“Sustainable Port Development in India

(Environmental Sustainability at Kamarajar port limited)”

Project Report submitted in partial fulfilment for the award of the degree of

Master of Business Administration (MBA)

in

Port and shipping management

by

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Under the guidance

Of

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(A Central University under the ministry of ports, shipping and waterways, Govt of India)

MAY 2024

DECLARATION

I, **Immanuvel jeyaraj**. V bearing **Register Number: 2203304011**, student of MBA –Port and Shipping Management, at School of Maritime Management, Indian Maritime University, Chennai Campus, hereby declare that the project report titled "**Sustainable port development in India-Environmental sustainability at Kamarajar port limited**" is my original work. This report is being submitted in partial fulfilment of the requirement for the award of the degree of Master of Business Administration (MBA) In Port and shipping management (PSM). The project report is output of my learnings and observations of my research under the guidance of Dr Lekha Ravi. Assistant professor School of Maritime Management, Indian Maritime University, Chennai Campus.

I declare that the information submitted is true and original to the best of my knowledge.

Place: Chennai

Date: 10/05/2024

signature

Immanuvel jeyaraj

(**2203304011**)

CERTIFICATE

This is to certify that this project report entitled **"sustainable port development in India, Environmental sustainability at kamarajar port limited"**-submitted to the School of Maritime Management, Indian Maritime University, Chennai Campus in partial fulfilment of the requirement for awarding the degree, MBA in Port and Shipping Management is a genuine work of **Immanuvel jeyaraj (Reg No. 2203304011)**.

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Last but the least my prayers and thanks to the "almighty" without whom the work would not have been materialized

Place: Chennai

Date: 10/05/2024

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Executive Summary

This project examines sustainable port development in India, focusing on environmental concerns. It begins by outlining the evolution of the Indian port sector and the environmental impact of these operations. Environmental initiatives undertaken by Indian ports are then explored, followed by a specific case study: Kamarajar Port Limited (KPL).in Ennore located in coastel Tmilnadu

The KPL profile details its vision, mission, and current environmental initiatives aimed at pollution reduction. However, the project highlights a critical incident - a collision at Kamarajar Port leading to an oil spill.

To further understand the environmental consequences of oil spills, the report delves into two separate incidents at ennore Port (2017 and 2023), analyzing their impact on the coastal water biota and marine ecosystem. The final section explores optimized oil spill recovery technologies, including mechanical containment methods. The project concludes by summarizing key findings and drawing conclusions about sustainable port development in India.

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Chapter :1

Introduction

1.1What is sustainability:

Sustainability means meeting our own needs without compromising the ability of future generations to meet their needs Sustainability is the ability of our society to survive and thrive without all the natural resources necessary for the future. Sustainability promotes longer goals through the use of methods, techniques and support from international, national and local organizations

1.2What is Sustainable in port sector:

India, with its vast coastline and strategic location, plays a crucial role in maritime trade. However, with increasing cargo volumes and environmental concerns, developing sustainable port infrastructure has become imperative. The Indian government has launched several initiatives to promote **green ports**, focusing on

Reducing emissions:

This involves using cleaner fuels like LNG, shore-to-ship power supply, and promoting electric vehicles within the port.

Renewable energy:

Ports use solar, wind and other renewable energy sources to power their operations

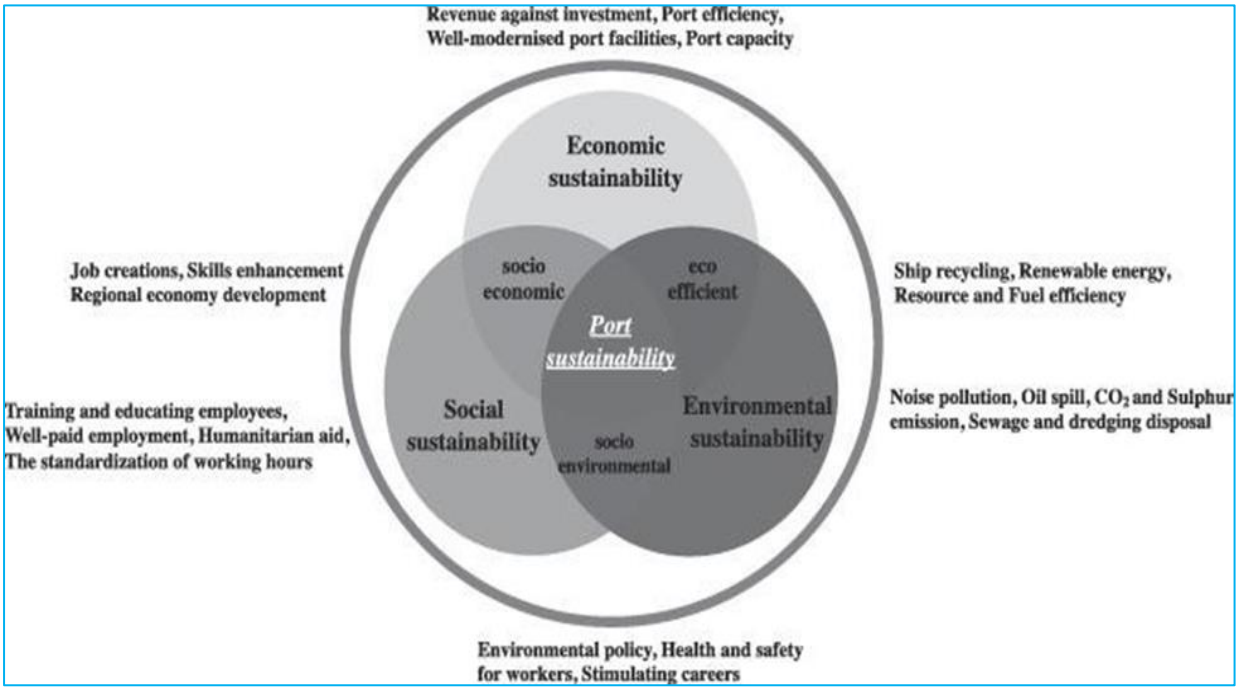
Waste management: Implementing efficient waste management systems, including wastewater treatment and recycling, is crucial.

Biodiversity conservation: Minimizing the impact on marine ecosystems and protecting sensitive habitats is essential.

From the standpoint of green port management, the effectiveness of the green port concept is reliant on a number of factors. All of the plans aligned hall takes into account all components, including economic and environmental aims, in terms of long-term growth. Aspects of green port sustainable development can be divided into three categories:

(i) Economic sustainability
(ii) Environmental sustainability

(iii) Social sustainability[1]



(sustainability)

Figure 1.1

1.3 Research question:

- How sustainability adopted by major Indian ports?
- How sustainability adopted in Kamarajar port limited?

1.4: Objective

The objectives of environmentally sustainable development in Indian ports are multifaceted, encompassing economic, environmental, and social aspects. Here's a breakdown of the key goals:

- To study sustainability practices in Indian ports with respect to Ennore port in Tamilnadu on the East coast

[1] https://en.wikipedia.org/

- To study and document the steps taken to achieve environmental sustainability by Ennore port
- To understand and analyse the challenges in implementation of the of the sustainable goals in Indian major public sector ports

1.5: Methodology:

The research was conducted based on secondary data. More articles, research paper press releases, review of literature and port websites and gathering information from port and non-port sector employees

1.6 Chapter Scheme

1.6.1 CHAPTER 1: This chapter gives the small introduction about the Indian ports and about KPL. Also, it includes the introduction about the different aspects of the project like scope, objectives, research methodology, data collection, statistical tools and limitations

1.6.2 CHAPTER 2: In this chapter study was done on the different papers related to the project title and summary and review of those papers are written. In the end literature gap is explained.

1.6.3 CHAPTER 3: In this chapter study was done by sustainable practices in Indian port of such as environmental issues and policy of environmental, turnaround time, financial aspects and employment.

1.6.4 CHAPTER 4: This chapter gives the details of various taking initiative of Ennore oil spill happening at KPL. Study Private sector participation is established in the chapter. The chapter end with future projects of KPL for a recovery method oil spill and how to using to advance mechanism in KPL

1.6.5CHAPTER 5: Based on the study of the optimized oil spill recovery technology Also, suggestions are given to KPL to improve the oil spill issue based on the study.

