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"Professional Doctorate" in "Maritime Business Management"

Topic of Research:

"Impact of ship-sourced oil pollution on maritime business through environmental and economic consequences, and mitigation strategies to minimize effects via integrated cooperation between the IMO, key stakeholders, and enhanced ship crew awareness."

A Dissertation for the "Professional Doctorate" in

"Maritime Business Management"

Central Global University, Georgia

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"Professional Doctorate" in "Maritime Business Management"

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Student Name: Dr. Captain Prodip Kumar Roy

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"Impact of ship-sourced oil pollution on maritime business through environmental and economic consequences, and mitigation strategies to minimize effects via integrated cooperation between the IMO, key stakeholders, and enhanced ship crew awareness"

A study & work-based research on

"Ship source oil pollution impact on Maritime Business through Environmental and Economic Consequences, and Mitigation Strategies to minimize effects", with existing regulations for mitigation through proper implementations, proposals for further ratification through establishing an "integrated management system of ISM SOLAS MARPOL & MLC" for effective prevention of ship sourced pollution and to a better Global Maritime Business.

Central Global University, Georgia

Dr. Captain Prodip Kumar Roy (PhD, Master Mariner)

"Professional Doctorate" in "Maritime Business Management"

Abstract

Today Maritime oil pollution has become a Critical Global issue affecting the Marine Environment, natural habitat of humans and many animal species. The Pollution from Maritime industries such as Merchant Ships, it threatens to disrupt the oceanic environment that makes up more than three-fourths of our Earth's surface. We shall discuss on the causes of Marine pollution, Existing Preventive & Control measures in place and what need to be done more by the International Maritime Organization (IMO), The Contracting member states & Governments, The Flag State Controls, The Port State Controls, MOUs, The Classification Societies, The various Maritime friendly Organizations & Federations, The Ship Owners, The Ship Managers, OCIMF, CDI, ICS, SIGTTO, INTERTANKO, Oil Vetting & Oil Major inspection Parties, The P&I Club and other similar Marine Insurance Institutions & Underwriters, ITOPF and similar other marine ship pollution response advisers & The Ship Charterers, The Crewing Agencies and The Shipboard Crew and All concerned friends & partners for further effective measures & solutions for Merchant Ship-Sourced oil Pollution Management.

Ship sourced oil pollution need to be addressed focusing mainly on the ship board crew & their available related resources and shore-based support centers & their available related resources. My real-life study & experienced based research on "Impact of ship-sourced oil pollution on maritime business through environmental and economic consequences, and mitigation strategies to minimize effects via integrated cooperation between the IMO, key stakeholders, and enhanced ship crew awareness", will help Marine Community to further mitigation & advanced solution towards to the real crisis of ship sourced oil pollution.

Acknowledgment:

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Special thanks to Central Global University, Georgia to support me to study & perform my work-based research under it’s unique alternative online distance learning education programme through VAE:

“Professional Doctorate” in “Maritime Business Management”

"Impact of ship-sourced oil pollution on maritime business through environmental and economic consequences, and mitigation strategies to minimize effects via integrated cooperation between the IMO, key stakeholders, and enhanced ship crew awareness."

ATTESTATION ON PLAGIARISM AND OTHER FORMS OF ACADEMIC DISHONESTY

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_____

(Dr. Capt. Prodip Kumar Roy)

Date: 26-June-2025

Declaration by Supervisor

This is to certify that the Thesis "Impact of ship-sourced oil pollution on maritime business through environmental and economic consequences, and mitigation strategies to minimize effects via integrated cooperation between the IMO, key stakeholders, and enhanced ship crew awareness", submitted by Dr. Capt. Prodip Kumar Roy, Central Global University, Georgia, in Partial fulfillment of the requirement for the Award of "Professional Doctorate" in "Maritime Business Management", is carried out under my guidance and supervision. However, the student bears full responsibility for the contents of this thesis/research.

Dr. Dewan Mazharul Islam,
Professor
Department of Maritime Science
Supervisor
Bangladesh Maritime University,
Date: 27-June-2025

DEDICATION

In the name of Allah, the most Gracious and the most Merciful!!

To my beloved parents and my family!

And

For all the seafarers and their beloved ones around the planet!

And especially

To all living creatures on this planet who are struggling every day for a pollution free sustainable maritime environment!

Acknowledgement

I thank the Almighty Allah for giving me His grace and strength to write this Thesis "Ship source oil pollution impact on Maritime Business through Environmental and Economic Consequences, and Mitigation Strategies to minimize effects with IMO and key stakeholders' integrated cooperation and ship crew awareness".

I am cordially thankful to Central Global University, Georgia, presenting the "Professional Doctorate" in "Maritime Business Management" Thesis to enlighten the Maritime community and internationally about Maritime Education. Especially thankful to different government, non-government authorities, the researchers as they enlightened me through their works and have made this investigation possible.

Lastly, I would like to express earnest regards and thanks to my Thesis Supervisor Prof. Dewan Mazharul Islam, Department of Maritime Science, Bangladesh Maritime University, for his excellent guidance and support.

ABSTRACT

Potential increase of worldwide maritime transportation of petroleum products ultimately results in unintentional oil spills. Introduction of preventative measures with the safety concerns globally and domestically were able to mitigate the potential consequences of spills and quantity of unintentional releases into the sea in the previous decades. However, recent occurrences in this area demonstrates that marine oil spills are unexpected events that may inflict considerable damage not only to the marine ecosystems and wildlife, but also the coastal populations in large. The research deals with the "Ship source oil pollution impact on Maritime Business through Environmental and Economic Consequences, and Mitigation Strategies to minimize effects with IMO and key stakeholders' integrated cooperation and ship crew awareness". particularly. A thorough study of associated components, which contribute to oil spill threats have been examined. Procedures performed in this incident to minimize and manage oil pollution hazards are evaluated particularly with the current oil spill preparedness measures. The legal arrangements in worldwide context to mitigate and manage possible oil pollution were taken into consideration to evaluate the oil spill control systems nationally and regionally. The major causes of oil pollution in the marine environment are investigated, utilizing literature review by drawing a comparison with prior studies and recommendations given regarding the potential of decreasing oil pollution. The Research emphasized the importance about the Impact of Oil Pollution to Marine Environment and Role of IMO and Key Stakeholders like NGOs, Maritime Global Universities, The Governments, International Labour Organisation (ILO), International Transport Workers Federation for seafarers (ITF), The Flag State Controls (FSC), The Port State Controls (PSC), The Classification Societies, The Ship Owners, The Ship Charterers, The P&I Club, Marine Insurance Institutions & Underwriters, Concerned friends & partners and The Ship Crew to understand their individual or collective responsibilities, shortcomings and spend more efforts to establish an Integrated Cooperation for existing Challenges and Strategies for mitigation & effective solutions for ship sourced Pollution Management.

Key words: "Impact of ship-sourced oil pollution on maritime business through environmental and economic consequences, and mitigation strategies to minimize effects via integrated cooperation between the IMO, key stakeholders, and enhanced ship crew awareness."

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Acronyms

For the purpose of this safety guide the following Acronyms apply:

Administration: Means Government of the State whose flag the ship entitled to fly.

CDI: Chemical Distribution Institute

CFR: Code of Federal Regulations

CLC: International Convention on Civil Liability for Oil Pollution Damage

CLBC: International Convention on Civil Liability for Bunker Oil Pollution Damage

D&A policy: Drug & Alcohol Policy

DPA: Designated Person Ashore

ECDIS: Electronic Chart Display and Information System

FSC: The Flag State Control

FSU: Floating Storage Unit

ICS: International Chamber of shipping

IMO: The International Maritime Organization

INTERTANKO: International Association of Independent Tanker Owners

ILO: International Labor Organization

IMS: An Integrated Management System

ISGOTT: The OCIMF "International Safety Guide for Oil Tankers and Terminals"

ISM code: The International Safety Management Code by IMO

ISO: International Organization for Standardization

ITF: International Transport Workers Federation for seafarers

ITOPF: The International Tanker Owners Pollution Federation

MLC: ILO Maritime Labor Convention, 2006

MSDS: Material Safety Data Sheet

M/T or, MT: Motor Tanker

NGOs: Non-Government Organizations

MARPOL: The International Convention for the Prevention of Pollution from Ships

MPA Singapore: Maritime and Port Authority of Singapore

NC: Non-Conformity

NOAA: The National Oceanic and Atmospheric Administration

OCIMF: The Oil Companies International Marine Forum

OILPOL: International convention for the prevention of pollution of the sea by oil

ORB: Oil Record Book

OSRA: Oil Spill Risk Assessment

P&I club: A Protection & Indemnity or P&I club

PSC: The Port state control

SIGTTO: The Society of International Gas Tanker and Terminal Operators

SIRE: Ship Inspection Report Programme

SMPEP: Shipboard Marine Pollution Emergency Plan

SOLAS: The International Convention for the Safety of Life at Sea

SOPEP: Shipboard oil Pollution Emergency Plan

STCW: International Convention on Standards of Training, Certification and Watchkeeping for Seafarers

UNCLOS: United nations convention on the law of the seas

UNEP: United Nations Environment Programme

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Marine environmental pollution is caused by five sources including land-based pollution, seabed activities, ocean dumping, vessel-source pollution and atmospheric (Tan, 2006). Land-based discharges and run-offs are the leading source of marine pollution, accounting for 44% of all human-induced marine pollution (Vander Zwaag et al, 1991). Ships are thought to be responsible for just around 13% of oil pollution in the ocean, while land-based pollution accounts for 70%. (Tan, 2006). This research will concentrate on marine oil pollution which includes contamination from both intentional and unintentional oil discharges from ships.

Ship-source oil pollution impact to Environmental and Economic Consequences are damaging.

Marine Ecosystem Damage: Oil spills can cause significant damage to marine ecosystems, marine life, including fish, birds, mammals, and other organisms, through direct contact, ingestion, and habitat destruction, impacting fish populations, seabirds, and other marine life.

Human Health Concerns: Oil spills can contaminate seafood and drinking water sources, potentially leading to long-term health problems.

Coastal Pollution: Oil contaminates shorelines, beaches, and wetlands, impacting recreational areas and potentially harming coastal communities.

Habitat Loss: Oil spills can destroy sensitive habitats like seagrass beds and coral reefs, disrupting ecosystems and biodiversity.

Long-term Effects: Some pollutants can persist in the environment for years, causing chronic damage to ecosystems.

Economic Losses: Oil spills can lead to substantial economic losses for fishing, tourism, and other industries that rely on a healthy marine environment.

Compensation Costs: Shipowners are liable for damages caused by spills, and compensation is often provided through international and national funds.

Legal and Administrative Costs: Litigation, investigations, and regulatory actions related to spills add to the financial burden.

Compensation Mechanisms:

International Funds: The International Oil Pollution Compensation Funds (IOPC Funds) provide compensation when shipowners' liability limits are insufficient.

National Funds: Some countries have established national funds to supplement international compensation or provide additional coverage.

Liability Insurance: Shipowners are typically required to have liability insurance through Protection and Indemnity (P&I) Clubs.

Legal Frameworks: International and national laws establish liability rules and compensation procedures for oil spill incidents.

Clean-up Costs: The cost of cleaning up oil spills can be enormous, placing a significant financial burden on responsible parties and potentially impacting the shipping industry.

Remediation efforts, including containment, cleanup, and disposal of contaminated materials, are very expensive.

Financial Compensation:

International Organizations: The International Oil Pollution Compensation Fund (IOPC Fund) (now part of the International Maritime Organization) provides compensation for oil pollution damage, covering costs for response measures, property damage, and economic losses.

National Funds: Many countries have established their own compensation funds, like China's China's Ship Oil Pollution Compensation Fund (CSOPC), to address pollution incidents.

Insurance: Ship owners' insurers, typically Protection and Indemnity (P&I) Clubs, cover pollution damage, including oil spills, as part of their liability coverage.

Liability: The shipowner is generally liable for pollution damage, but compensation can also come from the IOPC or other national funds if the shipowner's liability is insufficient.

Liability and Compensation Funds: International conventions like the International Oil Pollution Compensation Fund (IOPC) and national funds (e.g., China's CSOPC) provide financial resources to compensate for damages from ship-source oil pollution.

Liability and Compensation Framework:

International Conventions: The primary framework is built on conventions like the International Convention on Civil Liability for Oil Pollution Damage (CLC) and the International Convention on the Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS Convention).

Challenges in Compensation: Quantifying damages, particularly for intangible losses (e.g., environmental damage), and ensuring timely and adequate compensation can be challenging.

Strict Liability: Shipowners are held strictly liable for pollution damage, meaning they are responsible regardless of fault, with limited exceptions.

Compulsory Insurance: Shipowners are required to have insurance, often through Protection and Indemnity (P&I) Clubs, to cover potential pollution liabilities.

