shares,

  *When I was a cadet, I didn't have much responsibility or many things on my shoulders. Hence, the chief always trusted me with something, whether it was ballasting, deballasting, anything to do in port, or anything like that; the crew always looked up to me and said, ''OK, this guy knows his job though he's a trainee*.''

  Within the maritime system, safety rules, regulations, and procedures are all aspects of the situation that play a crucial role in encouraging safe work practices. As such, these elements are deeply interconnected and mutually constitutive. It involves more than one leader. It is viewed as a product of the interactions of leaders, followers, and their situations. The follower forms an integral part of the dynamic leadership system.

## 5. SUMMARY

It is clear that there has been a change in the way leadership is perceived over the years. From a commanding authoritarian style which was prominent in the good old days of shipping, there

seems to be a shift towards the leader delegating responsibilities and other team members displaying leadership to avert a dangerous situation from developing. The follower or team member also plays an integral role in performing the assigned activities.

Qualitative analysis showed that planfully aligned leadership was prevalent among seafarers. Responsibilities are deliberately distributed to those individuals and groups best placed to lead a particular function or task. It is interesting to note how leadership is distributed onboard the ship. This second form of leadership prevalent onboard is 'distributed leadership'; however, seafarers seem to have little or no understanding of this approach.

There were several instances in the qualitative responses where operational level officers/those of a junior rank rise to the occasion and manifest leader behaviours. Rather than viewing leadership in terms of a single person at the top, leadership is a practice involving the careful alignment of roles and responsibilities. Leadership does not rest with the Master alone; it is extended to the team members to take prompt actions when required.

Analysis of the responses concerning the behaviours displayed during critical operations revealed that it is not a one-man show. While one cannot deny the presence of the formal leader, there are instances of leadership among other crew members who interact with the formal leader and emerge as leaders in that situation.

### 5.1 Phase 2

*Descriptive Statistics and Reliability Index*

Data were summarized using descriptive statistics to provide a comprehensive picture. Table 2 summarizes the findings. It illustrates the mean and standard deviation of data collected from 216 individuals in a study.

Table 2 shows the reliability index for the three dimensions of the planfully aligned leadership scale. The mean score of the planfully aligned leadership scale was 4.16, and the reliability index was 0.99. The mean score of the dimension Setting Direction was 4.18, and the reliability index was 0.95. The mean score of the dimension Developing People was 3.63, and the reliability index was 0.99. The mean score of the dimension Building Trust was 4.14, and the reliability index was 0.99.

*Table 2: Descriptive Statistics and Reliability Index*

| | Minimum | Maximum | Mean | SD | Reliability |
|---|---|---|---|---|---|
| Planfully aligned leadership scale | 25 | 125 | 4.16 | 0.81 | 0.99 |
| Setting Direction | 1 | 5 | 4.18 | 0.81 | 0.95 |
| Developing People | 1 | 5 | 3.63 | 0.75 | 0.99 |
| Building Trust | 1 | 5 | 4.14 | 0.84 | 0.99 |

*N = 216

The above findings suggest that planfully aligned leadership was prevalent among seafarers. Behaviours associated with setting direction, developing people, and building trust were also identified. Behaviours associated with setting direction, developing people, and building trust were also evident from the means scores.

*Summary:*

The quantitative findings suggest that planfully aligned leadership practice was prevalent among seafarers aboard merchant ships. Behaviours associated with setting direction, developing people, and building trust were also identified.

The responses to the qualitative section suggested instances of planfully aligned leadership and effective leader behaviours such as alerting, informing, and reporting.

Responses showed that planfully aligned leadership was evident in the shared roles which emerged between the team members involved in the critical incidents cited by the respondents.

Qualitative analysis also showed that vertical leadership was evident in many situations; the authoritarian leadership style was identified in many of the responses. Behaviours associated with this leadership style were described as ineffective.

## 5.2 Phase 3

*Results:*

This section addresses research questions two to seven.

*RQ 2: What is the strength and direction of the relationship between planfully aligned leadership (PAL) and emergency response (ER) among team members?*

Ordinary least square (OLS) regression was employed to determine if leadership contributed to the effective response of team members to the emergency. As Table 3 indicates, there is a positive and significant relationship between PAL and ER. Table 6.13 displays effect size measures (R2) and adjusted R2 for the model, and Table 6.14 displays pooled unstandardized regression coefficients (B) and standardized regression coefficients (β). The Ezekiel adjusted R2 value indicates that PAL predicted just 47.8 percent of the variability in ER.