1.6.6CHAPTER 6: Based on the study findings are listed in the chapter. Also, suggestions are given to KPL to improve the port business based on the study. Finally, the chapter end by listing the various sources used for the study

Chapter :2

Review of literature

2.1 Environmental Sustainability in Ports

Author: Eduardo Lalla-Ruiz

Abstract:

Due to the evolution of environmental regulations and requirements in the maritime industry, it is important for stakeholders to see the positive impact of green problem solutions not only from an ecological perspective, but also the integration of the business. and business. important. Therefore, the business needs structures, processes, technologies and processes that promote green ideas, achieve business and environmental goals and contribute to growth and development. This chapter introduces the concept of port environmental sustainability and explains how to incorporate environmental indicators into the modelling and decision-making process. We propose a framework that includes a set of approaches to solving many operational level environmental problems currently discussed in science and industry. Consider strategy and tactics, such as driving slowly, in your decision**.**

2.2 Topic: Sustainable Goals of Indian Ports

Journal of Green Engineering (JGE)Volume-9, Issue-2, August 2019

Author: Dr. K. Yogeshwari

Abstract:

The literature review on sustainable indicators for port environment in the Indian context provides a comprehensive analysis of the challenges and [2]strategies for achieving sustainability in port development. The document emphasizes the significance of sustainable port development in contributing to economic, social, and environmental progress. It underscores the crucial role of ports in the supply chain, logistics, and transportation sector, and the need for sustainable practices to balance economic, social, and environmental perspectives.

The review highlights the research gap, indicating that the concept of sustainability in port development is not identified or implemented in the planning and development stages. It notes

[2] : https://doi.org/10.1016/B978-0-12-814242-4.00003-X

that most port authorities and statutory bodies do not consider long-term viability for successful port operation in a sustainable manner. The document emphasizes the importance of sustainable indicators, encompassing economic, environmental, and social perspectives, to be adopted during various stages of port development, including planning, construction, operation, and maintenance.

Furthermore, the literature review discusses the importance of stakeholder participation and public-private partnerships in port development. It emphasizes the need for sustainable initiatives, environmental management systems, and the adoption of green port strategies. The review also provides insights into the challenges and opportunities for sustainable port development in the Indian context, highlighting the necessity for expertise and profound knowledge at all stages of development.

The document also presents a detailed case study of 12 major Indian ports to assess their sustainability characteristics and initiatives. It identifies key sustainable indicators based on national and international literature, covering various aspects of sustainable port development. The study emphasizes the need for active stakeholder[3] involvement and the implementation of key sustainable indicators to promote sustainability in port development.

In addition, the literature review addresses the environmental and social concerns related to port development, emphasizing the importance of preserving the natural coastal morphology and biodiversity. It also discusses the significance of sustainable port development strategies in addressing challenges such as safe handling of cargoes, environmental management, and capacity development or expansion of ports

2.3 Sustainability initiatives in Canadian ports

Author: Michelle Adams

[3] https://doi.org/10.1016/B978-0-12-814242-4.00003-X

https://doi.org/10.3390/environments9090117

Abstract:

Canadian ports contribute to Canada's economic and social development. The organization wants Canadian ports to balance economic growth with social and environmental sustainability. In response, some Canadian ports have implemented strategic initiatives to integrate sustainability into their operations. These ports can measure and improve their environmental performance by participating in the Green Marine (GM) programme. The study evaluated the sustainability and environmental performance of 18 major Canadian ports. Use twenty-five indicators to identify operational factors related to port sustainability. Annual performance reports published by General Motors (eight years) were analysed to evaluate conditions in the working environment. All major Canadian ports participate in the GM program, but only seven organizations incorporate sustainability into their operations. Sustainability measures include environmental development, environmental protection, energy management, cooperation with partners, supporting port users for sustainable development, improved reporting environment and continuous research and development. All Canadian ports must come together to pursue and participate in GM to improve environmental performance and remain competitive in the shipping world.

2.4Topic: Assessing Dry Ports' Environmental Sustainability

Author: Erica Varese

Abstract

Sustainable development and environmental issues related to ports and the maritime industry highlight the need to strengthen transport and trade to incorporate green practices such as the use of dry docks. However, among existing studies investigating the effects of dry docks, only a few articles investigate their environmental impacts. Moreover, this final document addresses this debate in a general way, and the ecological issues associated with dry docks have not been fully examined or are less researched. Considering these areas, through this review the authors wish to develop a new dry port concept to support and encourage future research in this field. The method used by the authors is to search the literature in Scopus and Web of Science. They identified 107 articles, of which 43 were included at the authors' request. The main results show

that: (i) there is a lack of coordination between the various studies and discussions regarding the dry port environment; (ii) lack of effective equipment; Moreover, there is no discussion on the perspective of the sustainable development goals of the 2030 Agenda

2.5 Topic: Towards a sustainability management system for smaller ports

Author: Andrei Kuznets

Abstract

Larger ports routinely deploy environmental management tools but systematic sustainability management in smaller ports is rare. Accordingly, this paper assesses the sustainability needs of smaller ports in Cornwall and Devon, a case-study, and proposes a systematic method for identifying and managing them. The development and deployment of a Port Sustainability Management System for smaller ports in an environmentally sensitive but economically peripheral UK area is discussed. In-depth collaboration with Harbour Masters to identify sustainability management practice revealed few applications of the theoretical elements of triple bottom line accounting. Rather, semi-structured intervie[4]ws unearthed the essential elements of port management and facilitated mapping of the forces which underpin port sustainability practices. A constructivist grounded theory approach identified emerging concepts, common patterns and sustainability themes, which were synthesised into a Sustainability Management System based on 11 indicators of knowledge criteria and a self-scoring mechanism. Adopters reported a more proactive stance towards sustainability and safeguarding of local communities, improved understanding, and more effective discourse with stakeholders. Benefits spanned port improvements; awareness of progress, performance, strengths and weaknesses; enhanced communication and reporting; and improved processes. Almost all reacted positively and identified multiple benefits, equating to two new jobs in each port.

2.6 Topic: How to Measure Environmental Performance in Ports

Author: Alejandro Vega-Muñoz

[4] https://doi.org/10.3390/environments9090117

Abstract

Seas and oceans are important for achieving sustainable development goals. This relationship has led to the emergence of the blue market approach, in which experts and policy makers look at the activities of shipping ports from a different perspective. The Blue Economy approach shows t[5]he results of various international communications on this topic and the development of green ports and ports' environmental measures in general. In this context, our study aims to review various research articles on the environmental performance assessment of ports, h arbours, or port authorities in the sea and ocean. This study followed a scientometric analysis approach to achieve its aim. This study takes data solely for Environmental Port Performance (EPP) and extracts the body to examine material from five storage facilities in the Web of Science Core Collection. Selections were processed and developed according to PRISMA guidelines to create appropriate sample for the PICOS (Populations, Interventions, Comparators Outcomes, and Studies) tool. A study limitation was identified. These include research on the port's environmental performance and influenced by the European Sea Ports Organization and the Green Ocean Network. These are compared across ecological sustainability targets (SDGs), scale models and different types of use. Finally, we evaluate two types of measures documented in research on this topic worldwide and discuss their advantages and disadvantages

2.7Topic: Evaluating sustainability factors of green ports in China under fuzzy environment

Author: Chandra Prakash Garg

Abstract:

China's sea ports are the busiest in the world and face problems such as environmental pollution, greenhouse gas (GHG) emissions and damage to marine ecosystems. One way forward is to create green ports, but there is currently no wisdom on the sustainability of this

[5] https://www.mdpi.com/2071-1050/13/7/4035

idea. Therefore, this study aims to identify the key[6] factors of sustainability for green port development. Then, the analysis process was analysed using the FAHP (Fuzzy Analytical Hierarchy Process) method MCDM The results show that out of the six basic categories identified, environment, digitalization, automation and strategy are among the top three categories that attract the most attention. Sensitivity analysis is also performed to check the robustness of the method used. Business leaders and policy makers should pay attention and adopt the most important measures to create a green culture in China

2.8 Topic: Port sustainability initiatives: a study of Brazilian public ports

Author: Darlene Ribeiro Cunha

This article aims to analyse environmental security measures used in Brazilian public ports. Research conducted by 20 port managers along the Brazilian coast showed that the security plans of Brazilian public ports are in line with international practices This study demonstrated the trend of integrating management aspects of ports with sustainability goals. Brazilian ports are committed to publishing sustainability reports, but only eight ports currently use GRI guidelines to compile these reports. Therefore, there is still room for improvement in integration with international standards and strengthening external communication. By using consistent global standards, companies and stakeholders can more easily compare security reports, making it easier to measure and define practices. Increasing the port's resilience to the effects of climate change should be constantly monitored, as the port can use a variety of materials and tools. The study showed that the most used data from monitoring stations are weather/climate and sea/ocean. Only 5% of ports have cash incentives for reducing emissions in the port area. Additionally, around 40% of ports monitor CO2 emissions th rough an emissions inventory, and only two ports use solar energy. This document outlines the main initiatives for environmental sustainability in Brazil's public ports and provides information on supporting sustainable ports and cities

