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

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

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Indian Maritime University – Mumbai Port Campus comprises of two premier institutes, Lal Bahadur Shastri College of Advanced Maritime Studies and Research (LBS CAMSAR) & Marine Engineering and Research Institute (Former D.M.E.T.). LBS CAMSAR is the post sea training institute whereas MERI Mumbai is the pre – sea training institute.

LBS CAMSAR was founded in October, 1948 under the recommendations of the Merchant Navy Training Committee as Central Government premier post sea training institute for Merchant Navy Officers of Navigation & Engineering. And since then, it is offering the comprehensive range of courses for Merchant Navy Officers.

Marine Engineering and Research Institute (M.E.R.I.), formerly known as Directorate of Marine Engineering Training (D.M.E.T.), was established in the year 1949 by the Govt. of India, when the need was felt to train Marine Engineers separately. And since then, it is imparting the education and training to the cadets with a goal of producing the best marine engineers and nautical officers for the world with adopting the latest technology to meet the latest and demanding requirements of the shipping fraternity.
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MESSAGE FROM THE CONVENER

It is very heartening to note that Indian Maritime University – Mumbai Port Campus (Marine Engineering & Research Institute) is organizing a two days Technical Fest Brinicle in association with Maritime Training Trust, D.G Shipping on 28th & 29th March, 2019. This fest is an initiative taken by Maritime Training Trust with an objective of enhancing the maritime knowledge of the participants and to provide all the stakeholders of Maritime Industry an opportunity to gain a great deal of insight into the “emerging technologies”.

I am thankful to IIRE Journal of Maritime Research and Development for collaborating with us. It is pleasing to note that the twelve accepted papers dwell on maritime subjects ranging from Artificial Intelligence, IoT, Inland waterways in India, Sustainable Development, which will dominate the industry in the coming years.

As the success of the event depends ultimately on the people who have worked in planning and organizing it, so I would like to thank the members in all the committees for their great efforts on this success.

Hare Ram Hare
Convener, Brinicle
Editorial

IIRE efforts to ingrain culture of research continues unabated.

A specific seminar is planned in March 2019 at Mumbai bringing researchers, industry and academia together to discuss and highlight the importance of research in the maritime sector.

Yet another opportunity arose when the Indian Maritime University – Mumbai Port Campus invited IIRE to collaborate in the presentation and publication of research based papers of their young cadets pursuing graduate maritime courses. Twelve papers were selected after a process of review which are now being published in a Special edition of the IIRE Journal of Maritime Research and Development. It was heartening to see papers dwelling on some contemporary themes like, Technology inroads into shipping, Sustainable Shipping, Coastal & Inland Waterways that is finding lot of thrust in India. Block-chain technology, Artificial intelligence, Energy efficiency are the areas covered in some of these selected papers. Papers chosen for publication in the Journal was the reward propagated and this brought in much encouragement and healthy competition. The moot idea was once again to engrain the discipline of research in the impressionable minds of the young cadets finding their sea-legs in a dynamic and highly operationalized and challenging shipping environment.

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SHIPWRECKS, ITS EFFECTS ON ENVIRONMENT AND SUSTAINABLE SHIPPING

Shubham Bhagat
Muskaan Chauhan

Abstract
In this paper we will review about the causes, its effects on environment and how to prevent shipwrecks which ultimately leads to sustainable shipping. A shipwreck is the remains of a ship that had wrecked, which are found either beached on land or sunken to the bottom of a water body. Shipwrecking may be deliberate or accidental. Ship wrecks can cause damage to the underwater environment through oil spill, hazards materials and can damage corals and natural reefs. The recent global directives suggest an urgent need for a better understanding of causes and effects of ship wreck and find measure to counteract with its ill effects. Despite modern bridge equipment, new technologies, and improved safety measures, maritime accidents still occur, and an analysis of their causes is essential in preventing future accidents. Ship groundings are one of the more frequent types of accidents encountered. In this paper we discuss the remedial measures for finding the ways to control shipwrecks and hence lead to sustainable shipping.