*Table 3: Coefficients*

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -.297 | .261 | | -1.140 | .259 |
| | PAL Mean | .526 | .071 | .698 | 7.423 | .000 |
| a. Dependent Variable: ERM | | | | | | |

*Table 4: ANOVA Results*

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 12.962 | 1 | 12.962 | 55.097 | .000[b] |
| | Residual | 13.644 | 58 | .235 | | |
| | Total | 26.606 | 59 | | | |
| a. Dependent Variable: ERM | | | | | | |
| b. Predictors: (Constant), PAL Mean | | | | | | |

*RQ 3: What is the strength and direction of the relationship between the three dimensions of planfully aligned leadership viz. SD, DP and BT, and ER?*

When the three dimensions of PAL were examined individually, each dimension appeared strongly linked to emergency response. However, Developing People is the most potent contributor as it independently explained about 49.5% of predicted ER.

*Table 5: SD, DP, and BT Dimensions of Planfully aligned leadership as a Predictor of Emergency Response from Ordinary Least Squares Regression*

| **Model Summary** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Change Statistics | | | | |
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .673[a] | .453 | .444 | .50083 | .453 | 48.072 | 1 | 58 | .000 |
| a. Predictors: (Constant), SD | | | | | | | | | |
| | | | | | Change Statistics | | | | |
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 2 | .710[a] | .504 | .495 | .47700 | .504 | 58.936 | 1 | 58 | .000 |
| a. Predictors: (Constant), DP | | | | | | | | | |
| | | | | | Change Statistics | | | | |
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 3 | .662[a] | .438 | .429 | .50758 | .438 | 45.269 | 1 | 58 | .000 |
| a. Predictors: (Constant), BT | | | | | | | | | |

*Table 6: ANOVA*

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 12.058 | 1 | 12.058 | 48.072 | .000[b] |
| | Residual | 14.548 | 58 | .251 | | |
| | Total | 26.606 | 59 | | | |
| a. Dependent Variable: ERM; b. Predictors: (Constant), SD | | | | | | |
| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
| 2 | Regression | 13.410 | 1 | 13.410 | 58.936 | .000[b] |
| | Residual | 13.196 | 58 | .228 | | |
| | Total | 26.606 | 59 | | | |
| a. Dependent Variable: ERM; b. Predictors: (Constant), DP | | | | | | |
| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
| 3 | Regression | 11.663 | 1 | 11.663 | 45.269 | .000[b] |
| | Residual | 14.943 | 58 | .258 | | |
| | Total | 26.606 | 59 | | | |
| a. Dependent Variable: ERM; b. Predictors: (Constant), BT | | | | | | |

*RQ 4. After controlling for demographic measures, what is the strength and direction of the relationship between PAL and ER? What is the contribution of the demographic criteria such as age and contract period?*

The hierarchical OLS regression analysis was performed between emergency response as the criterion variable, age and contract period as predictor variables in the first block, and leadership as a predictor variable in the second block. Tables 7 to 9 display effect size measures (R2), change in R2, adjusted R2, F Change, and its Significance level for the entire model. Table 6.19 displays pooled unstandardized regression coefficients (B), standardized regression coefficients (β), and model significance p-value. R2 was statistically insignificant for the first block but highly significant for the full model. The final adjusted R2 value indicates that about 50 percent variability in emergency response was predicted by leadership and demographic measures. The role of age and contract period as predictors were insignificant. The change in R2 for the second block was 47.4 percent.

It indicates that the strength and direction of the relationship between PAL and ER are positive and strong after controlling for demographic measures. The contribution of the demographic criteria such as age and the contract period are almost trivial.