[6] https://ideas.repec.org/a/spr/endesu/v25y2023i8d10.1007_s10668-022-02375-7.html

2.9 Title: The Greening of Ports: A Comparison of Port Management Tools Used by Leading Ports in Asia and Europe

Author: jasmine Siu lee lam

Abstract

From a policy and management perspective, this study aims to investigate the port management tools offered by port/public authorities and then determine which of these tools are used to enforce or encourage green port operations. and development activities. We begin our research and comparison on two axes: on the one hand, the tools available to port authorities (prices, monitoring and evaluation, business management and environmental management), on the other hand, the work of port authorities. (Transportation, handling and storage, medium transport, trade and port expansion). The study compares the situation in Singapore, Shanghai, Antwerp and Rotterdam, the main ports of Asia and Europe, and discusses the effectiveness of the policies. The findings show that ports are unique in their management of environmental regulations and that management is expanded. The business of most concern is shipping, reflecting the fact that the port is operated by the International Maritime Organization. Compared to these two Asian ports, the ports of Antwerp and Rotterdam have more influence in the development of green port policies.

2.10 CASE STUDY:

Ennore ammonia gas leak: TNPCB to enforce recommendations of technical committee:(January 2,2024) The TNPCB shall take immediate action to direct the unit to pay the environmental compensation of ₹5.92 crore for environmental mitigation and to take legal action against the unit

[7] https://doi.org/10.1080/01441647.2014.891162

https://www.thehindu.com/

Coromandel International Limited:

Coromandel International Ltd is a fertilizer manufacturer based in Ennore importing and discharging 3,000 to 8,000 tonnes of ammonia per month from Iran or Saudi Arabia. Ammonia is obtained in liquid form at 33°C and stored in a storage tank under the same conditions. It is transported through a 2.5 km long 8-inch flexible high density polyethylene pipeline laid on the seabed from Ennore Port. Approximately 36 hours before the ammonia is shipped from the ship, pre-cooling is performed through the pipeline to release the liquid ammonia. How The Gas Leak Happened?

During the refreeze period on the night of December 26, 2023, the unit noticed a drop in the water pipes and saw foam emerging from the pipe water approximately 2 meters from the shore.

Immediate action of Tamilnadu pollution control board:

According to the Tamil Nadu Crime Control Commission, the shock was found in the room around 11.45 pm. and started depressurizing the pipeline by transferring ammonia vapor to the flame and completed the operation within 20 minutes TPCB staff and management, Directorate of Industrial Safety and Health (DISH) came to the site in the morning. Ammonia levels in the surrounding air were monitored at some locations before 14.15 Tncb

2.11 Title: The Emerging Blue Economy: Its Development and Future Prospects

Author: jui sha

Abstract:

Oceans cover approximately 71 percent of our planet's surface. They provide food and livelihood to the major part of the global population and almost 80 percent of International trade is carried out through the water, which makes it a key source for economic development. As a step to preserve these resourceful water bodies, the UN has included marine preservation

in its sustainable development goals - SDG14 “Conserve and sustainably use the oceans, seas and marine resources for sustainable development.” To work towards this goal, the concept of Blue Economy was first introduced in the UN conference on sustainable development in Rio, 2012.

Blue Economy as a concept aims for socio-economic development and the preservation and improvement of several livelihoods while maintaining the environmental sustainability of the oceans and coastal areas. It is not limited to just marine products and resources but also encompasses coastal tourism, maritime transport, aquaculture, offshore renewable energy, and various biotechnology aspects. Blue Economy has evolved largely from the concept of Green Economy. This article will focus on three basic aspects.
First, the introduction of the Blue Economy and its impact on achieving economic and social tranquillity and a major solution to attain sustainability[8]. Continuing from the evolution of this concept, the second will analyze India's increasing steps [9]in the development of the Blue Economy and its impact on its relations with other countries such as Bangladesh and Small Island Developing States (SIDS). Third, this& nbsp; article will analyse the impact of the Blue Economy on a select few nations with growing economies and the challenges the Blue Economy will bring forth. This article seeks to analyse the Blue Economy as an area of development for nation-states to improve society, the environment, and individual economic capabilities.

2.12Title: A Methodology for Measuring Sustainability of Dry Ports Location Based on Bayesian Networks and Multi-Criteria Decision Analysis

Book and volume: Transportation research procedia volume -13

Author: Nicoletta González-Cancels

Abstract:

Determining where to build a dry port requires analysis of all cargo with the aim of moving as much cargo as possible from road to different modes of transportation such as rail or short sea shipping. For a small environment this is less of a problem. However, the safety of underground

[8] https://www.ennoreport.gov.in/content/
[9] https://www.neliti.com/publications/321966/the-emerging-blue-economy-its-development-and-future-prospects

facilities should also be taken into account in such decisions. The purpose of this article is to investigate the variables that affect the stability of dry port and how to measure stability. We propose a method based on multiple decision analysis (MCDA) and Bayesian networks (BN). While MCDA was used as the score generation method, BN was chosen to eliminate the decision in determining the weights, a process that allows each variable to be prioritized according to the relationship established in different systems. To determine the relationship between all variables involved in the decision, we developed the K2 BN algorithm, taking into account the importance of each factor and variable. We use a full map analyzed by ArcGIS to obtain scores for each variable. Based on research data, we assessed the sustainability of all 10 dry ports in Spain. In this logistics platform, we see that the most important changes to achieve sustainable development are changes related to environmental protection, so the sustainable development of the area requires great respect for the natural environment and the urban environment in which it is located.

2.13 Title: The Sustainability of Oil Ports-frame work for china

Author: xuemuge Wang

Abstract

In recent years, government and nongovernmental organizations have shown interest in sustainable development and ports have begun to pay attention to sustainable development, and the will give more importance to the sustainable development problems of the port in the future. Currently, the main benefits of ports are to reduce costs and maximize profits while minimizing environmental impact and potential social impact. In this way, the management of sustainable development has become a reality and has become the most important goal for the port, which has been seeking a balanced development economy for many years and aims to prevent damage to the environment. This chapter highlights the importance of sustainable development for the oil port industry and puts this in the context of China

2.14 Title: Sustainability Ranking of the Iranian Major Ports by Using MCDM Methods

Author: Ali maid

Abstract:

The shipping industry is moving towards a continuous supply chain (SSC) in order to improve delivery quality and generate more profits. (doi.org) The sustainability of Iran's maritime transport (MSC) system is one of the least studied topics. The port plays an important role in improving Iran's position in international transportation, strengthening economic, social and environmental relations with residents of the east and northeast, increasing GDP and supporting the role of the free zone in the country. development. Port development is an important part of the country's strategic plan for the development and promotion of the east. It has special importance with government policies based on eradicating poverty and improving people's living conditions. This article discusses five important Iranian ports that are part of Special Economic Zones and examines the sustainability of these ports. In this study, several different decision-making methods were used to solve the sustainability problem of major ports in Iran. Firstly, with the SWARA method, sub criteria such as fuel handling, terminal length and population receive the highest scores in the economic, environmental and social quality of sustainable development, showing that these have the greatest impact on sustainable development. Review. Finally, MARCOS and CoCoSo technologies are similar in all three dimensions of operation, and both appear to be suitable models for port resilience assessment. Also, the performance of the MARCOS approach in solving port problems and the conceptual analysis and interpretation of different scenarios for port evaluation. According MARCOS results, economic, environmental and social[10] criteria are all valid criteria for the sustainable development of Iran's major ports and are widely used in Astra, Bushir and Imam Khomeini ports. Based on the analysis of the results, some management insights are also shown that can help make better business decisions

2.15 Title: Sustainability Assessment of Master Commercial European Ports through Environmental Promises

Author: Archontoula koshere (University of the Aegean, Mytilene, Greece)

[11]Abstract

[10] https://www.mdpi.com/2227-7390/9/19/2451
[11] **https://doi.org/10.3390/math9192451**