International Funds: For oil pollution, the International Oil Pollution Compensation Funds (IOPC Funds) provide a second tier of compensation when damage exceeds the shipowner's liability limits. The IOPC Funds are financed by the oil industry.

"Mystery" Spills: The IOPC Funds can also provide compensation for oil spills where the responsible ship is not identified, if it can be proven the oil originated from a ship.

HNS Convention: For hazardous and noxious substances, the HNS Convention will establish a similar system of two-tiered compensation, with the second tier potentially administered by a secretariat under similar circumstances as the IOPC Funds.

Types of Damages Covered: Compensation may cover costs associated with oil spill response (cleanup, containment), damage to property, economic losses (e.g., fishing, tourism), and restoration of the marine environment.

International Agreements: The International Convention on Civil Liability for Oil Pollution Damage (CLC) and the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (Fund Convention) establish liability and compensation frameworks for oil pollution incidents.

Potential for Advance Payments: Some suggest introducing advance payment rules for emergency response costs to address financial difficulties faced by clean-up entities.

Ship oil pollution, has direct financial impact on shipping industries.

Ship oil pollution, primarily from operational discharges and accidental spills, carries significant direct financial impacts for the involved ship. These impacts include cleanup costs, potential fines and legal fees, and compensation for damages to third parties. Furthermore, the incident can negatively affect the ship's reputation, leading to loss of future business.

Direct Financial Impacts on the Involved Ship are enormous.

Cleanup Costs: This includes the expenses associated with containing, recovering, and disposing of the spilled oil, as well as the cost of any specialized equipment or personnel required.

Fines and Legal Fees: Violations of environmental regulations, such as those outlined in MARPOL (International Convention for the Prevention of Pollution from Ships), can result in substantial fines. Legal battles arising from the spill can also incur significant costs.

Compensation for Damages: The shipowner may be liable for damages to third parties, including:

Environmental Damage: This includes damage to marine ecosystems, habitats, and wildlife.

Economic Losses: This could involve losses to fisheries, tourism, and other businesses that are affected by the spill.

Property Damage: Damage to other vessels, coastal infrastructure, or property.

Loss of Reputation and Future Business: Oil spills can severely damage a ship's reputation, leading to loss of contracts, increased insurance premiums, and difficulty securing future business.

Operational Disruptions: A spill can lead to the ship being detained for investigation and repairs, causing significant delays and financial losses.

Increased Insurance Premiums: In the aftermath of a spill, insurance premiums for the ship are likely to increase substantially.

Costs of Repair**:** If the spill was caused by a shipboard accident (e.g., collision or grounding), repairs to the vessel itself will also be a significant cost.

Damage to vessels and infrastructure: Spills can damage ships, port facilities, and other maritime infrastructure, leading to costly repairs and potential downtime.

Loss of revenue: Fishing, tourism, and other maritime industries can suffer significant revenue losses due to the impact of oil spills on their operations and resources.

Compensation and legal fees: Ship owners and operators may face substantial compensation claims from affected parties, including governments, individuals, and businesses, as well as legal fees related to spill incidents.

Increased Insurance Costs: Higher premiums/ Accidents and spills lead to increased insurance premiums for ship owners and operators, reflecting the higher risk associated with their operations.

Limited coverage: Insurance policies may have limitations on coverage for certain types of spills or damages, potentially leaving ship owners exposed to significant financial liabilities.

Damage to Reputation: Negative publicity/ Oil spill incidents can attract significant negative media attention and public scrutiny, damaging the reputation of the responsible ship owner or operator.

Loss of trust: Public perception of the shipping industry as a whole can be negatively affected, leading to a loss of trust and potential boycotts of shipping services.

Regulatory Compliance Burdens: Stricter regulations/ Oil pollution incidents often lead to the implementation of stricter regulations and monitoring requirements by maritime authorities, increasing compliance costs for ship owners and operators.

Increased inspections and enforcement: More frequent inspections and stricter enforcement of environmental regulations can disrupt shipping operations and increase costs.

Long-term Environmental and Socioeconomic Impacts:

Harm to marine ecosystems: Oil spills can have devastating impacts on marine life, habitats, and ecosystems, with long-lasting consequences for fisheries, tourism, and coastal communities.

Threat to human health: Exposure to oil pollution can pose risks to human health, particularly for those living near affected coastlines or working in the maritime industry.

The key stakeholders of IMO in the marine sector include the United Nations Environment Programme (UNEP), NGOs, Maritime Global Universities, The signatory Governments, International Labor Organization (ILO), International Transport Workers Federation for seafarers

(ITF), The Flag State Controls (FSC), The Port State Controls (PSC), The Classification Societies, The Ship Owners and Shipping Companies, The Ship Charterers, The P&I Club, Marine Insurance Institutions & Underwriters, Concerned friends & partners. As the stakeholders are accountable for the effects oil pollution, they are also responsible for preventing and minimizing the impact.

Ecosystem destruction, marine and coastal, as well as conservation areas, water quality degradation, and long-term recovery following harm are all examples of environmental effects from operational and accidental oil spills. The quantity of oil spilled determines the impact on the marine ecosystem to a significant degree (ITOPF, 2007). A tiny oil spill in sensitive areas may cause significantly more environmental damage than a much bigger spill in open waters. It has an economic effect on recreational areas, harbors, boats, commercial shellfish fields, and the coastal tourist sector. Furthermore, cleaning up oil-contaminated regions is time-consuming, difficult, and expensive.

Ship sourced oil pollution management begins from the first day of the architecture designing of a floating vessel under proposed technological details and criteria laid down by IMO SOLAS MARPOL regulations to maintain structural integrity for the safety and maintenance of the ship during the entire period of her service at sea along with routine maintenance, especially for a motor vessel MV and planning with designated oil tanks for ship engines' use as fuel or transport as liquid oil cargo in bulk, to the day of keel laid down and construction of the vessel until its day of delivery, sea trial successfully confirmed by the shipyard and the ship owners representatives.

Thereafter taking over the vessel from shipyard and the commencement of the maiden voyage by the ship crew and their responsibility begins to ensure proper running maintenance and overall management including ship sourced oil pollution management as per rules and regulations laid

down by IMO SOLAS MARPOL Local and international authorities, ship owner company or managers for the carriage of oil as engine fuel or transporting as cargo.

Accidental or deliberate, operational discharges and spills of oil by the ship crew, from ships especially tankers, offshore platforms and pipelines, is the most obvious and visible cause of oil pollution of the marine environment. As summarized by NOAA: "The kind of oil spill we usually think about is the accidental or intentional release of petroleum products into the environment as result of human activity (drilling, manufacturing, storing, transporting, waste management). Examples would be things like well blowouts, pipeline breaks, ship collisions or groundings, overfilling of gas tanks and bilge pumping from ships. The most common cause of Ship sourced oil pollution comes from human error or sometimes intentionally when the ship's crew does not follow the strict regulations and break the law. At the bottom of the ship under the engines is a space called the bilge. It collects water, oil and grease. When the ship's crew pumps out the engine room bilges, the oil is separated from the water. The waste oil is put into a special holding tank to be offloaded in the next port. The remaining water, which may have traces of oil, is pumped overboard through an oily water separator. This makes sure only the tiniest amount of permitted oil goes into the sea. The amount is so small it cannot be seen by the naked eye. If an oil slick can be seen behind a ship, it means that the ship may have broken the law and has discharged more oil than is allowed. Other operational spills may happen when a ship is loading bunker oil or lubricating oil for its engines. A hose can break and spill oil. If someone is not watching the level of oil going into the ship's tanks, the tanks could overflow. An operational oil spill can also happen after the crew of an oil tanker has cleaned the cargo tanks before loading a new cargo of crude oil. After a cargo oil tank has been cleaned with water and chemicals the oil residue will float on the wash water in the bottom of the cargo tank. This water can be siphoned off and put through an oily water separator leaving only cargo oil residue in the bottom of the cargo tank. The new crude oil cargo can be loaded on top of the remaining old cargo oil. Sometimes the Ship crew due lack of awareness intentionally does the wrong thing and illegally pumps the oily waste overboard into sea water.

Based on a report from The *International Tanker Owners Pollution Federation* (ITOPF), During the period 1970 to 2015, 50% of large spills occurred while the vessels were underway in open water; allisions, collisions and groundings accounted for 59% of the causes for these spills. These same causes accounted for an even higher percentage of incidents when the vessel was underway in inland or restricted waters, being linked to some 99% of spills.

Oil spill from Ship MT Exxon Valdez super tanker hit a reef off the Alaskan coast, 11 of its cargo tanks ruptured, dumping 11 million gallons of crude into Prince William Sound. But the spill could have been much worse — the Valdez was carrying 53 million gallons. In terms of sheer volume, the Exxon Valdez spill ranks as the 36th worst oil spill in history; however, the spill was far from small. Despite attempts to use dispersing agents and oil skimming ships, oil washed onto 1,300 miles of Alaskan coastline. Today, oil remains a few inches below the surface on many of Alaska's beaches. Responders found carcasses of more than 35,000 birds and 1,000 sea otters, which was considered to be a fraction of the animal death toll because carcasses typically sink to the seabed. It's estimated 250,000 seabirds, 2,800 sea otters, 300 harbour seals, 250 bald eagles, up to 22 killer whales died along with billions of salmon and herring eggs.

{{Oil spills in the Bay of Bengal and along the river navigation channel may occur due to rushing water near the coast and in the Sundarbans. There is also a danger of collision between vessels and grounding due to engine failures, navigational errors, or anchor dragging in both Chittagong and Mongla ports. Another threat posed by marine contamination is Illegal dumping from ships, industrial waste water, agricultural waste water, residential waste water, and so on are all taken into account. The operational oil leak is caused by ships and land sources, and the spilled amount in Bangladesh is limited to 2,500 Tonnes per year}} (Alam 2004).

Today Oil pollution has become a Critical Global issue affecting the Marine Environment, natural habitat of humans and many animal species. The Oil Pollution from Maritime industries such as Merchant Ships, it threatens to disrupt the oceanic environment that makes up more than three-fourths of our Earth's surface. This Thesis "Ship source oil pollution impact on Maritime Business through Environmental and Economic Consequences, and Mitigation Strategies to minimize effects with IMO and key stakeholders' integrated cooperation and ship crew awareness", will emphasize on the impact of ship sourced oil pollution, it's damaging effects on the Marine Environment including Marine Ecology System and natural habitat of humans or many animal species, existing regulations for mitigation through proper implementations and proposals for further ratification through establishing an integrated management system of applying correct Role of IMO, Key Stakeholders and Ship crew for effective prevention of ship sourced oil pollution.

1.2 STATEMENT OF THE RESEARCH PROBLEM

Oil spills may have disastrous consequences for rivers and seas. The polycyclic aromatic hydrocarbons (PAHs) in oil produce the majority of the toxicity, but the physical character of oil, i.e. its stickiness, is a significant issue for many species. Oil spills have a variety of immediate and long-term negative consequences. Because of the global nature of shipping, measures to prevent oil pollution from ships should be developed on a worldwide scale, and the international regime enabled by IMO is an essential foundation for marine protection from shipping operations.

Ship-source oil pollution liability and compensation mitigation involves a layered approach, primarily using international conventions and agreements to ensure those affected by spills are compensated, while also promoting preventative measures and responsible practices. Key aspects

include: strict liability for shipowners, compulsory insurance, and international funds for supplemental compensation.

Ship-source oil pollution, particularly oil spills, can lead to significant financial losses for various parties and require robust compensation and mitigation strategies. Compensation mechanisms, often involving international agreements and funds, aim to address damages to the environment, businesses, and individuals. Mitigation strategies focus on prevention through stricter regulations, technological advancements, and promoting cleaner shipping practices.

Ship-source oil pollution, particularly oil spills, can lead to significant financial losses and require substantial mitigation efforts. Compensation for damages is often available through various international and national funds, and mitigation strategies focus on prevention, containment, and cleanup.

Ship-source oil pollution is directly linked to shipping business management through operational practices, accident prevention, and the implementation of regulations. Effective management can minimize oil spills from routine operations, improve accident response, and ensure compliance with international standards, thus reducing the environmental and financial impacts of oil pollution.

Ship-source oil pollution, a significant environmental and economic concern, is directly linked to shipping business management practices. Poorly managed routine operations like ballast water discharge, bilge water dumping, and engine effluent discharges can lead to chronic oil pollution, while accidents during navigation, such as grounding or collisions, can result in major spills.

These incidents, and the resulting oil pollution, negatively impact marine ecosystems, coastal communities, and can lead to significant financial losses for shipping companies and others.