*Table 7: ANOVA*

| Model Summary | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .162[a] | .026 | -.008 | .67423 | .026 | .764 | 2 | 57 | .470 |
| 2 | .707[b] | .500 | .473 | .48733 | .474 | 53.106 | 1 | 56 | .000 |
| a. Predictors: (Constant), ContractPd, Age | | | | | | | | | |
| b. Predictors: (Constant), ContractPd, Age, PAL Mean | | | | | | | | | |

*Table 8: ANOVA*

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | .695 | 2 | .347 | .764 | .470[b] |
| | Residual | 25.911 | 57 | .455 | | |
| | Total | 26.606 | 59 | | | |
| 2 | Regression | 13.307 | 3 | 4.436 | 18.677 | .000[c] |
| | Residual | 13.299 | 56 | .237 | | |
| | Total | 26.606 | 59 | | | |
| a. Dependent Variable: ERM | | | | | | |
| b. Predictors: (Constant), ContractPd, Age | | | | | | |
| c. Predictors: (Constant), ContractPd, Age, PAL Mean | | | | | | |

*Table 9: Coefficients Results*

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | .994 | .608 | | 1.633 | .108 |
| | Age | .018 | .024 | .132 | .723 | .473 |
| | ContractPd | .008 | .039 | .040 | .218 | .828 |
| 2 | (Constant) | -.711 | .498 | | -1.428 | .159 |
| | Age | .014 | .018 | .101 | .772 | .444 |
| | ContractPd | .004 | .028 | .017 | .131 | .896 |
| | PAL Mean | .520 | .071 | .690 | 7.287 | .000 |
| a. Dependent Variable: ERM | | | | | | |

*RQ 5. After controlling the workload, what is the strength and direction of the relationship between PAL and ER? What is the contribution of workload?*

Hierarchical OLS regression analysis was performed between emergency response as the criterion variable, workload as the predictor variable in the first block, and leadership as a predictor variable in the second block. Tables 10 to 12 display effect size measures (R2), change in R2, adjusted R2, F Change, and its Significance level for the entire model.

Table 6.22 displays pooled unstandardized regression coefficients (B), standardized regression coefficients (β), and model significance p-value. R2 was statistically significant for both blocks. The adjusted R2 value in the first block indicates that about 28.5 percent variability in emergency

response was predicted by the workload on leaders. The changes in R2 for the second block when leadership was introduced became 53.8 percent and the R2 difference was 25.7%.

It indicates that the strength and direction of the relationship between PAL and ER after controlling the workload is positive and strong. Workload variable also plays a vital role in the emergency response. However, its relationship with the emergency response is negative and statistically significant.

*Table 10: ANOVA*

| **Model Summary** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Change Statistics | | | | |
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .545[a] | .297 | .285 | .56782 | .297 | 24.520 | 1 | 58 | .000 |
| 2 | .744[b] | .554 | .538 | .45627 | .257 | 32.825 | 1 | 57 | .000 |
| a. Predictors: (Constant), WL | | | | | | | | | |
| b. Predictors: (Constant), WL, PAL Mean | | | | | | | | | |

*Table 11: ANOVA*

| Model | | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 7.906 | 1 | 7.906 | 24.520 | .000[b] |
| | Residual | 18.700 | 58 | .322 | | |
| | Total | 26.606 | 59 | | | |
| 2 | Regression | 14.739 | 2 | 7.370 | 35.400 | .000[c] |
| | Residual | 11.867 | 57 | .208 | | |
| | Total | 26.606 | 59 | | | |
| a. Dependent Variable: ERM | | | | | | |
| b. Predictors: (Constant), WL | | | | | | |
| c. Predictors: (Constant), WL, PAL Mean | | | | | | |

*RQ 6. What is the strength and direction of the relationship between L and ER after controlling for power distance that prevails between the formal leader and team members? What is the contribution of power distance?*

Hierarchical OLS regression analysis was performed between emergency response as the criterion variable, power distance as the predictor variables in the first block, and leadership as a predictor

variable in the second block. Tables 13 to 15 display effect size measures (R2), change in R2, adjusted R2, F Change, and its Significance level for the entire model. Table 6.25 displays pooled unstandardized regression coefficients (B), standardized regression coefficients (β), and model significance p-value. R2 was statistically significant for both blocks. The adjusted R2 value in the first block indicates that about 29.1 percent variability in emergency response was predicted by power distance. The change in R2 for the second block when leadership was introduced was 51.2 percent and the R2 change was 22.5%.