The operation of European ports is an important part of today's world economy. In the wake of the global pandemic, ports must ensure that they are ready to rebuild business and relationships for the international market as they manage their business and continue to work for the environment. Environmental health safety issues, wind and solar energy and waste management are some of the measures available. Major European ports will be compared according to their environmental responsibility and performance. At the same time, climate change requires ports and operations to adapt. What role do robots play in transportation today? How do automated processes affect overall resilience? Digitalization and innovation are fundamental elements of the transportation sector. Each port is subject to certain regulations, and local regulatory standards not yet specified must comply with existing government regulations. Does this mean that the power of the state has an important role in maintaining and improving the environmental management system as a major port[12]

[12] https://ideas.repec.org/h/spr/prbchp/978-3-031-26829-8_1.html

Chapter :3

Sustainability practices in Indian ports

3.1 Evolution of the port sector:

The backbone of the expanding global economy and international trading system is maritime transit. Nonetheless, greenhouse gases and some other pollutants from ships and other marine commerce activities have had substantial environmental consequences, particularly in coastal areas. Local pollution and climate change exacerbated by GHG emissions from the port region are now attracting increasing attention as the functions performed by ports have expanded dramatically from only the handling of vessels and cargo to the pursuit of a broad variety of interests. Yet, both in maritime trade or within the port, balancing economic operations and environmental concerns remains tough. The United Nations established sustainable development in 1992, but the concept of "green ports" has only recently gained traction as it is understood that seaports must reduce emissions from current and future operations in the port region as well as the broader logistical area. At the same moment, ports must maintain an emphasis on port growth while also focusing on reducing emissions and more environmentally friendly methods. As a result, a green port strategy would achieve both environmental and economic goals, resulting in long-term development. As a result, the port's duty is to combine port strategy, corporate social responsibility and the requirement to comply with federal, state, and municipal environmental regulations. Some of Europe's and America's major hub ports have already implemented its own green port programmes. However, because each port has different operational conditions, pollutant targets, terminal type, and configuration, there is no "one size fits all" strategy for all ports, and every measure must be evaluated on an individual basis. Furthermore, there are few examples in the academic literature that focus on developing countries, where economic expansion and environmental conservation are increasingly at odds.

3.2 Environmental Impacts of Ports

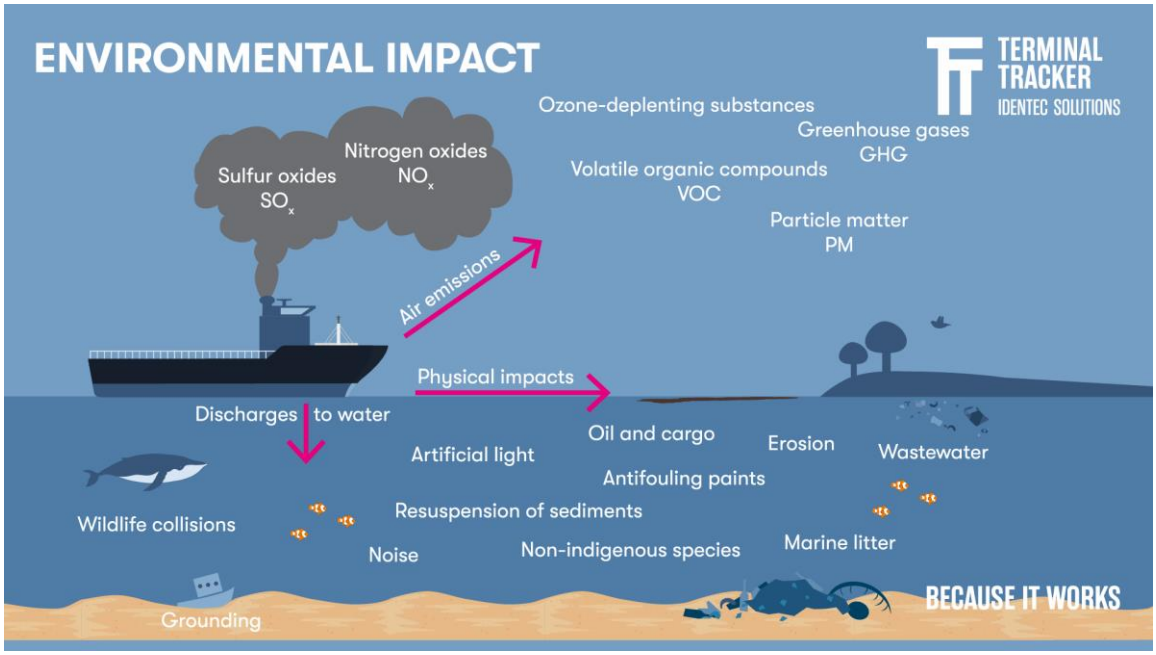


Figure:3.1

[13]

Air Pollution:

Most ships, cars and machinery still use fossil fuels. They produce greenhouse gases such as carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NOx) and sulfur oxides (SOx), as well as organic compounds (VOC) and particulate matter (PM). Another source of air pollution is electricity generation in ports, although it does not occur directly in ports important factor here is transportation to and from land ports. Most travel is still done in trucks, which are too slow to convert to electric vehicles. disease, lung cancer and premature death

Water Pollution:

Many ships also dispose of sewage and bilge water by pouring it into the sea. Bilge water is p roduced by large machines and collected on the ship. It is a contaminant of water, oil, grease and detergent. These additives slowly filter out and eventually mix directly into the sea. Appr oximately 20% of marine litter comes from commercial shipping. Unfortunately, a lot of

[13] https://www.oecd.org/fr/croissanceverte/transports-verts/environmental-impacts-of-ports.htm

waste and broken equipment still gets thrown overboard. Around 20% of marine litter comes from the shipping industry.

Noise Pollution:

Port Soundscape: The engines of large machines run day and night. This is not a concert you would go to on holiday. (lawnmowers) is painful when the sound is above 120 decibels (jack drill). The European Environment Agency estimate that noise causes 72,000 hospitalizations and 16,600 premature deaths each year in Europe alone. It also, of course, harms wildlife and prevents reproduction and nutrition.

Light Pollution:

The effects of people "turning night into day" have been well researched. Disruption of the natural circadian rhythm can lead to secondary diseases such as fatigue, sleep disorders, and eye diseases.

The effect on plant and animal species is also beneficial: birds will decrease and new turtles will enter the lighted areas without entering the limited sea. In addition, corals do not reproduce well, shiny plants pollinate less and produce less fruit. To understand this situation, let's look at another problem, this time climate change for ports

3.3 Environmental initiative taken Indian ports:

1.The Chennai Port Trust

Renewable Energy:

- Installing a 500-kW solar power plant and a 14.5 MW wind farm to meet a portion of their energy needs.
- Exploring further wind turbine installations through public-private partnerships to increase reliance on renewables**.**

- **Green Infrastructure:**
  - Developing a 31-acre green belt within the port premises to improve air quality and reduce the carbon footprint.

- Implementing environment impact assessments (EIA) for new projects to minimize ecological disruption.

- **Waste Management:**
  - Implementing proper waste segregation, collection, and disposal systems.
  - Treating sewage through dedicated treatment plants.
- **Oil Spill Preparedness:**
  - Establishing oil spill response facilities to minimize potential environmental damage from accidental spills.
- **Sustainable Cargo Handling:**
  - Promoting coastal and inland shipping to reduce the environmental [14]impact of long-distance cargo transportation.[i]

2. Jawaharlal Nehru Port Authority (JNPA):

Possible JNPA Initiatives:

- **Green Port Initiatives:** JNPA has already conducted workshops on "Green Port Initiatives," indicating a commitment to environmental responsibility This likely involves exploring areas like clean energy use, emissions reduction, and waste management.
- **Vadhavan Port Project:** The upcoming Vadhavan Port project emphasizes "embodying sustainability in every aspect". This suggests JNPA is incorporating sustainable practices into new infrastructure development.
- **Focus on Clean Energy:** The Vadhavan Port being planned as a "green fuel hub" suggests JNPA might be exploring shore power or on-site renewable energy generation for vessels.