Keywords: Shipwreck, sustainable shipping, wreck corrosion, grounded vessels, human error, marine accident, grounding accident, human factor, accident analysis.

NOMENCLATURE:
NOAA- National Oceanic and Atmospheric Administration
WW11- World war two
ECDIS- Electronic Chart Display and Information Systems
BRM- Bridge Resource Management

1. INTRODUCTION:

By the word ‘wreck’, we usually mean the remains of a Vessel, aircraft or any other object of conspicuous size which, due to various possible causes (from accidental collisions to acts of war or terrorism, or deliberate sinking), is partially or totally submerged by sea body. Most of the ships were sunk in wartime or by pirates in blazing cannon duels. It is roughly estimated that there have been about 3 million shipwrecks worldwide and only less than 1% of these ships has been explored (Jay Bennett, 2016). The majority of all shipwrecks are caused by the ship collision, fire onboard ship, poor navigation like running aground on rocks, a coral reef, a sandbar, or even another wreck ship. There are thousands of vessels, aircraft and other commercial and military wrecks located at the bottom of the Sea due to accidents, collision or any other reason, are a cryptic source of pollution, since the ships contain various oils and toxic material of
both organic/inorganic types starts leaking and these pollutants can generate ecological
damage, thus modifying the natural arrangement of oceanic floor in seas. There are high
number of military ships abandoned on the seabed of the Mediterranean Basin due to
accidents during the First and Second World Wars (Sprovieri et al., 2013), it is pressing
to increase our knowledge about the causes and preventive measures for controlling
and overseeing shipwreck. This becomes crucial and is assuming considerable
importance on a worldwide scale. The main aim of this study was, therefore, to study
causes of Shipwrecks and its effects on environment.

2. CAUSES OF SHIPWRECK:

2.1. Accident onboard ships:

Marine vessels contain lot of highly sensitive and flammable tanks and machineries
which are prone to explosion, like auxiliary engine, boilers, generators, fuel bunker
tanks and cargos. Due to mishandling of these various onboard equipment’s and lack
of knowledge these machineries leads to big explosion which ultimately leads the ship
to wreck.

2.2. Collision of ships:

Due to globalization there is increase in global trade and thus increase in number of
ships, due to this there is more chances of collision of ships. These collisions may be
sever depending on the speed of the vessel during collision and can lead to the wrecking
of the ship. The reason for collision may vary from poor navigation to machinery
failure, ultimately resulting in wrecking of ship.

2.3. Military activity:

Military activity is one of the main reasons for most number of ship wrecks. During
wars a very large number of ships are sunken by military in which most of the ships are
carrying dangerous munitions and weapons which have oil and toxic material which
are pollutant to the sea. still now light military activity like basic and intermediate
military training exercise for navy, if goes wrong or disarming of live mines compromised can cause damage or if a hostile vessel needs to be put out of action, like pirates or illegal ships these damage can cause serious damage to ship resulting in shipwrecks. In such incident, no concern is likely to be given if the ship is destroyed and shipwrecks.

3. EFFECTS OF SHIPWRECK:

3.1. Oil and Chemical spills:

Petroleum entering the marine environment has a negative effect on living organisms. There are three different pathways through which oil can be exposed to receptors; direct contact or ingestion, intake of bio available components through water, and ingestion of prey contaminated by oil. Oil washed up on beaches or covering areas at sea can attract and smother seabirds.

Oil is not the only threat to marine biodiversity. The warships used in the WWII also carried munitions which, over the years, have become corroded to the point where they are liable to start leaking significant quantities of toxic substances. Some of these toxic substances, such as mercury, are not biodegradable and can cause chemical contamination of the food chain. It has been researched that oil released into the marine environment can also effect and cause changes in community structure in meio fauna which is a small microorganism, hence affect marine ecosystem.