*Table 12: Coefficients Results*

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 3.631 | .421 | | 8.633 | .000 |
| | WL | -.286 | .058 | -.545 | -4.952 | .000 |
| 2 | (Constant) | 1.143 | .550 | | 2.077 | .042 |
| | WL | -.152 | .052 | -.290 | -2.922 | .005 |
| | PAL Mean | .428 | .075 | .568 | 5.729 | .000 |
| a. Dependent Variable: ERM | | | | | | |

It indicates that the strength and direction of the relationship between PAL and ER are positive and robust after controlling for power distance. The variability caused by power distance on emergency response is 29.1 percent which is statistically very significant. The coefficient results indicate a negative and significant relationship between power distance and emergency response.

*Table 13: ANOVA*

| **Model Summary** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Change Statistics | | | | |
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | .551[a] | .303 | .291 | .56536 | .303 | 25.239 | 1 | 58 | .000 |
| 2 | .727[b] | .528 | .512 | .46921 | .225 | 27.207 | 1 | 57 | .000 |
| a. Predictors: (Constant), PD | | | | | | | | | |
| b. Predictors: (Constant), PD, PAL Mean | | | | | | | | | |

*Table 14: ANOVA*

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 8.067 | 1 | 8.067 | 25.239 | .000[b] |
| | Residual | 18.539 | 58 | .320 | | |
| | Total | 26.606 | 59 | | | |
| 2 | Regression | 14.057 | 2 | 7.028 | 31.925 | .000[c] |
| | Residual | 12.549 | 57 | .220 | | |
| | Total | 26.606 | 59 | | | |
| a. Dependent Variable: ERM | | | | | | |
| b. Predictors: (Constant), PD | | | | | | |
| c. Predictors: (Constant), PD, PAL Mean | | | | | | |

*Table 15: Coefficients Results*

| **Coefficients** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. | 95.0% Confidence Interval for B | |
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 2.817 | .257 | | 10.970 | .000 | 2.303 | 3.331 |
| | PD | -.262 | .052 | -.551 | -5.024 | .000 | -.366 | -.158 |
| 2 | (Constant) | .602 | .475 | | 1.266 | .211 | -.350 | 1.553 |
| | PD | -.115 | .052 | -.242 | -2.231 | .030 | -.218 | -.012 |
| | PALMean | .427 | .082 | .566 | 5.216 | .000 | .263 | .590 |
| a. Dependent Variable: ERM | | | | | | | | |

*RQ 7. Is distributed leadership a better predictor of emergency response among team members than authoritarian leadership?*

We conducted an Independent Sample T-test to observe the mean difference in the emergency response of team members of the two experimental groups, i.e., PAL and AL. The mean of the PAL group (M = 2.15, SD = .31) is significantly higher than the AL group (M = 1.0, SD = .36). The p-value of Levene's test is $p > 0.05$. A non-significant p-value of Levene's test shows that the variances are equal, and there is no difference in variances of both groups.

Therefore, we counted only on the p-values obtained from the independent samples t-test, which is statistically significant, $p < 0.001$.

It indicates that distributed leadership or PAL is a better predictor of emergency response among team members than authoritarian leadership.

*Table 16: Group Statistics*

| | L | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| ERM | 1.00 | 30 | 2.1567 | .31479 | .05747 |
| | 2.00 | 30 | 1.0033 | .36102 | .06591 |

Note: ERM:

*Table 17: Independent Samples Test Results*

| | | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | | F | Sig. | t | Df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| ERM | Equal variances assumed | | .021 | .886 | 13.188 | 58 | .000 | 1.15333 | .08745 | .97828 | 1.32838 |
| | Equal variances not assumed | | | | 13.188 | 56.944 | .000 | 1.15333 | .08745 | .97821 | 1.32845 |

Note: ERM:

## 5.3 Summary

This phase was an attempt to examine the relationship between leadership and emergency response. A simulation was used to analyse the relationship between planfully aligned leadership and emergency response and authoritarian leadership and emergency response. In the simulation, an attempt was made to increase the workload gradually.

A manipulation check was used to gauge the effectiveness of the manipulation in this simulation. *The T-test results indicated that team members' responses to the two types of leadership prompt*

*in the manipulation were triggered by the manipulation.* The participants in both groups were meticulously involved in the simulation, and they were not subject to boredom or fatigue. Hence, the probability of boredom and disengagement impacting the emergency response of team members was ruled out.