[14] https://www.chennaiport.gov.in/

General Sustainable Port Development Initiatives:

Here are some broader trends JNPA might be considering:

- **Energy Efficiency:** Upgrading port equipment to be more energy-efficient and exploring renewable energy sources like solar power for port operations.
- **Emission Reduction:** Implementing stricter emission regulations for ships calling at the port, potentially offering incentives for cleaner technologies.
- **Waste Management:** Developing sustainable waste management systems to minimize pollution and promote recycling within the port.
- **Community Engagement:** Collaborating with local communities to address environmental concerns and ensure port development benefits the [15]surrounding area

3.Paradip Port:

The Paradip Port Trust has taken several decisions to improve its environmental sustainability

- **Air Quality:** They are concerned about air pollution caused by dust from coal and iron ore. To address this, they use mobile mist cannons for dust suppression, mechanical road sweepers, and a net barrier around the port area. They also have wheel washing systems to prevent material from being carried outside the port.
- **Energy Conservation and Climate Change:** The website doesn't specify their initiatives in this area, but it is likely they are looking at ways to reduce their energy consumption and greenhouse gas emissions.
- **Waste Management:** They likely have plans for managing waste generated by port operations.
- **Noise Management:** The website doesn't mention specific decisions but they likely have protocols to reduce noise pollution.

[15] **https://www.jnport.gov.in/energy_and_environment.**

- **Water Management:** They are committed to both reducing water consumption and maintaining water quality.[16]

4.Visakhapatnam Port:

The Visakhapatnam Port Authority (VPA) has undertaken several initiatives to become more environmentally sustainable. Here are some key examples:

- **Renewable Energy:** The VPA is committed to generating more renewable energy than it consumes. They already have solar power operational and are planning to expand capacity by another 15 MW.
- **Clean Vehicles:** They've replaced traditional diesel and petrol vehicles with Compressed Natural Gas (CNG) alternatives for port operations, reducing emissions.
- **Shore to Ship Power:** This project aims to supply electricity to docked ships from the shore, eliminating their need to run polluting generators.
- **Green Tugs:** VPA plans to replace traditional bunker oil-powered tugboats with electric ones, significantly reducing emissions within the port.
- **Dust Suppression:** Measures are in place to control dust generation, including water sprinklers, fog cannons, and covered storage sheds for bulk cargo.
- **Wastewater Treatment:** The VPA operates a sewage treatment plant and has plans for another, ensuring proper wastewater management.
- **Environmental Monitoring:** They actively monitor air and water quality around the port to track the impact of their operations.`

[17]

[16] **https://paradipport.gov.in/environment.aspx**
[17] https://vizagport.com/

5.V.O. Chidambaranar Port (formerly Tuticorin Port):

However, Indian ports are implementing various environmental measures to reduce their impact. These might include:

- **Waste management:** Treatment and disposal of sewage generated on ships and at the port, solid waste management plans including recycling initiatives.
- **Water conservation:** Measures to reduce freshwater usage in port operations, rainwater harvesting.
- **Air pollution control:** Use of low-sulphur fuels by ships, shore power connection for docked ships to reduce emissions, dust suppression measures at stockyards.
- **Renewable energy:** Solar power plants within the port limits.

6.The Cochin Port Trust:

The Cochin Port Authority is working on several initiatives to improve environmental sustainability, in line with the Maritime India Vision 2030. Here are some key areas they're focusing on:

- **Renewable Energy:** They aim to convert their operations to 100% solar power by 2030. This includes using solar-powered cranes and installing shore-based power supply for docked ships, reducing reliance on fossil fuels.
- **Waste Management:** The Cochin Port has a bio-gas plant that processes food waste and other biodegradable waste into usable biogas. They also have systems for treating wastewater.
- **Energy Efficiency:** They've implemented smart meters and lighting to reduce overall electricity consumption.

[18]

[18] https://www.cochinport.gov.in/cpt

7. Mormugao Port Authority (MPA):

Recent Commitment to Sustainability:

- In April 2023, the new chairman of the MPA, Dr. N. Vinod Kumar, emphasized the importance of sustainable development alongside port growth. He aims to minimize the environmental impact while maintaining the port's economic function

Challenges and Concerns:

- Proposed expansion plans for the port have faced criticism for lacking a comprehensive environmental impact assessment and neglecting sustainability considerations. This highlights the need for concrete actions to follow through on the recent commitment.

8.The Kolkata Port Trust (KoPT):

Pollution Reduction:

- **Emissions Control:** Kolkata Port trust has implemented measures to control air and water pollution from port operations. This includes using cleaner fuels for cargo handling equipment, installing emission control systems on chimneys, and treating wastewater before discharge.
- **Waste Management:** The port follows a comprehensive waste management plan, including segregation, recycling, and safe disposal of various waste streams generated during operations.

Environmental Monitoring:

- **Regular Monitoring:** Kolkata port trust conducts regular monitoring of air, water, and noise pollution levels around the port area. This data helps them track the impact of their operations and identify areas for improvement.
- **Reporting:** Kolkata port trust publishes environmental monitoring reports and compliance reports, demonstrating transparency and accountability in their environmental performance.

Sustainable Infrastructure Development:

- **Environmental Impact Assessments (EIAs):** KoPT conducts EIAs for new development projects to assess potential environmental impacts and implement mitigation measures.
- **Green Infrastructure:** The port is exploring the use of green infrastructure solutions, such as renewable energy sources, to reduce its carbon footprint.

Collaboration and Awareness:

- **Engagement with Stakeholders:** Kolkata port Trust collaborates with various stakeholders, including government agencies, environmental NGOs, and local communities, to address environmental concerns.
- **Community Awareness Programs:** The port conducts awareness programs to educate the local community about the importance of environmental protection and encourage their participation in sustainable practices.

9.Mumbai Port Trust:(MBPT)

The Mumbai Port Trust (MBPT) acknowledges the need for environmental sustainability and has outlined a "Green Port Program" to address concerns. However, reports indicate areas for improvement:

Initiatives:

- **Green Port Program:** This program focuses on six key areas:
    - Water: Preserving water resources and promoting rainwater harvesting.
    - Energy: Encouraging the use of renewable energy sources and improving energy efficiency.

- Air: Reducing air pollution through measures like cleaner fuel options for ships and port equipment.[19]
- Waste Management: Implementing proper waste disposal systems and promoting recycling.
- Sustainable Development: Protecting marine biodiversity and collaborating with local communities.
- Sustainable Business Practices: Adopting eco-friendly practices throughout port operations.

Areas for Improvement:

- **Documented Plan:** An audit report by the Comptroller and Auditor General of India (CAG) noted the absence of a documented Environmental Management Plan (EMP) for the Mumbai Port [3].
- **Environmental Audits:** Regular environmental management audits are crucial for monitoring progress and identifying areas requiring further action.
- **Manpower and Equipment:** Equipping the Pollution Control Cell with adequate resources and qualified personnel is essential for effective environmental monitoring and enforcement.

Overall, while the Green Port Program presents a framework for environmental sustainability, addressing the shortcomings identified in the CAG report is crucial for ensuring its successful implementation.

- **Community Involvement:** Engaging with local communities can foster a sense of shared responsibility for environmental protection.

https://mptgoa.gov.in/.

- **Stringent Regulations:** Implementing stricter regulations on waste discharge, ballast water management, and air emissions is necessary to minimize environmental impact.
- **Collaboration:** Cooperation between port authorities, shipping companies, and regulatory bodies is vital for achieving long-term sustainability goals.

10.mangalore port authority:

The Mangalore Port Authority, also known as the New Mangalore Port Trust (NMPT), has undertaken several initiatives towards environmental sustainability. Here's a glimpse into their efforts:

Existing Programs:

- **Green Port Initiatives:** NMPT is actively pursuing the goals set under the **MARITIME INDIA VISION-2030**. This includes:
    - **Greenery and Afforestatio[20]n:**
        - Dedicating 33% of their land area for developing a green belt.
        - Planting over 1 lakh saplings in the past 5 years.
- **Clean Energy Adoption:**
    - **Solar Power:** The port is self-sufficient in generating electricity through a solar power plant.
    - **Reduced reliance on fossil fuels:** 86% of cargo handling is mechanized and uses electric power.

[20] https://mumbaiport.gov.in/

- **Waste Management:**
    - **Sewage treatment plant:** Effectively manages wastewater within the port.
    - **Vermicomposting unit:** Converts organic waste into usable compost.
    - **Monetizing waste:** Following hazardous waste management rules, they even earn revenue by collecting and disposing of such waste.
- **Water Conservation:**
    - **Rainwater harvesting**: Collects rainwater for various purposes within the port.