3.2. Wreck Corrosion:

It will affect a steel structure on the sea floor. The rate of corrosion is in general affected by e.g. dissolved oxygen, temperature, pH, salinity, current velocity, wave action, marine growth and bacteria (Kuroda et al., 2008; Sender, 2010). The wreckage of WWII threatens to destroy the beauty of the Pacific. Home to hundreds of species of coral - and thousands of fish species, including important tuna habitat, the Western Pacific is the most prolific ecosystems on the planet. For the last sixty-five years, the marine environment has slowly corroded the steel of their hulls; their interior compartments and their ordnance. Shipwrecks are one of among the biggest sources of marine
pollution. These wrecks are estimated to contain nearly 38% of the total volume of oil are still trapped in sunken vessels. Some 75% of sunken wrecks date back to the WWII is corroded and their metal structures are ageing resulting in deterioration of metal plates are thus threatening to release their contents like oils and other pollutant into the ocean due to these effects of corrosion.

3.3. Ship traffic:

Smaller vessels such as private boats, ferry traffic, tourist vessels, research vessels and coastguard are assumed to have a speed of about 7-20 knots and might anchor in the area of a shipwreck or might get collided dues lack of information of wreck vessels location. Intermediate sized and large sized vessels such as ice breakers, short sea shipping vessels, service vessels, container vessels, bulk vessels, specialized shipping vessels, cruise ships and large ice breakers might also anchor in the vicinity of a shipwreck and can cause both environmental and economic damages. The hazard posed from ship traffic is damage due to anchoring and the squat effect. The squat effect occurs when water is pushed in front of a ship due to its movement forward. This will leave a deficit of water behind the ship and the return flow is speeded up under the ship. This causes a pressure drop and the ship drops vertical in the water. The squat effect is assumed to potentially destabilize a ship wreck.

3.4. Loss of capital and property:

Apart from environmental effects ship wrecks are responsible for major capital and monetary losses of the shipping company as ship sinking cost the ship owners the cost of cargo it was carrying and loss of reputation of company excluding various fines from particular sea/port authority where the ship is sunken. The sum of loss of a ship is in millions or even billions and can easily strain or demolish the shipping company’s bank account.
3.5. Effects on environment:

Governments may not be aware of the oil onboard or its potential impact, environmental protection may not be a priority, or simply, they are not aware of wrecks in their waters. Only recently have nations begun investigating the potential of pollution from wrecks within their own waters. The United States was unable to trace the source of a series of oil spills in San Francisco Bay for years. At the time, these mystery oil spills were the “largest killer of sea birds in North America” (Basta, 2010). Only after several years of collecting oil samples and ruling out modern vessels did government researchers identify the culprit as the wreck of the S.S. Jacob Luckenbach. We can see the NOAA’s data of known shipwreck in US coastal area.

In 1952, the freighter Luckenbach struck another ship and sank 17 miles southwest of San Francisco, near the future Gulf of the Farallones National Marine Sanctuary (Monterrey Bay National Marine Sanctuary). Upon discovering this wreck as the source of multiple oiling events in the Bay, and as a wreck capable of significant environmental damage (the ship sank with 457,000 gallons of bunker fuel), the Office of National Marine Sanctuaries began the Resource and Under Sea Threats (RUST) database “to find the next Luckenbach” (Basta, 2010). This database now comprises thousands of wrecks and aims to catalogue data on the more than 150,000 sunken vessels in U.S. waters (Zelo et al, n.d.). Japan, the UK and France have also begun cataloguing their wrecks.
HFO is likely more persistent on the water surface than lighter refined products, involving the risk that it may drift and impact other areas, for instance coastlines. This is in line with the overall findings from the four Norwegian oil spill incidents that the water surface, upper parts of the water column as well as the coastline is the most vulnerable parts of the environment. (J. F. Rasmussen)

3.6. Analysis of Shipwreck:

Many of these wrecks pose environmental threats, either because of the hazardous nature of their cargoes, presence of munitions, or because of the bunker fuel oils left on board. As these wrecks corrode and decay, they may release oil or hazardous materials. This wreck poses an immediate pollution threat or impede navigation, the vessels are left alone and are largely forgotten until they begin to leak. (D helton, 2010)

![](image.png)

**Figure no. 1**

We can see in graph no. 1 that there is data of shipwreck of known ships for last 20 years. We can clearly see that at first decade the no of shipwrecks was very less around 41(Approx) ships per year on an average. It is clearly seen that after 2010 the no. of shipwreck has increased. In 2016 there is total of 229 shipwrecks, which is the highest in last 2 decades. The lowest no. of shipwreck was observed in 2005.