Quantitative analysis of the findings showed a positive and significant relationship between planfully aligned leadership and emergency response. When the three dimensions of planfully aligned leadership were examined individually, each dimension appeared strongly linked to emergency response. However, Developing People was the most substantial contributor as it independently explained about 49.5% of predicted ER. Results indicated that the strength and direction of the relationship between planfully aligned leadership and emergency response after controlling for demographic measures were positive and strong. The contribution of the demographic criteria such as age and contract period were almost trivial. Results indicated that the strength and direction of the relationship between planfully aligned leadership and emergency response after controlling for workload were positive and strong.

The workload variable also played a vital role in the emergency response. However, its relationship with emergency response was negative and statistically significant. The findings also showed that the strength and direction of the relationship between planfully aligned leadership and emergency response after controlling for power distance were positive and strong. Lastly, the results showed that planfully aligned leadership was a better predictor of emergency response than authoritarian leadership teams.

## 6. CONCLUSION

Among merchant mariners on board ships, researchers examined how distributed leadership practices affect safety. Qualitative and quantitative analyses of data suggested that merchant mariners have a strong preference for leaders who are strategically oriented.

There is a strong and positive correlation between emergency response and planfully aligned leadership. After controlling for demographic variables such as age, experience, power distance, and workload, planfully aligned leadership predicts the emergency response of team members considerably. Workload and emergency response have a negative and significant association, as

do power distance and emergency response. Planfully aligned leadership is a better predictor of emergency response than authoritarian leadership.

Theoretically, distributed leadership is a fairly recent idea to emerge. Individual leaders, their qualities and behaviour, the standards they should meet (Gronn 2003), and their influences on followers (Camburn et al. 2003) have dominated the leadership literature. The fact that we have taken so long to notice and establish the conceptual frameworks that go along with distributed leadership is astonishing. We must not become blinded by the concept's constraints and our inability to think about it outside of it once we've begun to explore it. New ways of thinking about leadership practice and implementing practice in a deliberate manner are necessary. This shift is made possible by the use of distributed leadership.

### 6.1 Practical and Theoretical Implications

This research has contributed to knowledge in leadership and has implications for leadership training and development. Instead of focusing on 'what' leadership is, it delves into the 'how' of leadership and how leadership is manifested in seafarers' day-to-day operations and interactions. Considering the literature on distributed leadership gaps, this study helps broaden the scope beyond the educational context. The review of empirical and theoretical findings indicated that most work on the concept of DL is carried out in the academic context, especially on teacher leadership.

While prior studies limit the understanding of safety leadership, a distributed approach to leadership broadens one's understanding of this phenomenon by considering the follower and the situation. The findings of this study challenge existing leadership views as being focused and individualistic.

Implementing distributed leadership practice within the maritime context has important implications:

Distributed leadership can only work and thrive when the cultural and structural conditions for it are established by people in positions of formal authority. An organization’s structure establishes the specific tasks and roles of each employee within the larger framework of the business. The prevalence of informal interactions and a low power distance between supervisor and subordinate make DL techniques an ideal fit for the workplace.

Distributing leadership in any form may not necessarily be the answer. How leadership may be distributed is dependent on the organizational culture, people's readiness to change, and the developmental needs of the organization. Relationships among people and trust among people involved also play an important role.

### 6.2 Limitations and Pointers for Future Research

Literature on distributed leadership is still not thorough enough to offer a deeper understanding of the anatomy of distributed leadership and the relationship between distributed leadership and organizational development and change. This study explores planfully aligned leadership among seafarers and its relationship to emergency response and makes it worth further investigation and scrutiny.

Future research could delve into how leadership is distributed in other high-risk environments. It would be worthwhile to analyse the factors that facilitate distributed leadership, such as team member motivation, competency level, and self-efficacy. Future studies could also consider applying and validating the distributed leadership framework studied in this research. Studies exploring the organization's culture, readiness to change, and developmental needs would be beneficial to broaden the scope of distributed leadership within the maritime industry. Research studies using longitudinal design would be beneficial to explore distributed leadership further. Looking into hybrid patterns of distribution is also another key challenge for researchers.