Additional Information:

- NMPT is ISO 14001 certified, indicating their commitment to environmental management standards.
- They actively participate in events like World Environment Day, highlighting their focus on environmental protection.

While these initiatives showcase a proactive approach, there's always room for improvement. Here are some potential areas for further exploration:

- **Investing in shore power facilities:** This would allow docked ships to switch off their engines and use cleaner electricity from the port, reducing air pollution.
- **Promoting the use of electric or hybrid equipment:** This would further minimize emissions from port operations.
- **Collaboration with local communities:** Engaging with local communities can raise awareness about environmental issues and foster a sense of shared responsibility for the surrounding ecosystem

[21]11.Deenadayal port limited:

- **Renewable Energy:** They encourage the use of solar water heaters to meet hot water demands in commercial, institutional and residential buildings surrounding the port .
- **Energy Conservation:** They promote using energy-efficient lighting solutions like CFLs and LEDs throughout the port area. They also emphasize proper disposal and recycling of used bulbs to minimize mercury contamination.
- **Environmental Management Plan (EMP):** The port authority requires the preparation and implementation of an EMP to ensure compliance with environmental regulations This plan likely outlines measures to address various environmental concerns like waste management, pollution control, and habitat preservation.
- **Environment Monitoring Cell:** The establishment of a dedicated cell for environmental monitoring suggests their commitment to tracking the environmental impact of port operations and taking corrective actions if needed

12.kamarajar port limited:

while specific details about future plans might not be publicly available, based on Kamarajar Port Limited's (KPL) existing initiatives and the broader environmental goals, here are potential areas for strengthening their environmental sustainability efforts:

1. Renewable Energy Integration:

- **Solar Power Plants:** KPL could explore installing solar panels on available rooftops or vacant land to generate clean electricity for port operations, reducing dependence on fossil fuels.

[21] https://newmangaloreport.gov.in/
https://www.deendayalport.gov.in/en/

2. Green Cargo Handling:

- **Shore Power Facilities:** Providing shore power connection to ships at berth minimizes air pollution from onboard generators.
- **Emission Control Technologies:** Investing in cleaner cargo handling equipment with lower emissions can significantly improve air quality.

3. Sustainable Waste Management:

- **Improved Segregation and Recycling:** KPL can implement stricter waste segregation practices at the port and partner with authorized agencies for responsible recycling and waste disposal.
- **Organic Waste Composting:** Exploring possibilities for composting organic waste generated within the port premises can reduce landfill burden and create nutrient-rich compost for landscaping.

4. Water Resource Management: [22]

- **Rainwater Harvesting:** Capturing rainwater through strategically placed tanks can provide a sustainable source of water for cleaning, irrigation, and other non-potable purposes.
- **Wastewater Treatment Plants:** Investing in advanced wastewater treatment facilities can ensure proper effluent discharge and minimize water pollution.

5. Mangrove Restoration and Marine Conservation:

- **Collaboration with Local NGOs:** Partnering with environmental organizations for mangrove restoration projects can help protect coastlines, prevent erosion, and enhance marine biodiversity.

[22] https://www.ennoreport.gov.in/.

- **Habitat Creation for Marine Life:** Implementing measures to create habitats within the port area for fish and other marine organisms can promote a healthy ecosystem.
- **Energy Efficiency:** KPL can continuously strive to improve energy efficiency through measures like upgrading lighting systems to LEDs and optimizing equipment operations.
- **Sustainable Procurement:** Adopting policies that prioritize environmentally friendly materials and equipment for port operations can contribute significantly.

[23] 3.4 Profile of Kamarajar Port Limited:

3.4An Overview on Kamarajar port limited

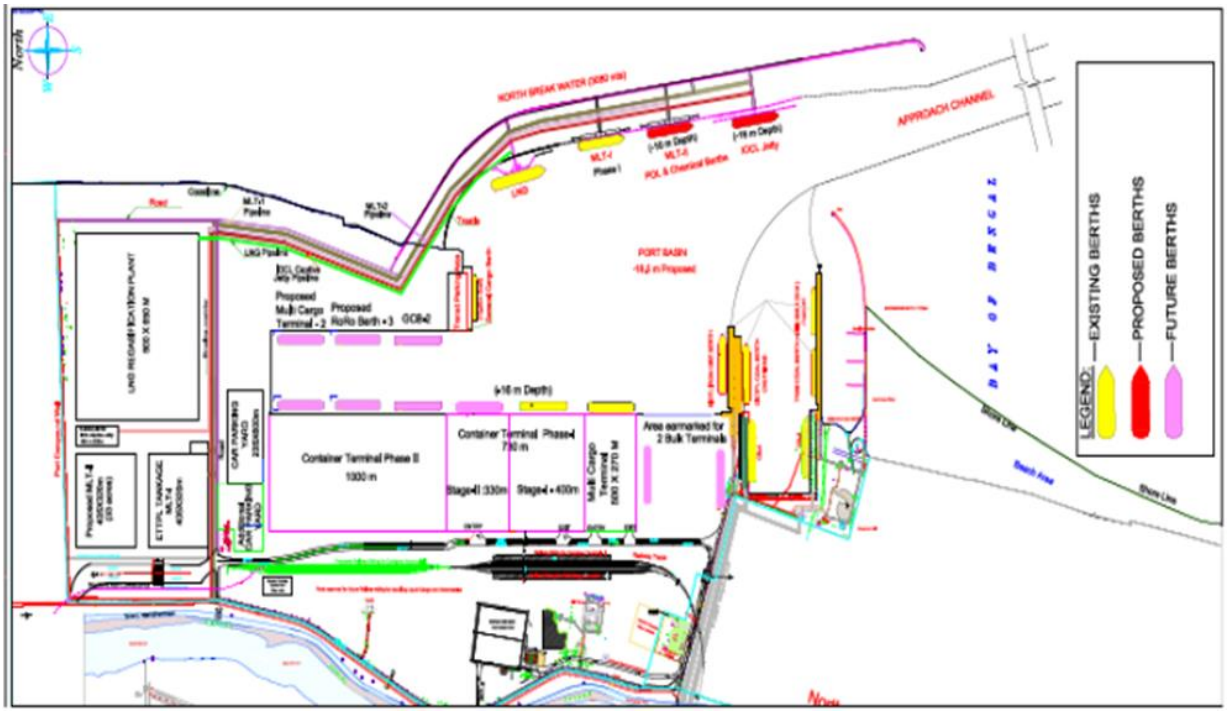
Kamarajar Port Limited, formerly known as Ennore Port Limited, was incorporated as a major port under the Indian Ports Act, 1908 in March 1999 and incorporated under the Indian Ports Act, 1956 in October 1999. It is registered as Ennore Port under the Companies Act. Otherwise. 11 of the 12 ports owned by the Government of India are under the jurisdiction of the Major Ports Authority, which is the rate regulator. Ennore Port is located on the coastal plain known as the Eastern Coastal Plain, 24 km north of Chennai, northeast of Chennai in the state of Tamil Nadu. Due to its coastal location and location in the thermal equatorial zone, the port has little seasonal variation; In summer, the maximum temperature is 38-42°C and the minimum temperature is 18-20°C. The climate in most ports is hot and humid. The region has hot and dry weather throughout the year. The northern monsoon brings seasonal rains and occasional storms to the region from September to December. The region receives approximately 1,400 mm (55 inches) of precipitation annually. South-western winds prevail from April to October, and eastern winds dominate the rest of the year. The port is vulnerable to earthquake III. It is located in the earthquake zone. Located on the east coast of the Indian subcontinent, on the Coromandel Coast in the Bay of Bengal, 2.6 kilometres north of the Ennore River, this port is

[23] https://www.ennoreport.gov.in/.

a satellite port of the Chennai port and handles thermal coal for TANGEDCO and NCTPS. Since is located in the Chennai metropolis, there is traffic congestion and environmental problems. However, following the installation of cargo container in 2001 and 2009 and the transportation of electrical and iron products to Kamarajar port in 2012, the Supreme Court ruled on the pollution of the port and its impact on people living near the port. has become a container. KPL loading and unloading port mainly consists of coal and other cargoes. The port, which was put into service in 2001, operates as a charter port, outsources all services required for operation and maintenance, and builds new terminals in cooperation with the private sector. Since its inception, it has attracted investments worth Rs 26,000 billion from the private sector.

Kamarajar Port is the only major commercial port and is registered as a company. Today, there is less main port structure in large and medium-sized ports. Port cargo is generally divided into five categories: dry cargo, liquid cargo, food, containers and ro-ro vehicles. KPL's largest cargo consists of thermal coal, followed by coke, POL, containers, vehicles, LNG and bulk products.