Let’s study the year when there was most no. of shipwrecks in this past 20 years, i.e; 2016, and last year of 2018. We will classify the shipwreck on basis of nature of accident. We broadly classify the types of accident as fire, collision, grounding, capsizing, natural and others.
On compiling the available data, we found out that most percentage of shipwreck on basis of nature of accident. The above figure no.2 shows the percentage of shipwrecks in the year 2016, which had maximum number of shipwrecks in this 20 year. It clearly shows that the maximum shipwrecks are caused due to grounding, followed by Capsizing of ships and collision of ships. Fire comes after that as 4\textsuperscript{th} major cause of shipwreck in 2016.
Now we will look into the last year of causes of shipwreck. The figure no.3 is prepared by collecting the data of the various known shipwrecks that’s has been reported, which clearly pectoris’s that within one year the percentage of shipwrecks caused due to grounding have massively increased from 42% to 52%. And therefore it is necessary to find out the reason for continuous increase in shipwrecks due to grounding. Maritime accident analyses aim to determine the root causes of accidents and recommend effective ways to prevent similar accidents. Maritime accidents may involve more than one factor, such as human errors, mechanical failures, adverse weather conditions, and traffic density. Safety measures are therefore essential in preventing accidents; it is vital to learn lessons from previous accidents to safeguard life, property, and the environment at sea.

<table>
<thead>
<tr>
<th>Causes of grounding accidents</th>
<th>Abbreviations</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Voyage Management Errors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1 Faulty or inadequate</td>
<td>VME-1</td>
<td>18</td>
</tr>
<tr>
<td>passage plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Inappropriate route</td>
<td>VME-2</td>
<td>10</td>
</tr>
<tr>
<td>selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Use of improper chart</td>
<td>VME-3</td>
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</tr>
<tr>
<td>2. Team Management Errors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1 Lack of communication and</td>
<td>TME-1</td>
<td>62</td>
</tr>
<tr>
<td>coordination in bridge</td>
<td></td>
<td></td>
</tr>
<tr>
<td>resource management</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Lack of external</td>
<td>TME-2</td>
<td>5</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3 Improper look-out</td>
<td>TME-3</td>
<td>20</td>
</tr>
<tr>
<td>2.4 Deficiency in safety</td>
<td>TME-4</td>
<td>11</td>
</tr>
<tr>
<td>management system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 Failure of watch</td>
<td>TME-5</td>
<td>3</td>
</tr>
<tr>
<td>arrangements</td>
<td></td>
<td></td>
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<tr>
<td>3. Application Errors</td>
<td></td>
<td></td>
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<tr>
<td>3.1 Position Fixing</td>
<td>AE-1</td>
<td>30</td>
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<tr>
<td>Application Errors</td>
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<td></td>
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<tr>
<td>3.2 Inefficient usage of</td>
<td>AE-2</td>
<td>31</td>
</tr>
<tr>
<td>bridge navigation equipment</td>
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<td></td>
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<td>3.3 Faulty maneuvering</td>
<td>AE-3</td>
<td>14</td>
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<tr>
<td>3.4 Interpretation Errors</td>
<td>AE-4</td>
<td>41</td>
</tr>
<tr>
<td>3.5 Unsafe speed</td>
<td>AE-5</td>
<td>4</td>
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<td>4. Individual Errors</td>
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<td>35</td>
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<td>4.1 Fatigue</td>
<td>IF-2</td>
<td>8</td>
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<tr>
<td>4.2 Alcohol</td>
<td>IF-3</td>
<td>7</td>
</tr>
<tr>
<td>4.3 Stress</td>
<td>IF-4</td>
<td>12</td>
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<tr>
<td>4.4 Lack of training &amp;</td>
<td></td>
<td></td>
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<tr>
<td>education</td>
<td></td>
<td></td>
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<tr>
<td>4.5 Watchkeeping officer</td>
<td></td>
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</tbody>
</table>