## REFERENCES

Alan Bryman, M. S. (1996). The importance of context: Qualitative research and the study of leadership. *The Leadership Quarterly*, 353-370. doi:https://doi.org/10.1016/S1048-9843(96)90025-9

Baddeley, A. (1992). Working Memory: The Interfhce between Memory and Cognition. *Journal of Cognitive Neuroscience*, 281–288. doi:https://doi.org/10.1162/jocn.1992.4.3.281

Bart C H de Zwart, M. H.-D. (1995). Physical workload and the ageing worker: a review of the literature. *Concepts in Occupational and Environmental Health*, 1-12. doi:https://doi.org/10.1007/BF01831627

Bolden, R. (2011). Distributed Leadership in Organizations: A Review of Theory and Research. *International Journal of Management Reviews*, 251-269. doi:https://doi.org/10.1111/j.1468-2370.2011.00306.x

Carlos A Comperatore, P. K. (2005). Enduring the shipboard stressor complex: a systems approach. *Aviat Space Environ Med*.

Çelik, H. (2017). The Relationship Between Employee Motivation and Leadership. *Balkan and Near Eastern Journal of Social Sciences*.

Cheng, J.-L. F.-S. (2000). A Cultural Analysis of Paternalistic Leadership in Chinese Organizations. In *Management and Organizations in the Chinese Context* (pp. 84-127). doi:http://dx.doi.org/10.1057/9780230511590_5

Christine Chauvin, S. L.-P. (2013). Human and organisational factors in maritime accidents: Analysis of collisions at sea using the HFACS. *Accident Analysis and Prevention*. doi:http://dx.doi.org/10.1016/j.aap.2013.05.006

Clarke, S. (2012). Safety leadership: A meta-analytic review of transformational and transactional leadership styles as antecedents of safety behaviours. *Journal of Occupational and Organizational Psychology*, 22-49. doi:https://doi.org/10.1111/j.2044-8325.2012.02064.x

Daniel Goleman, R. B. (2002). The Emotional Reality of Teams. *Journal of Organizational Excellence*, 55-65. doi:https://doi.org/10.1002/npr.10020

Dragomir, F. S. (2010). Leadership development training as method to increase seafarer competitiveness. *Annals of DAAAM & Proceedings*.

Goetsch, D. L. (2005). *Occupational Safety and Health for Technologists, Engineers, and Managers.*

Halverson, R. (2007). A distributed leadership perspective on how leaders use artifacts to create professional community in schools. *Professional learning communities: Divergence, detail and difficulties*, 93-105. Retrieved from https://web.education.wisc.edu/halverson/wp-content/uploads/sites/33/2012/09/Halverson-PLC-Book-Chapter-7.pdf

Harris, A. (2009). Distributed Leadership: What We Know. *Distributed Leadership* , 11-21. doi:http://dx.doi.org/10.1007/978-1-4020-9737-9_2

HSIAO, S. G. (1990). An Emperical Study of Overseas Chinese-Managerial Ideology. *International Journal of Psychology*, 629-641. doi:https://doi.org/10.1080/00207599008247917

James P. Spillane, R. H. (2001). Investigating School Leadership Practice: A Distributed Perspective. *Educational Researcher*, 23-28. doi:http://dx.doi.org/10.3102/0013189X030003023

Katherine Devitt, S. H. (2010). The development of resource management and leadership behavioural markers for the Merchant Navy. *Maritime Human Resources Solutions Conference*, 1-24. Retrieved from https://pure.solent.ac.uk/en/publications/the-development-of-resource-management-and-leadership-behavioural

Kenneth Leithwood, A. H. (2007). Distributed leadership and organizational change: Reviewing the evidence. *Journal of Educational Change*, 337–347. Retrieved from https://link.springer.com/article/10.1007/s10833-007-9048-4

Kenneth Leithwood, B. M. (2009). *Distributed Leadership According to the Evidence.* New York: Taylor & Francis e-Library. Retrieved from https://books.google.co.in/books?id=5k2OAgAAQBAJ&lr=

Lützhöft, G. P. (2011). “Safety is everywhere”-The Constituents of Maritime Safety. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*. doi:https://doi.org/10.1177/1071181311551373