Therefore, the research seeks to find the answers to the following research questions:

1. What are the major impacts of oil pollution on Maritime Business through Environmental and Economic Consequences?

2. What are the roles of IMO and the key stakeholders to ship sourced oil pollution management?
3. What are the roles of ship crew to ship sourced oil pollution management?
4. What are the challenges & Strategies to ship sourced oil pollution management?

1.3 OBJECTIVE OF THE STUDY

The main objectives of this research may be highlighted as:

1. To highlight the major impacts of oil pollution on Maritime Business through Environmental and Economic Consequences;
2. To emphasize on IMO and key stakeholders' for promoting ship crew awareness towards an effective ship sourced oil pollution management;
3. To emphasize on ship crew to promote self-awareness towards an effective ship sourced oil pollution management;
4. To identify the challenges, assess strategies to mitigate the challenges for an effective ship sourced oil pollution management.

1.4 SIGNIFICANCE OF THE RESEARCH

- The significance of this study bears from its potential to improve policy, performance improvements, further research and advance the frontier of the knowledge, beneficial to the marine environment comprising of the flora and fauna living there. It would also be beneficial to the whole maritime community of the world, develop Ship crew awareness and in general all human beings on the globe.

- The study would be relevant to researchers who might wish to embark on further studies into this or related subjects, useful to any reader, provide information to the general public

and add to the existing body of knowledge on managing effectiveness of environmental protection from ship sourced oil pollution.

1.5 SCOPE OF THE RESEARCH

- The scope of this study covered time boundary, space boundary and context boundary of the research with rational justification.
- This study will cover the time boundary from the Year 1954 to the present time of Year 2022. The period chosen marked the historical booming in international shipping after the second world war and when the International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL) was signed in London on May 12, 1954.
- The context boundary is framed within environmental degradation of the marine environment due to oil pollution. Also discussed the Role of IMO and Key Stakeholders for establishing an Integrated Co-operation among IMO and Key Stakeholders towards a sustainable Oil Pollution free Maritime Environment.
- This study discussed about (space Boundary) the Global impact oil pollution in the Oceans, Seas, Rivers and in all waters connected therewith and Maritime Environments-Worldwide and Bangladesh perspective.

1.6 METHODOLOGY OF THE RESEARCH

This Thesis "Impact of ship-sourced oil pollution on maritime business through environmental and economic consequences, and mitigation strategies to minimize effects via integrated cooperation between the IMO, key stakeholders, and enhanced ship crew awareness" is accomplished by:

- Various literature review.
- Using primary and secondary data collection method.

- The nature of data collected for this study was an integration of both quantitative and qualitative data for an informed analysis.
- The level of research boarded in this study was descriptive research.
- Both quantitative and qualitative research design were used for the study to enable researcher obtain data from the field and existing literature on the subject for an informed analysis.

1.6.1 TYPE OF RESEARCH

- NATURE OF RESEARCH: By nature, it's an empirical approach to enable established new factual information through integration of both quantitative and qualitative data for an informed analysis.
- LEVEL OF RESEARCH: The level of research is a descriptive research implemented to present researcher's perspectives on the subject.
- RESEARCH DESIGN: Both quantitative and qualitative research design used to enable researcher obtain data from the field and existing literature on the subject for an informed analysis.

1.6.2 SOURCES OF DATA

- The Primary data were obtained from direct/ online/ VHF conversations with various ship personnel, onboard interviewing different officials, stakeholders and ship crew with strict compliance against Covid-19 pandemic.

- The questionnaire survey method involved selecting samples of respondents and administering of structured questionnaires. Other methods used in the study included personnel interviews from ship & shore based Marine professionals, opinion polls,

laboratory experimental techniques using MSDS of various grades of oil carried on board ships as cargo & as fuel to determine the toxicity of oil on biological species.

- Questionnaires consisted of structured questions administered to different respondents to solicit for specific information. The questionnaires were given out to a cross-section of stakeholders within the personnel from ship & shore based Marine professionals, Responsible personnel related to the Maritime industries, The Flag State Controls, The Port State Controls, The Classification Societies, The various Maritime friendly Organizations, The Ship Owners, The Ship Managers, OCIMF, CDI, Oil Vetting & Oil Major inspection Parties, The P&I Club and other similar Marine Insurance Institutions & Underwriters, Marine & ship pollution response advisers, The Ship Charterers, The Crewing Agencies and The Shipboard Crew and All similar concerned friends & partners;

- Asked opinions over topics Maritime Laws & Regulations- Regulations concerning SOLAS MARPOL MLC related to Ship sourced oil pollution management- IMO and key stakeholders' integrated cooperation and ship crew awareness has effective solution from both International and Local related personnel, cross checked all opinions and selected to fit my Research & Study to Ship Sourced Oil Pollution management.

- Ship Based and Shore Based Attendance- Self attending personally to various shipboard Drills, Trainings & Exercises meant for the Prevention of ship sourced Marine Pollution Drills & Exercises, Reviewing of requirements and availability shipboard Certifications meant for the Prevention of ship sourced Marine Pollution, Collection and Review various Incidents/ Accidents/ Near Miss concerning Ship sourced Marine Pollutions, Practically conducting the Audits, Inspections, Surveys those meant for the Prevention of ship sourced Marine Pollution, Reviewing the various Check Lists by various institutions meant for the Prevention of ship sourced Marine Pollution;

Respondent group number selected:

Ship based Marine professionals= 24,

Shore based Marine professionals= 6,

The Flag State Controls and The Port State Controls= 2,

The Classification Societies= 2,

The various Maritime friendly Organizations & Federations= 1,

The Ship Owners and the Ship Managers= 4,

OCIMF, CDI, Oil Vetting & Oil Major Inspection Parties= 3,

The P&I Club and Marine Insurance Institutions & Underwriters= 2,

Marine ship pollution response advisers= 2,

The Ship Charterers= 1,

The Crewing Agencies= 3,

Total= 50 persons

- The Primary data collection faced challenges as some of the respondents were not receptive in terms of information dissemination for the Prevention of ship sourced Marine Pollution, while a few others found to be well cooperative. Consequently, about 35% respondents shared their opinions with no comment remarks referring to our questionnaires willingly, about 20% respondents found not interested in responding to our questions. And about 45% of the total number of respondents did not cooperate to us over the questionnaire for the Prevention of ship sourced Marine Pollution probably due to their busy hours.

- This study obtained data from secondary sources, are collected from multiple text books, newspapers, journals, research papers, thesis, articles, publications, case studies, photographs, Maritime related research papers, dissertations, use of Internet, newspapers, magazines, shipping articles, market reviews, relevant published and unpublished materials. In addition, official documents, laws and amendments from websites of Shipping Offices have been regarded as source of secondary data.

- And this is especially a Professional Study & Practical Work- Experience based research conducted using real on scene physically collecting Ship sourced oil pollution related materials & data collections etc. while work on board ship.

1.6.3 METHODS OF DATA COLLECTION

- The Primary data were obtained from online interviewing due strict compliance against Covid-19 pandemic situation specially in shipping industries.
- Secondary data were collected from official documents, laws and amendments from the websites of Shipping Offices and by searching of recent trends and review on "Ship sourced oil pollution management- IMO and key stakeholders' integrated cooperation and ship crew awareness has effective solution" related articles, journals, and research papers of other Maritime institutions, published and unpublished materials, and magazines with the help of the Internet.

1.6.4 METHODS OF DATA ANALYSIS

- Data analysed both quantitative and qualitative methods for logical reasoning to arrive at cogent deductions. Data generated from primary and secondary sources were analyzed by adopting content analysis method. The analyses were used to draw conclusions and make recommendations of this study.

1.6.5 METHOD OF DATA PRESENTATION

- The presentation of the Thesis on the "Ship sourced oil pollution management- IMO and key stakeholders' integrated cooperation and ship crew awareness has effective solution" has been logically established with the traditional mannerism as were deemed necessary

to establish the fact of proposition and proposals to suffice the contents towards an effective solution to the issue using both quantitative and qualitative measures as appropriate to the needs of the Topic and save the world from ship sourced Oil Pollution.

- All Research materials for the Topic has been well collected, well selected, well studied, practically experienced, thoroughly checked, analyzed and reviewed as necessary with available data to reach towards a fruitful conclusion on the Topic and best results of the study within the authorized time period.

1.7 LIMITATIONS OF THE STUDY:

- The research scope is limited due to a lack of adequate database.

- The questionnaires & personnel interactions through interviews, discussions and consultations were not physically possible due to Covid-19 situation in Bangladesh and around the world. Collection of data documents records through travelling places, visiting universities & search for guidance were almost stand still restricted due nationwide travel restrictions, closure of most offices, organizations and movement lockdown against Covid-19 crisis.

- Data scarcity and lack of record keeping on the Bangladesh part was a major challenge for this research work.

- It is a Professional, Study & Work- Experience based research. The research has been conducted at land, on rivers, on seas, on oceans while the researcher was sailing on board ships throughout major Maritime Nations and specially many a time conducted close up survey, study, observation and monitoring the behavior of Coastal Maritime waters like the busiest TSS Traffic Separation Scheme of the world including "The Singapore Strait". From the Bay of Bengal to the South China Sea, then to Arabian Sea, from Karnafuli

River to the Amazon River; All major Oceans- from Indian Ocean to Pacific Ocean to Atlantic Ocean; over the seas and the Bays to the Rivers, and through the Canals like Panama & Suez and Kiel Canals.

- The research continued throughout the years with my added-up experiences as a long time Master Ship Captain on board VLCC Oil Tankers and as a life time student of Maritime Science and Environment by nature.

CHAPTER TWO: LITERATURE REVIEW

2.1 CONCEPTUAL DISCOURSE:

Not only did the general public's interest in the environment grow after WWII. Coastal governments' concerns about rising ship-related marine pollution and oil spills began to increase as well. Some recent tanker accidents have shown that oil spills in ecologically or economically sensitive areas may result in irreversible harm. (Gold, 1999).

Oil pollution is described as the contamination of any environment by oil or other petroleum products, typically freshwater or marine habitats. Oil pollution is one of the most serious environmental problems, with both short- and long-term consequences for local ecosystems. Almost every step of the petroleum exploration and production process generates hazardous waste with different chemical compositions. Improper disposal of drilling muds, maritime and terrestrial traffic accidents, tank cleaning and oil ballast releases, depot leakage, and oil pipeline failure or rupture are all major causes of oil pollution. (IJESD, 2012).

By the 1960s, oil pollution from ships had become a greater concern, as the quantity of oil carried by sea, as well as the number and size of tankers, had increased. Oil spills at sea have resulted in the loss of other sectors such as fishing and tourism, as well as the pollution of the marine environment. Petroleum has the potential to harm the maritime environment and its amenities. Oil pollution not only harms the natural environment, but it also harms the economy. Spills from non-vessel sources, like as pipelines and offshore installations, are actually more common than spills from vessels. Even though oil spills from ships are not the most damaging activity in terms of marine pollution, a large crude oil leak at sea is catastrophic. At the same time, the size of tankers has grown in tandem with technical advancements, posing a greater risk of worsening oil pollution at sea. (Hendrickx, 2007).

2.2 OIL POLLUTION:

Oil Pollution is defined as Contamination of any ecosystem, but usually of freshwater or marine ecosystems, by oil or other petroleum products (inforMea). Oil pollution is one of the most disastrous damages to the environment and can cause both short- and long-term side effects to the local ecosystems. Almost every phase of the petroleum exploration and production produces toxic wastes of varying chemical compositions principal sources of oil pollution include improper disposal of drilling muds, shipping and terrestrial traffic accidents, tank washing and oil ballast discharges, depot leakage, and failure or rupture in oil pipelines (Hendrickx, 2007).

Oil pollution may result from any spill of crude oil or its refined products. Oil spills from stranded tankers or drilling rigs at sea, barges or ships on major interior rivers, or well blowouts and pipeline breaks on land are, on average, the worst and most destructive pollution events. Land runoff, natural seeps, boats, pipelines, and offshore exploration and production platforms all contribute to oil entering the marine environment. (Freedman, 1995). Oil enters the marine environment from land runoff, natural seeps, vessels, pipelines and offshore exploration and production platforms (Clark, 1992).

Cormack (1999) examined the many environmental consequences of pollutants present on the sea surface and on land, as well as contaminants distributed in the water column. He looked studied the physical effects of spilled oils of various characteristics on response tactics, procedures, and equipment, as well as the processes that influence them. The main environmental effects in the atmosphere, on the sea surface, in the water column, and onshore, as well as the kind and efficacy of potential response solutions, are said to be dependent on the characteristics of the oils and the processes that they go through when spilled. In addition, while determining amongst the response options in terms of the main issues, the possible secondary environmental effects of the response options themselves must be considered.