*Table no. 1*
On researching the causes of shipwreck, we can see that human errors played a major role. This Table reviewed about maritime accident reports related to groundings caused by human error, and the causes were. Categorised to enable interpretation (Mullai and Paulsson, 2011), the causes of grounding accidents attributable to human error are defined by four main categories: team management errors, voyage management errors, application errors, and individual errors. Table below illustrates the causes of groundings and their frequency.

We will now classify the shipwreck on basis of their flag state. On collecting the data of 2018, we found out that major no. of shipwrecks is from China that is 13% of overall shipwreck followed by Indonesia with 10%, PANAMA and Russia are next with 8% of shipwrecks each with USA of 4%. There rest of the countries comprised is at 57% of whole shipwrecks as we can see in figure no. 4.

![Shipwreck by Flag states](image)

**Figure no. 4**

4. **COUNTERMEASURES:**

Countermeasures for ill effects of ship wrecks are:

- Improvising navigation and ship equipment management to avoid/minimize accidents and ship wrecks.
  
  Also implementing better training and navigational equipment’s which enables ship to avoid any collation or grounding in shallow waters.
• More support and research in order to improve knowledge about existing ship wrecks as:
  Location of existing wrecks that are known for creating a no anchor and diving zone to isolate the wreck until unless its wreck conditions been identified.
• New research and study of the ability to predict rates of corrosion and degradation of sunken wrecks for different conditions (water temperature, currents, etc.).
  The technology of remotely operated underwater vehicles (ROVs), with a view to reducing the cost of identifying and locating wrecks, as well as the cost of removing oil or neutralizing toxic or nuclear waste, and/or wreck removal.
• Removal of Wreck by various methods like full removal, partial removal, pulling ashore using ground tackle, refloating vessel to water surfaces, etc.
  Knowledge of the physical properties of oil and toxic and radioactive substances in deep water, cold water and high-pressure seawater environments for safely removal of wreck ship.
• There are technology offers solutions to prevent the ships from releasing their oil known as “offloading”. When ship is sinking the integrity of the hull is established with a process called “hot tapping” is used to drill into sunken vessels and remove the oil. This technique is used on the USS Mississinewa by U.S. Navy with a Salvage teams (SUPSALV) and contracted salvage teams to drill through the hull and install valves for a controlled removal of fuel. A number of taps was drilled to speed offloading of the Mississinewa, with each tap taking 15 minutes to install (U.S. Navy, 2004). Once a valve is in place, a hose is attached and the oil is vacuumed to containment barges at the surface (SPREP, 2002). Once the oil is removed, seawater and other impurities are filtered out and the oil may be reused.

5. CONCLUSION:

The Causes, effects and of ship wrecks has been discussed in this report. A shipwreck shatters all the MARPOL regulation with a huge margin. So it is our prime duty to protect the marine environment from polluting and ultimately lead to sustainable shipping. There is a need for a strong regulation and convention that strictly implies on all major counties. The special measures to be taken are as follows: Improvement of education and training, Obligation to have Electronic Chart Display and Information, Systems (ECDIS) and compulsory ECDIS training for Watch keeping officers.
Amending the working hours of watch keeping officers in Accordance with STCW, not only on records but also in Practice (improvements in seafarers’ hours of work and Rest). Improvements in the SMS. Compulsory Bridge Resource Management (BRM) training. For watch keeping officers, captains, and pilots. Increasing the number of seafarers, especially the number of watch keeping officers.

It is over Civic duty to take responsibility of our environment and try and maintain all the rules and regulations. Improve the shipwreck governing system and collect the data on known shipwrecks as there are more than 3 million shipwrecks whose location are unknown. These are a grave danger as its potential harm on environment cannot be reversed. It’s our responsibility to learn about past, work better in present and leave a safe and sustainable future for next generation.

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