Malloy, J. (2017). Effects of Distributed Leadership on School Academic Press and Student Achievement. *How School Leaders Contribute to Student Success*. doi:http://dx.doi.org/10.1007/978-3-319-50980-8_5

Marshall, S. P. (2002). The Index of Cognitive Activity: Measuring Cognitive Workload. *Human Factors and Power Plants, 2002. Proceedings of the 2002*. doi:http://dx.doi.org/10.1109/HFPP.2002.1042860

O'Toole, M. (2002). The relationship between employees' perceptions of safety and organizational culture. *Journal of Safety Research*, 231-243. doi:http://dx.doi.org/10.1016/S0022-4375(02)00014-2

Rhona Flin, G. S. (1996). Emergency Decision Making in the Offshore Oil and Gas Industry. In *Human Factors* (pp. 262-277). doi:DOI: 10.1177/001872089606380207

S. E. Roberts, D. N. (2014). Fatal accidents and injuries among merchant. *Occupational Medicine*, 259–266.

Scandura, E. K. (2008). Paternalistic Leadership: A Review and Agenda for Future Research. *Journal of Management*. doi:https://doi.org/10.1177/0149206308316063

Schmidt, J. K. (2000). Emergency response training: strategies for enhancing real-world performance. *Journal of Hazardous Materials* , 195–215. doi:http://dx.doi.org/10.1016/S0304-3894(00)00180-1

Shayne Loft, P. S. (2007). Modeling and Predicting Mental Workload in En Route Air Traffic Control: Critical Review and Broader Implications. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 376. doi:http://dx.doi.org/10.1518/001872007X197017

Sheridan, T. B. (1981). Understanding human error and aiding human diagnostic behaviour in nuclear power plants. doi:https://doi.org/10.1007/978-1-4615-9230-3_3

Smith, A. P. (2017). Workload, Fatigue and Performance in the Rail Industry. *International Symposium on Human Mental Workload: Models and Applications*. doi:http://dx.doi.org/10.1007/978-3-319-61061-0_17

Spillane, J. P. (2006). Distributed Leadership. *The Educational Forum*, 143-150. doi:http://dx.doi.org/10.1080/00131720508984678

Staal, M. A. (2004). Stress, Cognition, and Human Performance: A Literature Review and Conceptual Framework. *NASA/TM*. Retrieved from https://human-factors.arc.nasa.gov/flightcognition/Publications/IH_054_Staal.pdf

Sydnes, B.-M. B. (2013). Maritime safety and the ISM code: A study of investigated casualties and incidents. *WMU Journal of Maritime Affairs*. doi:http://dx.doi.org/10.1007/s13437-013-0051-8

Tae-eun Kim, A. K.-M. (2020). Development and validation of a safety leadership Self-Efficacy Scale (SLSES) in maritime context. *Safety Science*. Retrieved from https://reader.elsevier.com/reader/sd/pii/S092575352030428 8?token=AEB7311EF192F94D97FCCD31757050B2CF70C6E9B98A2674D57916EA5B9FF7DB9D57227127035C79A47D3363B7A150AB&originRegion=eu-west-1&originCreation=20221103101413

Vidulich, P. S. (2006). Mental Workload and Situation Awareness. *Handbook of Human Factors and Ergonomics, Third Edition*, 243 - 268. doi:http://dx.doi.org/10.1002/0470048204.ch9

Vineet Kaur Sandhu, K. L. (2021). A Transactional Approach of Occupational Stress and Behaviour Pivotal to Human Error. *Journal of Environmental and Occupational Health*, 9-17. Retrieved from https://www.jenvoh.com/jenvoh-articles/a-transactional-approach-of-occupational-stress-and-behaviour-pivotal-to-human-error-and-leadership-in-maritime.pdf

Wickens, C. D. (2008). Multiple Resources and Mental Workload. *Golden Anniversary Special Issue*. doi:https://doi.org/10.1518/001872008X288394

Yukl, G. (2006). *Leadership in Organizations* (6th Edition ed.).

Zhen Wang, Y. L. (2019). Authoritarian leadership and task performance: the effects of leader-member exchange and dependence on leader. *Frontiers of Business Research in China*. doi:https://doi.org/10.1186/s11782-019-0066-x

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