2.3 IMO, KEY STAKEHOLDERS AND SHIP CREW:

The key stakeholders of IMO in the maritime sector are the parties, beneficiaries, groups, organizations, or individual persons involved in a process or activity like NGOs, Maritime Global Universities, The Governments, International Labour Organisation (ILO), International Transport Workers Federation for seafarers (ITF), he Flag State Controls (FSC), The Port State Controls (PSC), The Classification Societies, The Ship Owners, The Ship Charterers, The P&I Club, Marine Insurance Institutions & Underwriters, The Ship Crew, Concerned friends & partners etc. The importance of active stakeholder participation in management and decision making of protection of the coastal and marine environment has to be been integrated in various recent policies because residents were not satisfied from the activities of the government stakeholders. Less rigorous were with the others stakeholders active in environmental protection. (Tampakis, 2018).

Ball (2011) in his study "Liabilities of industry stakeholders for pollution caused in Australian waters", outlines the possible scope of stakeholders' responsibilities under applicable international agreements, federal, state, and territorial laws, and the common law. It takes into account the impact of expected changes in the operational environment.

As Dempsey (1984) has indicated in "Compliance and Enforcement in International Law--Oil Pollution of the Marine Environment by Ocean Vessels" that The port state enforcement seems to be a cost-effective and efficient way to address environmental degradation inside a state's territorial seas. However, the efficacy of a flag state enforcement system is hampered by flags of convenience as well as overwhelming economic reasons. This seems to be the legal framework on which the international community is so reliant. The major flaw in existing marine pollution conventions, particularly those drafted by the International Maritime Organization (IMO), is that they rely heavily on flag states for enforcement while giving coastal states no explicit opportunity to participate in their own enforcement, even in prohibited zones.

2.4 REVIEW OF EXISTING LITERATURES:

Oceanic oil pollution has become a major environmental issue. Atlas (1973) in his paper "Fate and effects of polluting petroleum in the marine environment." assesses the scope of the pollution issue and its consequences on the maritime ecosystem. Petroleum's complicated nature is addressed to the degree that it relates to its impacts and destiny at sea. Physical, chemical, and biological processes are discussed in relation to the removal of polluting oil from the marine environment. The routes and products of microbial breakdown of different petroleum components are described, and the potential of oil removal via accelerated biodegradation is addressed in relation to other pollution abatement and preventive methods. The review focuses on biological impacts and biodegradation, although these topics are discussed in the context of the overall issue of marine oil pollution.

RBK, Kiran (2010) mentioned that the International Maritime Organization (IMO) treaties regulate the universal system addressing the problems of ship-source oil spill responsibility and compensation. The IMO system holds the maritime sector accountable under the concept of polluter pays. The civil liability agreements establish a system of mandatory liability insurance and establish the concept of strict responsibility for ship owners.

Anyanova (2012) in "Oil pollution and international marine environmental law" has assessed that the spilled oil is poisonous enough to kill adult animals even at low quantities It may potentially induce physiological or behavioral changes in animals. Not only do oil spills kill ocean species, but they also kill marine life on the shore by disrupting normal feeding, breathing, and movement processes. Birds are particularly vulnerable to oil spills. Fish and shellfish may get tainted as a result of an oil leak. The effects of oil spills may sometimes be detected in the seafood by an oily flavor or odor. An oil spill harms not just animals, plants, and corals, but also human activities in the fishing industry by destroying fishing boats, fishing gear, and floating fishing equipment.

Despite the fact that there is such a big number of different representatives of countries and interest groups within committees and the time for meetings is very limited a lot of work has been done to deal with ship-source pollution. It is often claimed that progress at IMO is slow, but many times the activity of IMO is overlooked and it is remembered only when an incident happens at sea (Fayette, 2001).

However, IMO endeavors to take rapidly effective measures to prevent accidents in future, to minimize the damage for the environment and manage the oil pollution regime in an efficient way. During the recent years of the IMO work safety has increased and "oil spills have been reduced to one third or less of the level they were at 10 years ago" (Mitropoulos, 2007b).
Shaw (1987) has expressed in "The global environment: A proposal to eliminate marine oil pollution" that Because all nations are affected to some degree by operational oil pollution, strong international leadership is required to combat the problem. There is little doubt that responsible action to control it would benefit the marine environment, human health, commercial and sport fishing, ocean water quality, and global amenities available. While concern for the issue has resulted in a plethora of paper proposals, the economic interests of countries with the key to a solution are the primary barrier to finding one.

After reviewing the existing literatures, it seems that there have been very few research works conducted regarding the impact of oil pollution in the marine environment. A number of research has also been done about the role of IMO to prevent marine oil pollution. However, no attempts have been made to address the Key Stakeholders and the Ship crew of the maritime industry and their roles to prevent oil pollution. This is the research gap and the objective of this study is to bridge this gap by analyzing the impact of oil pollution in the marine environment and acknowledge the Key Stakeholders & Ship crew and their roles.

CHAPTER THREE: IMPACT OF OIL POLLUTION TO MARINE ENVIRONMENT

To assess the impact of oil pollution to the marine environment properly, initially we will discuss about the impacts on marine flora and fauna and then we discuss about the impacts on human beings.

3.1: IMPACT OF OIL POLLUTION TO MARINE FLORA (PLANT LIFE) AND FAUNA (ANIMAL LIFE)

3.1.1: IMPACT ON MARINE ORGANISM- The effect of oil on marine organisms (ALGAE, SPONGES, BARNACLES, SOFT BODY FISHES etc.) is determined by the oil's route of flowing. Oil in water, it is either distributed on the top layer of the water or stays on the surface. On the coastal regions, the oil will stay on the surface if it is not dispersed. Currents carry the oil to the shore harming coastal creatures such as sea animals and birds. If the oil is spread, it is harming fish, plankton, and larvae to oil toxicity right away.

3.1.2: IMPACT ON PLANKTONIC ORGANISMS- Plankton (ALGAE, BACTERIA, PROTOZOANS etc.) is a significant food source for innumerable marine species, especially whales. Some planktons absorb hydrocarbons directly from saltwater as well as via oil droplets and contaminated food. These creatures often die after ingesting oil, and those that survive typically have developmental and reproductive problems.

3.1.3: IMPACT ON BENTHIC ORGANISMS AND INVERTEBRATES- Petroleum hydrocarbons may be accumulated by BENTHIC ORGANISMS (SEA WORMS, OYSTERS,

SHRIMPS, MUSSELS etc.). BENTHIC ORGANISMS collect and retain petroleum hydrocarbons at greater quantities and for longer periods than other species. As a result, they are more likely to pass them on to their predators. Marine animals that eat a lot of BENTHIC ORGANISMS, are more likely to absorb petroleum hydrocarbons.

INVERTEBRATES (EARTH WORMS, SPONGES, JELLY FISH, LOBSTERS, CRABS, SNAILS, INSECTS, SQUIDS etc.) are very susceptible to oil contamination and take a long time to repopulate and recovery. Oil and toxic dispersants have harmful effects affecting reproduction, growth, movement, behaviour, breathing to invertebrates.

3.1.4: IMPACT ON CORAL REEFS- Coral reefs are (ACTUALLY A LIVING ANIMAL - COLONIAL ORGANSMS) and are significant components of marine ecosystems, serving as recreational attractions. The poisonous chemicals in oil pose a threat to the aquatic creatures that dwell inside and surrounding coral reefs, as well as suffocation.

3.1.5: IMPACT ON FISHES- Most fish, even in heavily oil-contaminated environments, do not accumulate and retain high concentrations of petroleum hydrocarbons due to the well-developed hepatic mixed function oxygenase system, as well as the reactivity of the metabolites that would not be released in a toxic form during digestion and absorption. Petroleum molecules in diet are inefficiently assimilated by marine predators in general. As a result, there is an indirect relationship between the trophic level of a marine animal and the concentration of leftovers it may eat. Species like whales, which eat zoo-plankton and benthic invertebrates are more likely to be exposed to petroleum in their diet.

3.1.6: IMPACT ON SEABIRDS- Physical contact is one of the most common ways of exposure for birds. Following the 'MT Treasure' oil disaster in South Africa in year 2000, hundreds of African penguins were oiled. As a result, large numbers of seabirds killed. For example, approximately 35,000 seabird dead bodies were collected in the northern Gulf of Alaska after the 'MT Exxon Valdez' oil spill in year 1989. Oil destroys the insulating ability and the water repellency of a bird's feathers, leaving them vulnerable to hypothermia or overheating.

3.1.7: IMPACT OF OIL SPILL ON MARINE MAMMALS- Dolphins, Whales, Seals and many furred mammals depend on their outer coats for buoyancy and warmth. Direct contact with oil generally causes these animals to get ill. As a result, when oil floats to the upper water layer, these creatures often die to cold, drowning, and suffocation. Oil usually clogs the blowholes of the whales, or dolphins thus make it impossible for them to breathe properly and limit their ability to communicate.

3.1.8: IMPACT ON MARINE PLANTS- MARINE PLANTS (SEAGRASS, MANGROOVES, ALGAE, SEAWEEDS etc.) play an essential role in ecosystem functioning in a variety of ways. They are oxygen generators, have the capacity to trap carbon, and are at the bottom of aquatic food systems, among other things. They also serve as nurseries, feeding grounds, and breeding grounds for a wide range of animal and plant species, including recreational and economically valuable fish. The oil that comes in touch with plants and animals as a consequence of an oil spill has an impact on them. Toxicities of oils and dispersants are found to be harmful to marine plants.

3.1.9: IMPACT ON MICRO ORGANISMS- Oil spills lead to rapid changes in the composition of the MICRO ORGANISMS (BACTERIA, VIRUS, FUNGI, etc.). Variables that influence MICRO ORGANISMS's biodegradation of hydrocarbons and environmental factors may influence hydrocarbons eliminated from the environment.

3.2: IMPACT OF OIL POLLUTION ON HUMAN BEINGS- Oil spills may have both direct and indirect impacts on people, depending on the kind of interaction with the spill. *Careful study of a Material Safety Data Sheet* (*MSDS) for Crude Oil Cargo carried by ship reflects the damaging Toxic effects of Oil as Cargo carried by ships to human health like damaging of lungs, respiratory tracks, skin nose eyes irritation, damaging brain & nervous system etc.* The oil has simultaneous interactions with people living by the coastal area affecting water quality in oceans seas rivers lakes from human consumption/ drinking.

3.2.1 DIRECT OIL SPILL EXPOSURE- Direct exposure to oil spill happens near people's workplaces- where they may come in touch with oil spill by inhalation volatile oil products or vapors, which produce distinct smells. Through direct skin contact- when wandering in a polluted location, individuals may come into direct touch with oil. There will be some irritation at first. Contaminants may also be absorbed via the skin and absorbed into the body. Also the loss of human life and adverse effects on the human health of 'response and cleanup' workers and any coastal or nearby people and human communities.

3.2.2 INDIRECT OIL SPILL EXPOSURE- It happens even when individuals live far away from the actual site of the spill by bathing in polluted water - for example, swimming in a contaminated stream - even though an oil sheen is not apparent, dissolved oil pollutants may be present in the water if it has been contaminated by an oil spill. Human might get exposed even if they live far away from an oil polluted area, if they consume food and drink water from far spilled region.

3.2.3 ECONOMICAL IMPACT- Oil spill pollution has a significant negative economic impact. It may have a variety of effects on the community where the oil leak happened, the most

significant of which are the decrease of Tourism in the affected regions, the disruption of land and sea transportation, which impacts import-export operations and the long-term cessation of activities such as fishing in contaminated seas, which affects fishermen and fisheries if a significant quantity of oil is spilled.

CHAPTER FOUR: ROLE OF IMO, KEY STAKEHOLDERS AND SHIP CREW

As the United Nations agency responsible for developing and adopting measures to improve the safety and security of international shipping and to prevent pollution from ships, the International Maritime Organization (IMO) has an integral role in meeting the targets set out in United Nations Sustainable Development Goal (SDG) 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development. (United Nations- UN Chronicle).

An Integrated Management System (IMS) can benefit IMO, key stakeholders' and ship crew through increased cooperation, communication, efficiency and effectiveness, thus enhancing strong management to mitigate shipboard accidents/ ship sourced pollutions for a sustainable green marine environment. Integrated Management System also to exhibit IMO, key stakeholders' and ship crew commitment to increased performance, employee and customer satisfaction, and continuous improvement. With an integrated management system, IMO key stakeholders' and ship crew work together, with each function aligned behind a single goal, improving the performance of the entire industry. Instead of silos, we have a coordinated effort which is greater than the sum of its parts and is not only more efficient but more effective. An integrated management system among IMO, key stakeholders' and ship crew will provide a clear, uniform image of entire industry, how they impact each other, and the associated risks. Efficiency is gained from less duplication, and it becomes easier to adopt new systems in future. An integrated management system among IMO, key stakeholders' and ship crew will allow the entire maritime industry to work as a team to create one system that can help to effectively and efficiently deliver our maritime industry assigned objectives. From managing all party needs, to monitoring risks and hazards, from reducing inefficiencies and maximizing resources, an integrated approach can help IMO, key stakeholders' and ship crew to achieve our industry objectives- Zero Accidents and Zero Pollution Policies.