3.5 Master plan of Kamarajar port limited:(figure 3.2)



3.6 MANAGEMENT AND ORGANITATION STRUCTRUE:

GM (Marine Services)

- Marine Services
- ISPS Compliance

- Pilotage & Navigation
- Survey & Dredging
- Environmental Management & Pollution Control
- Port Reception Facility
- Dock Safety

GM (Operations)

- Port Planning & Development
- Operations & Maintenance
- Project Management
- Traffic
- Technical Services

GM (Finance)

- Corporate Finance
- Budget & Costing
- MIS Reports
- Corporate Accounts & Audit
- Taxation
- Treasury Management
- Internal Control & Internal Audit

GM (CS&BD)

- Port Planning & Development
- Operations & Maintenance, etc.

Company Secretary

- Secretarial Compliance
- Board Meeting, Committee Meeting & Shareholders Meeting
- Legal Matters
- RTI

3.7 VISION

To develop Kamarajar port as a mega port with world class facilities to become the Eastern Gateway Port of India.

3.8 MISSION

To provide port services of International Standards

3.9 Ennore Kamarajar port limited current initiative plan to reduce the environmental pollution:

Environment Management Plan

Sea ports are very complex systems with a wide range of environmental issues: releases to water, air and soil, waste production, noise, and dredging amongst others. Kamarajar Port continuously strives for the protection of environment.

Environmental Monitoring

Kamarajar Port is monitoring ambient air and marine water quality. BOT operators are also monitoring the environment the quality reports are submitted to statutory authorities

Solid Waste Management

Port is having a Solid Waste Management with an overall approach of creating sustainable systems and environmentally effective and friendly.

The solid wastes generated from the ships and port are collected, segregated and disposed to authorized agents for further beneficial use.

Environmental Management System ISO 14001 - 2004

Kamarajar Port received ISO 14001:2004 Environmental Management System Certificate for its administrative building, terminal and general cargo facilities. The scope of the certificate is "provision of basic services in import and export ports".

Chapter-4

Collision at Kamarajar Port Leading to Oil Spill

A case study of an incident causing environmental hazard

4. Ennore oil spilling 2017 on ennore coastal water and biota:

4.1 Introduction:

On 28 January 2017, at 03:45 Indian Standard Time (IST), liquefied petroleum gas (LPG) tanker BW Maple and incoming chemical tanker MT Dawn Kanchipuram collided for about two nautical miles near Ennoor Kamaraja Port. According to the local port, MT Dawn's hull burst, damaging the hull and (fastercapital.com) water pipes on deck. According to information received from the Indian Eastern Coast Guard, 196.4 tons of heavy fuel oil (HFO) was formed in the accident. The HFO leakage zone is shown in Figure 4.1. We now produce estimates of HFO drift using oil spill trajectory models from the National Oceanic and Atmospheric Administration (NOAA) Operational Simulation Environment (GNOME). This article compares and presents simulated and observed drifts of HFO Incident:

Date: January 28, 2017

Location: Kamarajar Port, Ennore, near Chennai, Tamil Nadu, India

Cause: Collision between two ships:

BW Maple: Outbound empty tanker

Dawn Kanchipuram: Inbound loaded oil tanker

Spill:

Type of oil: Heavy Furnace Oil (**HFO**)

Estimated volume: 196.4 metric tonnes (around 216,000 gallons)

[24]

Figure 4.1

4.2 Diagram of Ennore oil spilling at 2017:

(13.2282◦North , 80.3633◦East)

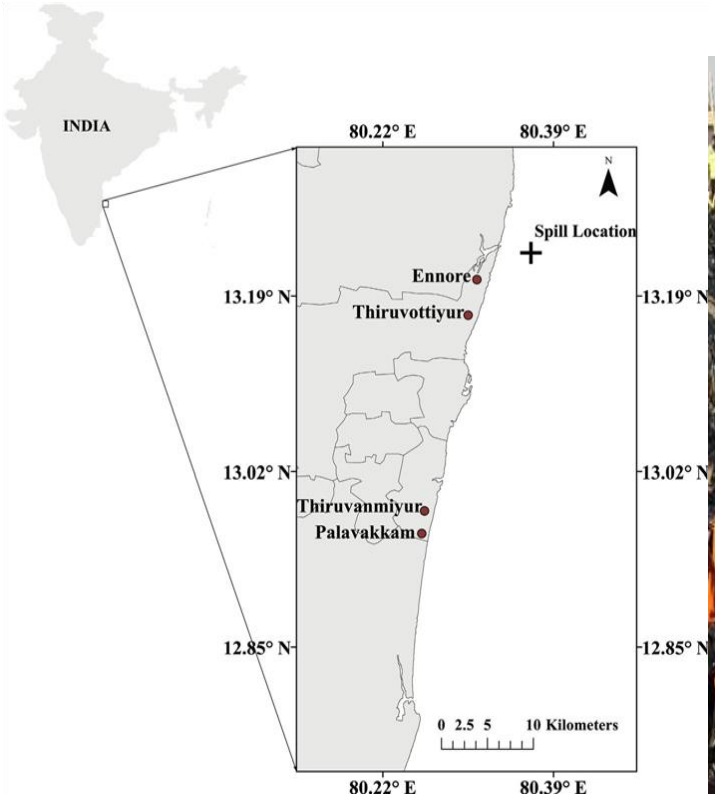


Figure 4.1.1

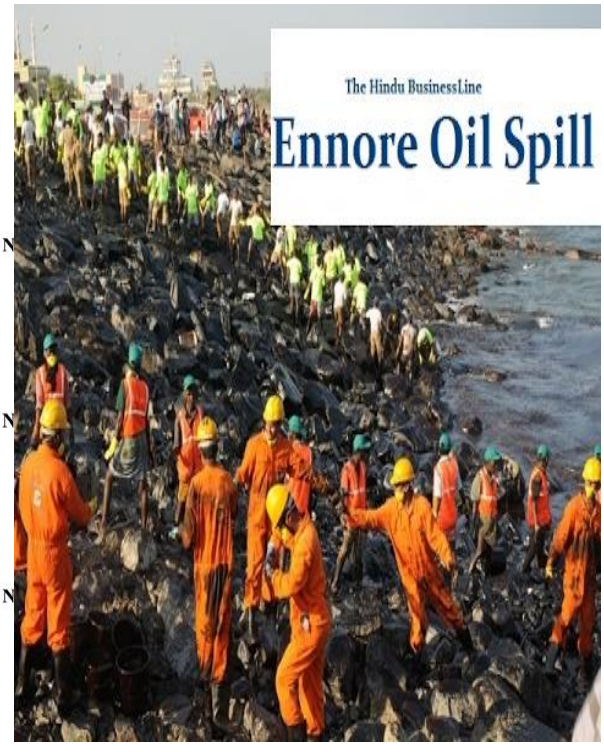


Figure 4.1.2

[24] https://www.ennoreport.gov.in/.

4.1.3 Request to Indian Coast Guard:

The Indian Coast Guard (ICG), under the Ministry of Defence, is responsible for cleaning up and mitigating damage caused by oil spills off the coast of India. Indian Coast Guard Chennai has specifically requested INCOIS (www.scribd.com) to obtain advisory opinion on moisture of HFO released so far and to run predictive models as requested from ICG. Approximately 20 metric tons of heavy oil have been contained and instructions were issued immediately after it was announced that cleanup operations would begin after January 28, 2017. Changes in HFO range due to cleanup operations were not taken into account when simulating drift. After a detailed analysis, ICG announced that the actual amount of HFO leaked was 196.4 metric tons. Then, for measurement purposes, the model was repeated using the actual amount (196.4 tons) between 4 am on January 28, 2017 and 23:00 on February 5, 2017, to estimate the drift of heavy oil