4.1 ROLE OF IMO TO SHIP SOURCED OIL POLLUTION MANAGEMENT

IMO has created, ratified and implemented various conventions regarding the prevention of oil pollution of the marine environment. Amongst these OILPOL, London Convention, MARPOL, International Convention on Civil Liability for Oil Pollution Damage (CLC 1992) and Bunker CLC 2008 are mentionable.

4.1.1: OILPOL 1954 & MARPOL 1973/1978

On May 12, 1954, the International Convention for the Prevention of Pollution of the Sea by Oil (OILPOL'54) was signed in London.

On November 2, 1973, the Inter-Governmental Maritime Consultative Organization (now IMO) approved another agreement to combat pollution from ships, the International Convention for the Prevention of Pollution from Ships (MARPOL'73).

In February 1978, the IMCO (now IMO) called an International Conference on Tanker Safety and Pollution Prevention (TSPP Conference) in response to tanker accidents that occurred in 1977/78. The combined document is known as the International Convention for the Prevention of Marine Pollution from Ships, 1973, as amended by the Protocol of 1978 (MARPOL 73/78), and it became effective on October 2, 1983.

Oil discharge is entirely banned in "Special areas under MARPOL Annex 1" that are deemed especially pollutant-prone, such as the Mediterranean, Baltic, Black Sea, Red Sea, Gulf, Antarctica and NW Europe.

4.1.2: CIVIL LIABILITY AND BUNKER CONVENTION

International Convention on Civil Liability for Oil Pollution Damage (CLC), Adoption: 29 November 1969; Entry into force: 19 June 1975; Being replaced by 1992 Protocol: Adoption: 27 November 1992; Entry into force: 30 May 1996.

The Civil Liability Convention was adopted to ensure that adequate compensation is available to persons who suffer oil pollution damage resulting from maritime casualties involving oil-carrying ships.

The Convention covers pollution damage resulting from spills of persistent oils suffered in the territory (including the territorial sea) of a State Party to the Convention. It is applicable to ships which actually carry oil in bulk as cargo, i.e. generally laden tankers. Spills from tankers in ballast or bunker spills from ships other than other than tankers are not covered, nor is it possible to recover costs when preventive measures are so successful that no actual spill occurs. The shipowner cannot limit liability if the incident occurred as a result of the owner's personal fault.

{{{The 2000 Amendments, Adoption: 18 October 2000, Entry into force: 1 Nov 2003
The amendments raised the compensation limits by 50 percent compared to the limits set in the 1992 Protocol, as follows:

For a ship not exceeding 5,000 gross tonnage, liability is limited to 4.51 million SDR (US$5.78 million); For a ship 5,000 to 140,000 gross tonnage: liability is limited to 4.51 million SDR plus 631 SDR for each additional gross tonne over 5,000; For a ship over 140,000 gross tonnage: liability is limited to 89.77 million SDR}}}

-International Convention on Civil Liability for Oil Pollution Damage (CLC) (imo.org)

The International Convention on Civil Liability for Bunker Oil Pollution Damage (Bunker CLC or BCLC), Adopted in 2001; Entry into force in 2008; adopted to ensure compensation to persons who suffer damage caused by oil spills, when carried as fuel in ships' bunkers. The Convention

applies to damage caused on the territory, including the territorial sea, and in exclusive economic zones of States Parties. The bunkers convention provides a free-standing instrument covering pollution damage only.

4.1.3: LONDON CONVENTION 1972

The "Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972", the "London Convention", is one of the first global conventions to protect the marine environment from human activities and has been in force since 1975.

4.1.4: UNITED NATIONS CONVENTION ON THE LAW OF THE SEAS (UNCLOS)

The UNCLOS regulations on marine protection are very important all around the globe. They are included in the Convention's Part XII. These rules apply to everyone. The convention declares that governments have a general responsibility to preserve the marine and coastal environment, as well as its resources in Art. 192. Art. 193 gives states the freedom to exploit their natural resources while keeping their natural environmental policies in mind. Art. 235 declares nations liable for international responsibilities relating to the preservation and protection of the maritime environment. Art. 235 (2) mandates that governments provide for the option of obtaining compensation or other remedies in the event of pollution related damage.

4.1.5: SOLAS MARPOL STCW MLC 2006 (SHIP CREW COMPLIANCE TO PROMOTE AWARENESS)

SOLAS:

IMO's first task when it came into being in 1959 was to adopt a new version of the International Convention for the Safety of Life at Sea (SOLAS), the most important of all treaties dealing with

maritime safety. IMO has also developed and adopted international collision regulations and global standards for seafarers, as well as international conventions and codes relating to search and rescue, the facilitation of international maritime traffic, load lines, the carriage of dangerous goods and tonnage measurement.

MARPOL:

In 1973, IMO adopted the International Convention for the Prevention of Pollution from Ships, now known universally as MARPOL, which has been amended by the Protocols of 1978 and 1997 and kept updated with relevant amendments. The MARPOL Convention addresses pollution from ships by oil; by noxious liquid substances carried in bulk; harmful substances carried by sea in packaged form; sewage, garbage; and the prevention of air pollution from ships. MARPOL has greatly contributed to a significant decrease in pollution from international shipping and applies to 99% of the world's merchant tonnage.

STCW:

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978, was adopted by the International Conference on Training and Certification of Seafarers on 7 July 1978. The 1978 STCW Convention entered into force on 28 April 1984. Since then, amendments thereto have been adopted in 1991, 1994, 1995, 1997, 1998, 2004, 2006, 2010, 2014, 2015, 2016 and 2018.

The 1994 amendments on special training requirements for personnel on tankers were adopted by resolution MSC.33(63) and entered into force on 1 January 1996.

The 2010 amendments (the Manila Amendments) to the Convention and Code were adopted by resolutions 1 and 2, respectively, by a Conference of Parties to the STCW Convention, held in Manila, Philippines, from 21 to 25 June 2010 (2010 STCW Conference). The amendments mainly introduced:: Improved measures to prevent fraudulent practices associated with certificates of competency and strengthen the evaluation process (monitoring of Parties' compliance with the

Convention), Revised requirements on hours of work and rest and new requirements for the prevention of drug and alcohol abuse, New certification requirements for able seafarers, deck and engine, New requirements relating to training in modern technology such as electronic charts and information systems (ECDIS), New requirements for marine environment awareness training and training in leadership and teamwork, Introduction of modern training methodology including distance learning and e-learning.

MLC 2006:

The Convention, known as "MLC, 2006" came into force on 20 August 2013 – effectively becoming binding in international law – and established minimum working and living standards for all seafarers on those ships. What's more, it is also an essential step toward ensuring fair competition and a level-playing field for quality owners of ships flying the flags of ratifying countries. The MLC, 2006 was adopted by government, employer and worker representatives at a special ILO International Labour Conference, in February 2006, to provide international standards for the world's first genuinely global industry. Widely known as the "seafarers' bill of rights," it is unique in its effect on both seafarers and quality ship owners. The comprehensive Convention sets out in one place seafarers' rights to decent conditions of work on almost every aspect of their working and living conditions including, among others, minimum age, employment agreements, hours of work or rest, payment of wages, paid annual leave, repatriation at the end of contract, onboard medical care, the use of licensed private recruitment and placement services, accommodation, food and catering, health and safety protection and accident prevention and seafarers' complaint handling.

4.2 ROLE OF KEY STAKEHOLDERS TOWARDS PROMOTING SHIP CREW AWARENESS FOR SHIP SOURCED OIL POLLUTION MANAGEMENT

Stakeholders are the parties, beneficiaries, groups, organizations, or individual persons involved in a process or activity. In maritime industry, the United Nations Environment Programme (UNEP), NGOs, Maritime Global Universities, The Governments, International Labour Organisation (ILO), International Transport Workers Federation for seafarers (ITF), The Flag State Controls (FSC), The Port State Controls (PSC), The Classification Societies, The Ship Owners and Shipping Companies, The Ship Charterers, The P&I Club, Marine Insurance Institutions & Underwriters, The Ship Crew etc. are the key stakeholders of IMO.

Shipping companies have been confronted with an increasing number and variety of requirements in ship management and ship operations. Audits and inspections are performed to ensure and measure the degree of implementation and effectiveness of arrangements in place. This is in fact a periodical verification of the effectiveness of the Safety Management System and the compliance with rules.

We have a monitoring tool that allows us to analyze outcomes of audits/inspection and vetting and can show trend lines of observed deficiencies.

Audits / Inspections / Vetting are performed by either authorities, recognised bodies like Class or representatives of 3rd parties like oil majors.

Inspections & audits compliance to SOLAS MARPOL & MLC- The objective of a company SMS & ISPS audit is to seek information about the Safety Management System and to determine (by objective evidence) the degree of compliance with the applicable rules, regulation and standards (ISM, ISO etc.), and the documented company procedures. The audit should identify strengths and weaknesses, verify that procedures are controlled properly and that they are being followed. The system audit should also establish corrective action and improvement plans and ensure that personnel understand the requirements and that management commitment is evident. Internal audits are carried out on board and in the office with intervals not exceeding 12 months.

A yearly Audit Plan shows the planning of internal and external audits. The Quality & Safety Manager is responsible for the internal audit process.

Classification Societies yearly performs a combined quality & environmental audit of Company management system, on board and in the office.

The Flag State Control FSC performs a yearly audit of the Company management in shore office and twice every 5 years on board to verify compliance with national and international maritime laws and effectiveness of the SMS. The flag state may delegate this task to a recognized body (Class). Results of an audit by flag state are between flag state, Class and the owner/manager of the vessel.

The Port State Control or, PSC is a technical inspection focused on compliance with international maritime safety and environmental rules for ships in port of a foreign country. In case of serious observed deficiencies ships can be detained in a Port. Ships older than 10 years of age, are submitted to an annual extended PSC inspection. The results of PSC inspections are generally made public in international databases. In the Modern Port Facilities oil spills from ships are quite rare events. This is because they have a good system of efficient PSC (Port State Control) inspections where surveyors who work for Maritime Port & Safety Authority inspect foreign ships coming to their ports to make sure they meet all the international safety and marine environment regulations. This system makes sure that only safe and well-run ships come to Modern Port Facilities around the world. MARPOL Inspections by local authorities check the vessel compliance with environmental rules/requirements when coming in the port.

Ship sanitation Inspections by local authorities Port Health check and issue certificates for the hygienic situation on board every 6 months.

ILO Inspection, by flag state control FSC periodically checks the working and living conditions of the crew on board.

4.2.1: THE UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP):

UNEP is responsible for coordinating responses to environmental issues within the United Nations system. Its purpose is to provide leadership and provide solutions on climate change, the management of marine and terrestrial ecosystems, and green economic development. The UNEP is a key Stakeholder of the oil pollution to the marine environment.

4.2.2 P & I CLUB:

P&I club is a non-profit marine insurers' association. It is a group of shipowners who mutually indulge in the coverage of their own CIVIL LIABILITY risks. Generally, P&I cover variety of risks including Pollution damage. The P&I Clubs provide insurance coverage of up to USD 1B for compensation of environmental damages by oil pollution for tankers in accordance to CIVIL LIABILITY (CLC 1992) and for the BUNKER CIVIL LIABILITY (Bunker CLC 2008).

4.2.3 FLAG STATE CONTROL (FSC):

The flag state has the power and duty to implement laws related to inspection, certification, and the issuing of safety and pollution prevention certificates on vessels registered under flag. However, flag states' supervisory duty for ship-caused pollution is limited owing to a lack of effort in monitoring pollution by registered ships with flags of convenience.

4.2.4 PORT AUTHORITY AND PORT STATE CONTROL (PA AND PSC):

A port authority is a governmental entity to manage ports and other transportation facilities in a special-purpose area. The rules and regulations of the port must be followed by a ship. A port authority's responsibilities for maritime safety and environmental protection are to regulate and

control navigation within the limits and the approaches to the port, to inform nautical and other relevant information to ships and all other involved parties.

4.2.5 SHIPPING COMPANIES AND SHIP MANAGERS:

A shipping company is a business that deals with marine transportation. Typically, shipping companies are engaged in either ocean going or inland river transportation. They are responsible for oil pollution from their owned ships.

Shipping company or ship managers has Designated Person Ashore (DPA) who is the "keystone" for an efficient and successful Safety Management System aboard a vessel to ensure a reliable connection between the company and the ship, to supervise the safe operation of the vessel, as required by the ISM Code by providing links between the company and the crew onboard. So, if there is an oil leak or pollution on board the ship, it must be immediately notified to the DPA so that they may take action as per the law and the company policies.

4.2.6 SHIP CREW:

By definition, "Crew" – refers to all persons carried on board the ship to provide navigation and maintenance of the ship, its machinery, systems and arrangements essential for propulsion and safe navigation or to provide services for other persons on board.

On ships Seafarers can be divided into 2 departments based on their operation onboard ship: a) Nautical/ Deck department and b) Engine department. Master is in Command and overall responsible for ship management; C/O is head of the Deck department, responsible for cargo operation (e.g., Oil Cargo on Oil Tankers) and maintain ORB Part II- Cargo/ballast operations; C/E is head of the Engineering department of a ship, who is responsible for all the machineries and bunkering- oil transferring, oil discharging, waste oil burning in incinerator, or in any event of oil spill and he maintains ORB Part I- Machinery space operations;

All ship crew including officers, engineers and ratings must have adequate and updated knowledge of IMO, Flag state Control (FSC), Port State Control (PSC), Company/ managers/ owners/ charterers, Local and International regulations including SOLAS MARPOL MLC and the basics or specialization knowledge for the prevention of all ship sourced pollutions, especially ship sourced oil pollution. Ship crew must has to be very concerned about the rules and the penalties of the consequences which makes them key stakeholders.

4.2.7 GOVERNMENT:

Most of the countries are signatories of IMO conventions on oil pollution such as OILPOL 1954 & MARPOL 1973/1978 and UNCLOS. Being member states, they implement several strategies to prevent oil pollution within their maritime boundary.

4.2.8. INTERNATIONAL LABOUR ORGANISATION (ILO):

The ILO is a specialized agency of the UN to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialogue on work-related issues. IMO and ILO cooperate on issues which come under the remit of both Organizations, when they relate to seafarers. IMO and ILO have expert working groups on hours of work and rest, fair treatment of seafarers in the event of a maritime accident, and liability and compensation regarding claims for death, personal injury and abandonment of seafarers. The Maritime Labour Convention, 2006 (MLC, 2006), by ILO came into force on 20 August 2013, established minimum working and living standards for all seafarers on board ships. (IMO- Seafarers- Information resources for and about seafarers).

CHAPTER FIVE: CHALLENGES

As we have discussed, IMO & key stakeholders are involved in the reduction of oil pollution in the marine environment. However, despite their efforts, there remain some challenges which remain as obstacles to the implementation of strategies to prevent oil pollution.

5.1 NON-COMPLIANCE OF REGULATIONS:

The majority of the time, oil pollution happens as a result when regulations are not being properly followed and resulting illegal to intentionally dumping of oil and oily mixes from certain ships to sea water. Also, despite having an incinerator to burn them, oily rags, sometimes even directly dirty or waste oil, are thrown overboard from ships. Number of cases have been seen where ships have been detained in foreign ports by the port state control because they have failed to comply to the rules and regulations.

5.2 CREW FATIGUE:

Crew fatigue is one of the leading causes of oil pollution on ships. Fatigue, according to the IMO, is a condition of tiredness, weariness, or sleepiness caused by continuous mental or physical labor, lengthy periods of stress, exposed to harsh environments, or a lack of sleep. Fatigue has a negative impact on performance as well as attentiveness bodily and to mental health. Overwork, long and irregular hours, and lack of sleep are the most common causes for sailors. The crew becomes tired as a consequence of work overload, no rest hour, extended periods of separation from family, insufficient sleep, over contracting, extended periods of sailing without signing off, and a lack of recreation. They make errors during ship operations such as bridge duties, engine room duty, and cargo operations, resulting in oil spills.

Fatigue in a medical sense represents a state of physical and/or mental weakness and is affecting everyone, regardless of occupation and cultural influences, but it is also a symptom accompanying

numerous diseases and one of the most frequent reasons for seeking medical attention. At the same time, however, fatigue is particularly linked to specific circumstances of work.

Fatigue and sleepiness are often used as synonyms but differ because sleepiness will always end with a sufficient amount of sleep while this is not the case for fatigue, which has also physical aspects involved. Physical fatigue follows prolonged periods of physical activities and causes weakness and reduced endurance. Mental fatigue is mainly the consequence of mental stress and emotional exhaustion, or high workload such as long working hours. In particular disruption of the sleep-wake cycle and circadian rhythm, which is occurring in jet lag and shift work, causes irregularity of work and sleep and reduces the amount and quality of sleep between work cycles. Mental fatigue occurs gradually and insidiously, and may appear as cognitive impairment, reduced performance, mental symptoms such as a sense of weariness, and reduced alertness. The International Maritime Organisation (IMO) defines fatigue as "a reduction in physical and/or mental capability as the result of physical, mental or emotional exertion, which may impair nearly all physical abilities including: strength; speed; reaction time; decision making; or balance" We suggest a feasible definition as "a progressive loss of mental and physical alertness possibly ending in sleep".

Work-related fatigue is particularly an issue in safety sensitive occupational sectors, such as transportation (both at land, sea and in the air). The consequences of work-related fatigue have been widely studied in occupational settings. Many experiences from land-based trades such as road and rail transport as well as from air transport can be extrapolated to the maritime context.

The maritime industry is characterised by the necessity of seafarers to work in shifts to keep the vessel going continuously. Various forms of shifts have been applied, but common to most of them is that shifts permit less sleep because they break up the day in portions that leave insufficient time for rest and restitution. Sleeping may take place under unfavourable circumstances due to continuous exposures such as noise, vibration, movements of the ships and other disturbing factors at sea. Consequently, the quantity and quality of sleep is prone to be disfavoured, which is even worse if being forced to sleep at unfavourable times of the day when working outside the regular

daytime hours. The work patterns and life on board vary enormously according to factors such as cargo, type of trade, the crew nationality and flag state and so does the extent of fatigue. Working in the short sea sector appears to cause more fatigue due to more port calls and the associated increase of workload. Compared to shore based workers, seafarers report higher levels of lethargy and poor quality sleep. It is, however, impossible to globally estimate the extent and impact of fatigue on seafarers. Previous studies suffer from low response rates and consequently it is difficult to compare with the fatigue rate of the general population. However, patterns of day to day changes in fatigue have been shown to be measurable and vary considerably among particular subgroups of seafarers and between the start and end of voyages. There is evidence of under-recording of seafarers' working hours, and that this may be related to cultural and commercial pressures.

The most common causes of fatigue known to seafarers are lack of sleep, poor quality of rest, stress and excessive workload. There are many other contributors as well, and each will vary depending on the circumstance (i.e. operational, environmental). There are many ways to categorize the causes of fatigue. To ensure thoroughness and to provide good coverage of most causes, they have been categorized into 4 general factors,

- Crew-specific Factors- which are related to lifestyle behaviour, personal habits and individual attributes;
- Management Factors (ashore and aboard ship)- which are related to how ships are managed and operated. These factors can potentially cause stress and an increased workload, ultimately resulting in fatigue;
- Ship-specific Factors- which are related to ship specific factors that affect the crew's ability to sleep, and others affect the level of physical stress on the crew (i.e. noise, vibration, accommodation spaces, etc.);
- Environmental Factors- which are related to exposure to excess levels of environmental factors, e.g. temperature, humidity, excessive noise levels;

Alertness is the optimum state of the brain that enables us to make conscious decisions. When a person's alertness is affected by fatigue, his or her performance on the job can be significantly

impaired. Impairment will occur in every aspect of human performance (physically, emotionally, and mentally) such as in decision-making, response time, judgement, hand-eye coordination, and countless other skills. For example, Fatigued individuals become more susceptible to errors of attention and memory. Chronically fatigued individuals will often select strategies that have a high degree of risk on the basis that they require less effort to execute.

Fatigue may be caused and/or made worse by one or a combination of things:

Lack / Poor Quality of Sleep; Insufficient / Poor Quality of Rest in Interval Between Work Periods; Stress; Boring or Repetitive Work; Noise or Vibrations; Ship Movements; Food at Improper Timings, Frequency, Content and Quality; Medical Conditions / Illness; Ingesting (Consuming) Chemicals such as Alcohol, Caffeine; Jet Lag; Excessive Workload.

{{{What are the consequences of fatigue? The MAIB Bridge Watch-keeping Safety Study (2004) examined the association between fatigue-inducing working conditions and accidents. This study confirms that minimal manning, consisting of a master and a chief officer as the only two watch-keeping officers on vessels operating around the UK coastline, leads to watchkeeper fatigue and the inability of the master to fulfil his duties, which, in turn, frequently leads to accidents. It also found that standards of lookout in general are poor, and late detection or failure to detect small vessels is a factor in many collisions. The study concludes that the current provisions of STCW 95 in respect of safe manning, hours of work and lookout are not effective. Results reported by Houtman et al. (2005) also confirm that fatigue may be a risk factor in collisions and groundings. Such incidents can have serious economic consequences for companies. In addition to accidents at sea can be devastating for the marine environment and fatal for the seafarers involved.

In the first systematic review of work hours, fatigue and safety at sea, Brown (1989) found little objective evidence of the effects of fatigue, although he did find anecdotal evidence regarding personal fatigue experiences. Seafarers reported that they were often expected to work continuously, under conditions of task-induced or environmental stress for excessive (in relation to other industries) periods of time. Respondents attributed a number of fatigue symptoms to their working arrangements that were in general agreement with research into fatigue effects (e.g.

Bartlett, 1948, cited in Brown 1989). Thus early research on seafarers' fatigue was largely based on Brown's (1989) assertion that long hours are a major contributor to fatigue and accidents at sea. Eleven years later a review focused on the British offshore oil support industry found a similar picture to Brown, concluding that fatigue has been noticeably under-investigated in the maritime domain (Collins, Mathews and McNamara 2000).

Working at sea is likely to be fatiguing for a number of reasons: fast port turn-arounds, demanding (often split) shift systems, regular periods of sustained attention, physical exertion and harsh environmental conditions have all been associated with interrupted sleep patterns and fatigue (Smith, Lane and Bloor, 2001, 2003; Smith, 2003; Smith et al., 2003; Allen et al., 2004). Minimal manning is often associated with increased automation which has led to passive jobs which themselves can cause mental fatigue (Bielic and Zec, 2006). Research on risk factors for fatigue has often focused on associations between these factors and health and safety outcomes. However, some research has been carried out on the prevalence of these risk factors, especially on working hours, and these are now reviewed. It should be noted that it is important to specify the contextual factors associated with fatigue – the different vessels, different regulatory regimes and different types of operations. Some risk factors will be common to most sectors whereas others will be sector specific. Wigmore (1989) surveyed masters of offshore supply vessels and found they tended to work longer hours than other crewmembers, sometimes in excess of 19 hours per day. In a survey of over 1,000 officers across all sectors NUMAST (1995) concluded that reduced crew size (and therefore increased workload) was the main cause of fatigue in seafarers: shifts of between 12-20 hours (upwards of 85 hours per week) were commonly reported.

Another common feature of occupational fatigue is that there is often a failure to act on recommendations. A good example of this in the maritime sector can be seen in the USA. The National Transportation Safety Board (1999) reviewed issues relating to transport fatigue. This report confirms the role of fatigue in shipping accidents (e.g. the Exxon Valdez) and demonstrates that fatigue is often the result of high workload resulting from under manning. On the basis of

this report recommendations were made to the US Coastguard. The first was to set limits on hours of work based on scientific knowledge. This was ignored and the US Coastguard developed a non-regulatory approach based on training rather than prescriptive regimes. A second recommendation was that officers on watch during departures from ports should have at least 6 hours off-duty in the previous 12 hours. Again, no action was taken on this recommendation.}}} -(ITF FATIGUE REPORT final.pdf)

5.3 LACK OF CREW TRAINING EDUCATION AWARENESS:

One of the reasons of oil pollution is a lack of awareness. The majority of people are unaware of the dangers of oil contamination in the water. Many know how to prevent Oil Pollution, but do not know about why to prevent oil pollution, why is it so important. Most of the time, the ship crew do not follow the rules and regulations of oil pollution. Lack of knowledge is one of the reasons of oil contamination. People's carelessness, mistakes, and errors are some of the main causes of oil pollution.

Most of the oil pollution are linked to human error, negligence, and mistakes that might have been prevented. Petroleum refineries, barrages, tankers, storage facilities, and pipelines are all examples of such instances. The Exxon Valdez Oil Spill in March 1989, was connected to all human errors and negligence. In a second instance, BP's director of safety blamed the 2010 oil disaster on human error. According to accounts, the Gulf oil rig explosion was caused by five major human mistakes, resulting in one of the most damaging and largest oil pollution in human history.

Ship crew must keep on learning how to prevent ship sourced pollution from study through personal interest text books, newspapers, magazines, shipping articles, journals, articles, publications, case studies, photographs, by the use of Internets official documents, laws and amendments from websites of Shipping Offices, STCW course materials, shipping company

manuals etc. and then practical application when on board ships, thus improve knowledge and as always alert against all possible risks & hazards.

On board ships, ship crew can Prevent all types of Pollution to Marine environments if we follow/ check/ ensure as per ship owners' guidelines e.g.,

i) Pollution to Marine environments from Spillage Oil & Chemical

a. When Bunker Operations:

1. Are scuppers on deck all around, positively plugged before start of operations?

2. Are transfer procedures established & being adhered to by staff in charge of the operations?

3. Have communications been established with shore-staff and loading procedures agreed?

4. Are oil spill containment and clean-up materials readily available in place to fight oil spills?

5. Have emergency stops for pumps been identified and tested in working condition?

6. Are portable transfer pumps readily available or other means on aft part of the vessel to fight oil spills together with oil pollution absorbent pads?

b. When Cargo Oil Loading/Discharging Operations:

1. Are scuppers on deck all around, positively plugged before start of operations?

2. Are transfer procedures established & being adhered to by staff in charge of cargo operation?

3. Have communications been established with shore terminal and cargo loading/discharging procedures, sequences and start-stop signals agreed?

4. Are oil spill containment and clean-up materials readily available in place to fight oil spills?

5. Have emergency stops for pumps been identified and tested in working condition?

6. Have sea-chest and overboard discharge valves been examined and correctly set?

7. Are portable transfer pumps readily available or other means on aft part of the vessel to fight oil spills together with oil pollution absorbent pads?

ii) Pollution to Marine environments from Disposal of Garbage & Ship-Generated Waste

1. Is the incinerator in working condition & used in designated location for incineration waste?

2. Is the sewage plant in working condition & discharges controlled as per MARPOL Annex-IV?

3. Are segregation and disposal of the garbage & other ship-generated wastes according to the pollution regulations, MARPOL 83, Annex V?

iii) Pollution to Marine environments and Air by Emission from Cargo Operation or Machinery Running

1. Are you aware and acting to control emission of black smoke from the vessel's funnel & other machinery uptakes?

2. Are the gases harmful to atmosphere identified and control of emission such gases from cargo or from any machinery in place?

A SHIP CREW MUST REMEMBER: Prevention is better than cure. Respect and prevent damage to the marine environment. It is part of our good life.

5.4 BREAKDOWN OR FAILURE OF EQUIPMENT

Any piece of equipment may break down or fail at any time, and depending on the function of the piece of equipment, severe consequences can result. Breakdown and failure of equipment in the petroleum sector has resulted in many oil disasters, and it is generally the most feared. Whether on a drilling rig or in refineries, mechanical failure has resulted in catastrophic oil leak disasters.

The Gulf disaster, for example, was partially caused by the mechanical collapse of BP's drilling rig, which was one of the world's largest oil spills in history.

5.5 SHIPPING ACCIDENTS:

Maritime accidents are unavoidable when there are so many vessels navigating on the world's waterways, especially when navigating in narrow channels, Traffic Separation Scheme, dense traffic areas, shallow waters, reefs, icebergs, and landmasses due human errors, crew negligence, crew fatigue, machinery failure or unintentional & unavoidable elements. Accidents involving oil tankers may have catastrophic consequences for the ocean, its creatures, and people who depend on the ocean's wellbeing for their own existence.

5.6 OPERATION OF UNFIT VESSELS:

Current classification of a vessel based on approved seaworthiness standards and documentation as required by the SOLAS & MARPOL.

All seagoing vessels must be classified under a Classification Society and have their seaworthiness assessed on a regular basis.

However, numerous unsuitable ships are in operation all over the globe. Due to poor or unfit safety standards, these vessels are particularly prone to causing oil pollution.

5.7 NATURAL CAUSES:

Natural reasons include oil seeping from the ocean's depths and entering the marine ecosystem from naturally spilled oil due to a variety of reasons (including climatic conditions, disturbance, earthquakes, volcanic eruptions etc.). Natural oil leaks may happen in oceans owing to dissolving sedimentary rocks from the ocean's bottom (which may have similar effects like the accidental oil spill from drilling in oceans as the recent BP oil spill in the Gulf of Mexico).

CHAPTER SIX: STRATEGIES TO MITIGATE EXISTING CHALLENGES

Prevention: Implementing stricter regulations, improving ship design and maintenance, and enhancing crew training can help prevent spills. Preventative measures like the Shipboard Oil Pollution Emergency Plan (SOPEP) on tankers and other vessels, and adopting shore-side electricity to reduce emissions while in port are crucial.

Response Plans: Having clear response plans in place, such as SOPEP, helps in managing incidents effectively.

Industry Agreements: Voluntary agreements like STOPIA and TOPIA between P&I Clubs and the IOPC Funds aim to balance compensation between shipowners and cargo interests.

National Legislation: Many countries have developed their own marine pollution legislation, often in response to major incidents, and may also provide compensation funds.

Regional Cooperation: Regional cooperation and agreements are also vital for addressing pollution incidents. By integrating effective management practices and complying with international regulations, the shipping industry can minimize its environmental impact and contribute to the long-term sustainability of the marine environment.

Technical Standards: International conventions like MARPOL (International Convention for the Prevention of Pollution from Ships) set technical standards for ship construction and operation to minimize pollution.

Operational Practices: Implementing best practices for ship operations, such as proper cargo handling and waste management, can reduce the risk of spills.

Emission Control: Reducing air pollutants from ships through measures like using cleaner fuels or installing exhaust gas cleaning systems is crucial.

Containment:

Boom Deployment: Using booms to contain oil spills at sea is a common practice.

Shoreline Protection: Protecting sensitive coastal areas with barriers and other measures can minimize the impact of spills.

Cleanup: Skimmers and Sorbents, Using specialized equipment to recover spilled oil and absorbents to clean up affected areas.

Disposal: Properly disposing of recovered oil and oily debris is essential.

Public-Private Partnerships: Encouraging collaboration between governments, industry, and communities can enhance preparedness and response to pollution incidents.

Capacity Building: Investing in training and resources for communities and responders can improve their ability to handle spills.

Detection: Utilizing sensor networks and IoT technologies can improve early detection of spills.

Response: Establishing effective response plans, deploying booms and skimmers, and utilizing chemical dispersants can help contain and clean up spills.

Remediation: Implementing strategies to restore damaged ecosystems and habitats is crucial for long-term recovery.

AI Integration: AI can analyze data from various sensors, predict spill trajectories, optimize response strategies, and assess environmental risks, according to scientific publications. AI can play a crucial role in enhancing these efforts by improving detection, prediction, and response to spills. Compensation mechanisms, both international and national, exist to cover damages, while mitigation strategies focus on prevention, containment, and remediation.

AI's Role in Mitigation: Real-time Monitoring: AI can analyze data from various sensors (e.g., water quality, weather conditions) to provide real-time alerts about potential spills and track their movement.

Predictive Modeling: AI can develop predictive models to forecast spill behavior, assess potential impacts, and optimize response strategies.

Decision Support: AI-powered tools can assist in decision-making during spill response, helping prioritize resources and actions.

Optimizing Remediation: AI can analyze environmental data to optimize remediation strategies, such as identifying optimal locations for cleanup operations or predicting the effectiveness of different cleanup methods.

By integrating AI technologies with existing mitigation and compensation strategies, it is possible to enhance the effectiveness of oil spill response and minimize the environmental and financial impacts of these incidents.

AI's Role in Mitigation and Management: Artificial intelligence (AI) is increasingly being used to improve oil spill detection, response, and prevention. AI-powered systems can analyze

satellite imagery and other data to detect spills quickly and accurately, enabling a faster and more effective response. AI can also be used to optimize fuel consumption and reduce emissions from ships, contributing to a more sustainable shipping industry.

Technological Advancements: Developing and adopting technologies like ballast water management systems, alternative fuels (e.g., hydrogen, ammonia), and emissions reduction technologies can significantly reduce pollution.

Adaptation vs. Mitigation: Recognizing the interaction between adaptation and mitigation strategies in managing polluting processes.

6.1 COMPLIANCE OF RULES AND REGULATIONS:

The Port State Control (PSC), Flag State Control (FSC), Ship Surveyor, Classification Society, Ship Owners, DPA, Master and the ship Crew needs to monitor the activities that might lead to oil pollution strictly. They need to arrange regular drills for the crew awareness, must comply to ISM code company manuals local & international rules & regulations.

For the prevention of ship sourced pollutions, Ship Master & Crew must confirm strict compliance to SOLAS MARPOL MLC Local & International rules & regulations and ready all required VALID documents for inspection by shore authorities like FSC, PSC or, authorized departments/ inspectors as Shipboard Requirements:

- All primary/ trading certificates including:

  International Oil Pollution Certificate; Statement of compliance for Air Pollution Prevention Certificate; International Sewage Pollution Certificate; Insurance for Hull & Machinery H&M, Protection & Indemnity P&I, ITOPF (The International Tanker Owners Pollution Federation), Liability (Pollution damage, Wreck removal, Collision damage etc.);

- All secondary safety fire machinery equipment service & calibration certificates;

- All tertiary STS equipment Fenders & Cargo Hoses service & calibration certificates;
- SOPEP;
- SMPEP;
- Oil Record Book;
- Cargo Record Book (If Annex II compliant);
- Garbage Management Plan;
- Ballast management plan;

6.2 MITIGATING CREW FATIGUE:

To combat Crew Fatigue, Working Hours onboard ship needs to be regulated with ample Rest Hours for the crew as per MLC that requires the maximum working hours must not exceed 14 hours in any 24 hours period and 72 hours in any 7 days period The minimum resting time cannot be less than 10 hours in any 24 hours period and 77 hours in any 7 days period. The hours of rest can be divided into a maximum of two parts. If the rest is split, One of the two rest hours must last not less than 6 hours and interval between consecutive rest periods not more than 14 hours.

The root causes of crew fatigue must be identified as these are responsible for unsafe navigation in busy coastal traffic area, unsafe crew fatigue physical & mental health condition resulting navigational disaster & environmental pollution.

The work patterns and life on board vary enormously according to factors such as cargo, type of trade, the crew nationality and flag state and so does the extent of fatigue. Working in the short sea sector appears to cause more fatigue due to more port calls and the associated increase of workload. Compared to shore-based workers, seafarers report higher levels of lethargy and poor quality sleep. It is, however, impossible to globally estimate the extent and impact of fatigue on seafarers. Previous studies suffer from low response rates and consequently it is difficult to

compare with the fatigue rate of the general population. However, patterns of day to day changes in fatigue have been shown to be measurable and vary considerably among particular subgroups of seafarers and between the start and end of voyages. There is evidence of under-recording of seafarers' working hours, and that this may be related to cultural and commercial pressures.

For recognizing Fatigue, the following list describes the various symptoms seen in fatigued persons:

a) Physical- Inability to Stay Awake; Difficulty with Hand-Eye Coordination Skills; Speech Difficulties (It May Be Slurred, Slowed or Garbled); Heaviness in The Arms and Legs or Sluggish Feeling; Decreased Ability to Exert Force While Lifting, Pushing or Pulling; Increased Frequency of Dropping Objects Like Tools or Parts; Non-Specific Physical Discomfort; Headaches; Giddiness; Heart Palpitations / Irregular Heart Beats; Rapid Breathing; Loss of Appetite; Insomnia (Not Able to Sleep); Sudden Sweating Fits; Leg Pains or Cramps; Digestion Problems;

b) Emotional- Increased Willingness to Take Risks; Increased Intolerance and Anti-Social Behaviour; Needless Worry; Reduced Motivation to Work Well; Increased Mood Changes (Examples Are Irritability, Tiredness and Depression)

c) Mental- Poor Judgement of Distance, Speed, Time, Etc.; Inaccurate interpretation of a situation (examples are focusing on a simple problem or failing to anticipate the gravity of the situation or failing to anticipate danger); Slow or no response to normal, abnormal or emergency situations; Reduced attention span; Difficulty concentrating and thinking clearly; Decreased ability to pay attention.

Fatigue Mitigation General guidelines that can help to manage fatigue and maintain performances are- Get Sufficient Sleep, especially before any period when you anticipate that you will not get Adequate sleep; When you Sleep, Make it a Long Period of sleep; o Take strategic Naps; Take breaks when scheduled breaks are assigned; Develop and Maintain Good Sleep Habits, such as a Pre-Sleep Routine (Something that you always do to get you ready to sleep); Monitor your Hours of Work and Rest when Opportunity Arises; Eat Regular, Well-Balanced Meals (Including Fruits and Vegetables, As well as Meat and Starches); Exercise Regularly.

Existing Minimum Safe Manning Certificate relates to ship crew Fatigue- It is understood that the shipboard Minimum Safe Manning Certificate may have been adopted looking at the commercial burnings of the ship owners and operators. Understand from long working at sea and practical experience on board ship that the Minimum Safe Manning Certificate should be redefined considering the Fatigue on the ship crew especially as the ship crew are working day and night hours, 7 days per week, 365 days in year if on board with a minimum rest hours or, the allocated prescribed rest hours by STCW or, MLC which found to be insufficient as compared to any of their shore based colleagues enjoying every day working 8 hrs. In average, every night hours sleeping hours with their family & children, enjoying all festive leaves, all Saturdays & Sundays, Sick Leaves and so many other facilities. Also must consider the job risk the ship crew facing every single day on board ship. Commercial pressure on ship crew causes unlimited pressure on the ship crew resulting Fatigue which many a times leads to unsafe acts, unsafe navigation especially in busy coastal navigational traffic areas leading to major Maritime accidents collision, contacts, groundings, oil pollution etc. causing dangers to life, sea and maritime environments.

The shipboard "minimum safe manning certificate" Need to be redefined and more research & investigations needed paying special attention for ship crew work & rest hours, ship crew fatigue as laid down in SOLAS, STCW, MARPOL & MLC. Ship crew fatigue on board due to compliance of excessive commercial need for the shipping world and from related commercial institutions causing real harm to ship crew physical & mental health and affecting proper observation towards SOLAS, STCW, MARPOL & MLC requirements. To some extent it could be proposed that if the shipboard "minimum safe manning certificate" is redefined, it could save the ship, crew and environments from Maritime accidents, groundings & pollution which are a by-product of ship crew fatigue where the ship crew are extremely tired, both of their physical & mental health conditions resulting navigational disasters & environmental pollutions to Maritime Environments. IMO, ILO, P&I, ITF and related authorities & institutions should pay special attention considering the nature of hazardous shipboard operations to appoint additional deck officers & deck able seamen for safe cargo & safe navigational watch keeping by minimizing the

excessive work load & fatigue on ship crew which could be possibly a remarkable step towards saving the ship & her crew and the environments from accidents contacts & collisions, running aground, pollutions and environmental disasters. Redefinition of ship "minimum safe manning certificate" could save coastal navigational areas & environments from contact damage/ collision, vessel aground & oil pollution.

6.3 PROMOTE SHIP CREW AWARENESS:

Awareness starts from the root level. So, the maritime educational institutes need to put special emphasis on teaching the seafarers of tomorrow to understand the impact of oil pollution, not just the theoretical knowledge regarding rules and regulations. The educational procedure needs to be much more practical based and as per IMO- STCW standards.

Ship crew required to be familiarized about IMO and Key Stakeholders like NGOs, Maritime Global Universities, The Governments, International Labour Organisation (ILO), International Transport Workers Federation for seafarers (ITF), The Flag State Controls (FSC), The Port State Controls (PSC), The Classification Societies, The Ship Owners, The Ship Charterers, The P&I Club, Marine Insurance Institutions & Underwriters, Concerned friends & partners and The Ship Crew documents, company policies, Books SOLAS/ STCW/ MARPOL/ SOPEP/ SMPEP/ Contingency & Response Planning/ Oil spill Risk Assessment OSRA/ ISO/ ISM/ DPA/ MLC/ ISGOTT/ INTERTANKO/ OCIMF/ ICS/ SIRE/ CDI related crew awareness publications, books, journals & guidelines. Class, Company and third party Inspections/ Surveys/ Audits/ Vetting/ NCs & Observations/ corrective actions and closing measures, Shipboard Safety Meetings, Crew training & exercise on oil pollution prevention/ online crew training e.g., Sea Gull/ Audio & Video trainings/ Company sharing routine Circulars, Info Shares, Lessons Learned / working practices- Risk Assessment, Tool box meetings, Near Miss, Best Practice reporting, oil pollution drills & exercises, proper keep arrangements procedures & maintenance of shipboard safety, fire and pollution prevention equipment- LSA, FFA, ODME, OWS, ORB, CRB, SOPEP/ SMPEP lockers equipment, Cargo & Bunker hoses, Cargo- Bunker- MARPOL- IG- COW lines valves

gauges, slop retention and De-Slop, Pneumatic Fenders as per PMS, Safe Navigation, Rules of the Road, Use and maintenance of Bridge & Nav Aids, Strict compliance to Company Drug & Alcohol Policy, Smoking regulations, Code of safe working practices for merchant seafarers, use of PPE, awareness about crew fatigue, work & rest hours, fire safety & pollution prevention procedures for mitigating all emergencies including Ship sourced oil pollution while working on board ship.

Contingency & Response Planning- Careful planning is essential to effectively prepare for oil spills. Developing a strategy and an operational plan before the event will result in a far more efficient and considered response. The process of producing a contingency plan identifies roles and responsibilities, priorities for protection, effective response strategies and operational procedures without the added pressure of a real spill incident. A well exercised contingency plan promotes trained and practiced personnel, and maximizes the preparedness of the organizations and individuals involved in a response.

Once a response to an oil spill has been initiated, continuous planning remains an important process to guide operations and monitor their effectiveness. It ensures that response techniques are adaptive to reflect changing circumstances inherent to the nature of marine oil spills. Aerial surveillance is an important element of planning during a response, and can establish the scale and nature of an incident at an early stage. Once a response is underway, aerial surveillance can be used to guide, monitor, and evaluate the effectiveness of operations. Contingency planning is an important step in ensuring effective response to oil spills. Response teams for ship sourced oil pollution include Ship Crew, Ship Master, Designated Person Shore DPA and all shore based Oil Spill Response authorities & Teams having a proper communications method procedures. Ship crew must at all times be prepared for handling on board oil spill and also if there is any spill overboard.

Uniform Vessel Inspection Procedure by Ship Inspection Report Programme SIRE- The programme requires that participating submitting companies follow a uniform Vessel Inspection Procedure. This procedure has an Inspection Element and a Report Element. The Inspection

Element uses a series of detailed inspection questionnaires as appropriate for the type of vessel inspected. These questionnaires address issues associated with safety and pollution prevention. Inspectors who are employed, or contracted by submitting companies must (with certain exceptions) answer all these questions. Questions are, in many cases, accompanied by guidance notes and/or references to source documents. Their purpose is to aid the Inspector's response. The Report Element is developed from the completed electronic questionnaire that is submitted by the Inspector, either directly to the SIRE web site, or to the submitting company for further processing prior to transmission to the vessel operator and to SIRE.

The ship crew awareness improved by ensuring an Integrated Management System (IMS) among IMO, key stakeholders' and ship crew through proper planning of crew continued trainings as per SOLAS STCW/ crew manning policy as per MLC/ shipboard management as per IMO ISM company policy/ maintenance as per PMS/ conducting routine drills, trainings & exercises/ surveys/ vetting/ inspections/ audits culture as per ISO ISM SMS ISPS MLC requirements.

6.4 MAINTENANCE OF MACHINERY:

It is crucial to maintain the integrity of machinery and make sure that all the systems are optimally operational at all times. Regular update and working in accordance with Planned Maintenance System or PMS has to be ensured keeping a close look at the Operating Hours of the machinery. Spare parts and inventory should be kept available onboard.

6.5 PREVENTION OF SHIP ACCIDENTS:

Crew fatigue is a major cause for Shipping accidents. It has been previously discussed how to reduce it. Instrumental failure must be kept to a minimum by inspecting and calibrating the machines. Restricted visibility demands more men at watch keeping to prevent dangers. The introduction of Electronic Chart Display and Information System (ECDIS) has made navigation

much easier. However, traditional chart planning must be practiced after a certain period to ensure that even at a failure of ECDIS, the seafarers can navigate.

6.6 INSPECTION OF VESSEL FITNESS:

Port State Control, Flag State Control, Classification Society, Ship Owners will strictly inspect the fitness of vessels to determine whether they should be operational or unseaworthy. In case of unseaworthy vessels, those should be detained as long as it is required to fix the issues which got the vessel detained in the first place.

6.7 REDUCING NATURAL OIL SEEPING:

In case of naturally seeping oil, it is not easy to prevent the force of the nature. offshore oil fields have to be identified and monitored. The seeping point has to be cemented to prevent the overflow and buildup of natural oil. Oil well cements are used for oil well grouting. The cementing process supports the casing and prevents blowouts by forming a seal while isolating oil, gas and water.

CHAPTER SEVEN: CONCLUSION AND RECOMMENDATIONS

7.1 CONCLUSION

The scenario in the maritime environment has changed dramatically over the years, as shown by the facts and figures presented in earlier chapters of this study. The major causes of marine pollution are many, according to studies conducted by various experts and relevant agencies, as well as this dissertation, which used many of these sources of information in due respect.

The significance and strength of applying and implementing legal instruments that should be linked with international agreements, regulations, and processes was also highlighted. In this case, it is critical to emphasize the legal connections with neighboring nations in order to achieve a shared understanding of these legal agreements, and local government should adhere to international standards. Furthermore, to reduce the dangers of oil contamination and spills, the requirements for developing and implementing an oil pollution contingency plan at two distinct levels, nationally and internationally, are important and addressed. Protecting the marine biological environment should get special attention, with appropriate regard for the growth of the maritime sector.

Unfortunately, the absence of such a legislative framework within the administration and among stakeholders has posed a significant barrier to eliminate the sources of pollution for operating merchant ships, as well as other facts that pose a significant danger to the maritime environment.

The first step is to join the International Maritime Organization (IMO) to receive the necessary assistance, guidance, and benefits for improving local capabilities, increasing the capacities and skills of people and all stakeholders involved in oil pollution, and ensuring future success by maximizing the protection of the marine environment while minimizing potential and existing risk.

Though I have found many negative impacts during my research & study of the topic "Ship sourced oil pollution management- IMO and key stakeholders' integrated cooperation and ship crew awareness has effective solution", yet with a big heart I would like to Conclude here with the light of hope of a great achievement today that the international Seafarers are trying very hard "to do the right thing" with strict MARPOL compliance. The Company recognises that safety, environment protection, pollution prevention and efficiency are an integral part of good ship management which can only be a result of a combination of right skills, knowledge and experience ashore and onboard vessels. As a result the ITOPF study suggest number of oil tanker spills in 2019 is the lowest in 50 years.

7.2 RECOMMENDATIONS

1. Law enforcement agencies must maintain law and order regarding oil pollution prevention in the marine environment.
2. Different stakeholders and government agencies need to cooperate and coordinate among themselves.
3. SOLAS & MLC 2006 needs to be executed properly on board to ensure that crew fatigue is mitigated.
4. Regular maintenance of all machinery needs to be carried out as per Planned Maintenance Schedule.
5. To prevent ship accidents and to maintain the seaworthiness of the ship, regular inspection needed to be held by the Master and the Surveyors
6. Different stakeholders in the maritime industry need to be identified and they have to carry out their respective roles to prevent oil pollution in the marine environment.

7. IMO and Key Stakeholders must spend more efforts to initiate further research and study to identify the root causes of ship crew fatigue, raise crew awareness about the impact of oil pollution to marine environment and effective management for the prevention of ship sourced oil pollution.

8. The shipboard existing "Minimum Safe Manning Certificate" need to be redefined paying special attention for ship crew work & rest hours, ship crew fatigue from excessive commercial need for the shipping world that causing real harm to ship crew physical & mental health and affecting proper observation of SOLAS, STCW, MARPOL & MLC 2006 requirements.

9. Authorities must ensure proper reception facilities to collect ship sourced operational wastes. All government authorities/ port facilities around the world must ensure proper reception facilities to collect ship sourced operational waste oil/ wastes those are the root causes & threats to environmental pollution & disaster. Many surveys show that many ship owners/ operators due to their ill commercial interest does not arrange proper shore reception facilities to collect ship sourced operational wastes those are the root causes & threats to environmental pollution & disaster, are to be addressed seriously. The IMO, Governments, Port Facilities, Ship Owners & Operators should act more for ensuring proper reception facilities to collect ship sourced operational wastes (waste oil, waste chemicals, sewage & garbage) those are the root causes & threats to environmental pollution & disaster.

10. IMO and Key Stakeholders to spend more efforts to initiate further research and study for promoting the ship crew awareness regarding the impact of oil pollution to marine environment and prevention of oil pollution, by establishing an Integrated Cooperation for existing Challenges and Strategies for effective management towards mitigation & solutions against the ship sourced oil Pollution.

11. Seafarers must keep the good works continued, as in recent statistics showing decreases in maritime oil pollution cases are having a positive impact on the marine environment, leading to improved water quality, reduced harm to marine life, and potential economic benefits. While some operational spills still occur, stricter regulations and technological advancements have contributed to a significant reduction in major oil spills from tankers. This positive trend is attributed to international regulations, technical advancements, and regional cooperation having tremendous positive impact on Maritime Business through Environmental Wellbeing and Economic Consequences.

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Thanks