4.1.4 The simulations of trajectory prediction model:

Simulations of the GNOME orbital model were performed using 196.4 MT of HFO. The orbital model is forced daily until 23:00 on February 1, 2017 by analysing the energy of GM4p1 (www.scribd.com). The HFO leak occurred from 04:00 on January 28, 2017 to 2,300 on February 1, 2017. Impact on January 28, 2017 (Figure 2a). At 23:00 on 29 January 2017, the affected area continued southwards, extending up to ± 18 kilometres along the coast (Figure 4.4). Over the next two days, HFO spread southwards and reached near Thiruvanmiyur and Palavakkam (Figure 4.5). The orbital model was run from 0000 hours on 2 February 2017 to 2300 hours on 5 February 2017, using the current estimate of GM4p1 diagnosed by our centre at 0000 hours on 2 February 2017. br> It is shown in Figure 4.6. The estimated state of the HFO was leaked from 0:00 on February 2, 2017 to 23:00 on February 5, 2017 (left as red dots long, black marks). Heavy oil was detected at Palavakkam during the southward extension between 23:00 on 2 February 2017 and 23:00 on 5 February 2017. HFO residue has been reported from various coastal areas including Ennore, Thiruvottiyur, Thiruvanmiyur and Palavakkam. It is in the area where the oil spill should move. We are also currently measuring the planned and predicted HFO velocity using independent satellites. These are the prediction area of the oil spill move to spreading:

These are the prediction area of the oil spill move to spreading:

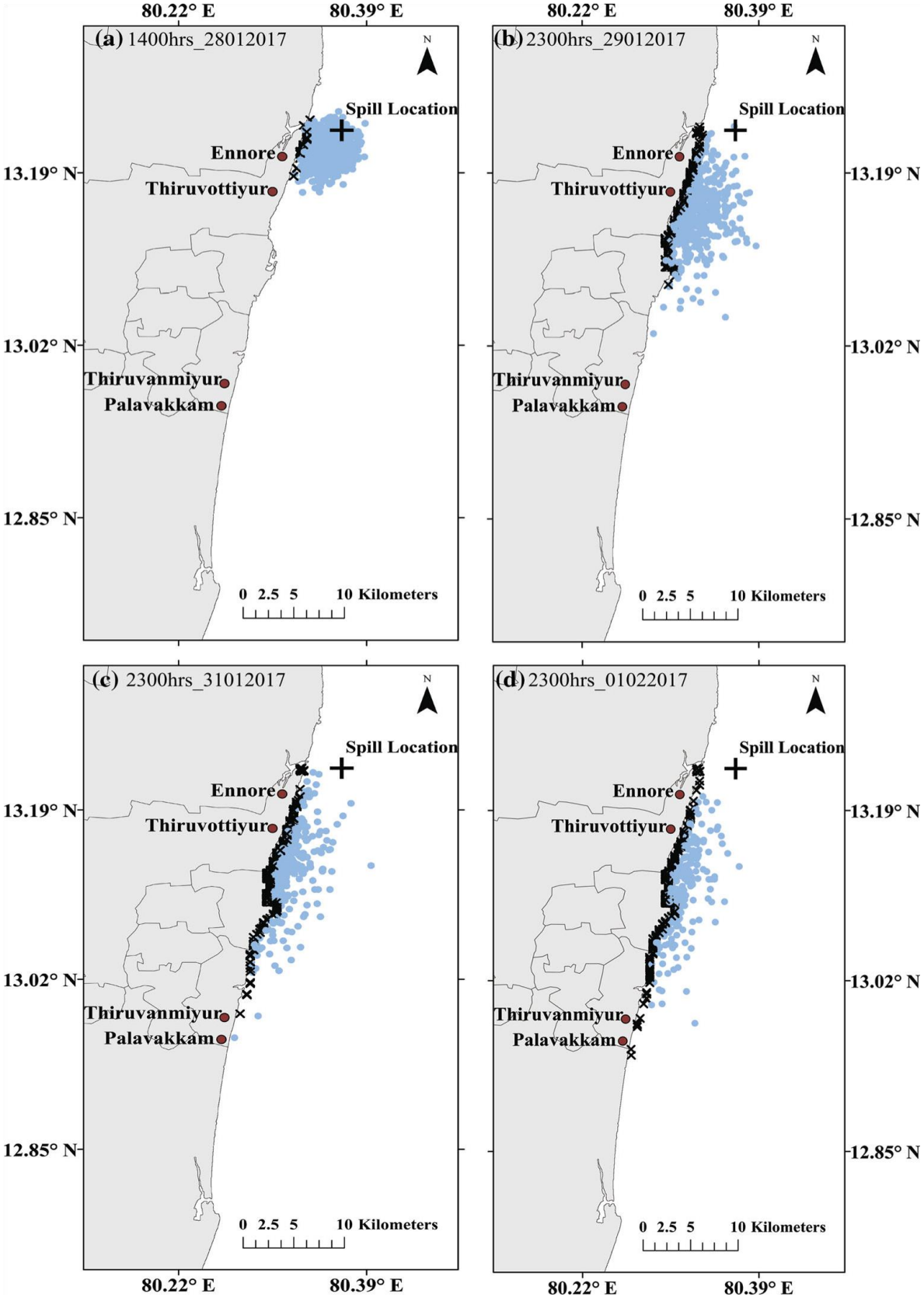
The black × (blue dot) denotes the beached (floating) status of drifted HFO in all the panels

(**a**) spread of HFO on 1400 hrs of 28 January, 2017,

(**b**) spread of HFO on 2300hrs of 29 January, 2017,

(**c**) spread of HFO on 2300hrs of 31 January, 2017,

(**d**) spread of HFO on 2300hrs of 1 February,2017.



[25]

Figure 4.2

[25] https://ieeexplore.ieee.org/document/9775218

Conclusion:

On January 28, 2017, an oil spill occurred near Ennore Port in Chennai due to the collision of two commercial ships. Advisory issued to the Indian Coast Guard between 28 January and 5 February 2017 based on available estimates and projections regarding the competition and spread of HFO up to 20 tonnes. Updated GODAS analysis/forecast ocean currents and ECMWF winds are used to force the model orbit. The simulated orbits are consistent with SAR and ICG field observations. GNOME, when forced to analyze GM4p1 ocean currents, captures the apparent spread of oil spills along the coast and offshore well. Using current (incois.gov.in) GM4p1 estimates, the FOB spread is slightly lower**.**

4.2 Ennore oil spilling 2023 on ennore coastal water and biota:

Introduction*:*

On January 28, 2017, an oil spill occurred near Ennore Port in Chennai due to the collision of two commercial ships. Advisory issued to the Indian Coast Guard between 28 January and 5 February 2017 based on available estimates and projections regarding the competition and spread of HFO up to 20 tonnes. Updated GODAS analysis/forecast ocean currents and ECMWF winds are used to force the model orbit. The simulated orbits are consistent with SAR and ICG field observations. GNOME, when forced to analyze GM4p1 ocean currents, captures the apparent spread of oil spills along the coast and offshore well. Using current (incois.gov.in) GM4p1 estimates, the FOB spread is slightly lower.

I. The Cyclone Michaung Trigger:

The Ennore oil spill of 2023 occurred amid the havoc wreaked by cyclone Michaung. Initial reports suggest that the overflowing of oil-mixed water was a result of inadequate storm water management at CPCL. The TNPCB identified this as a key factor, contributing to the contamination of the Kosasthalaiyar River and the subsequent spread of oil through Ennore Creek.

However, the CPCL, while representing the case in the National Green Tribunal (NGT), pointed fingers at the TNPCB, claiming that the pollution control board released an incomplete report. This contradictory narrative sets the stage for a contentious legal battle over accountability.

II. Responsibility of Chennai Petroleum Corporation Limited (CPCL):

CPCL, a major player in the oil industry, found itself under scrutiny as accusations were levelled against it for inadequate infrastructure and failure to prevent the spill. The company's assertion that there was no pipeline leak from the refinery raises questions about the preparedness and preventive measures in place during extreme weather events. The engagement of fishermen without proper protective gear for oil cleanup further raises concerns about safety and environmental stewardship.

Environmental activists argue that both the TNPCB and CPCL share responsibility for downplaying the severity of the situation. The conflicting statements from regulatory authorities and the oil company contribute to the confusion surrounding the true extent of the damage.

III. Regulatory Oversight and Accountability:

The regulatory framework governing oil spills is designed to hold responsible parties accountable for environmental disasters. In the case of the Ennore oil spill, Section 356J of the Merchant Shipping Act, 1958, empowers the government to issue notices to the owner of a polluting ship. Failure to comply can result in criminal convictions under Section 356K. Additionally, the National Green Tribunal's imposition of a Rs 25 crore penalty on Oil India in 2020 serves as a precedent, highlighting the severity of consequences for environmental negligence.

IV. Environmental Impact and Community Response*:*

The ecological consequences of the Ennore oil spill are significant, with the contamination reaching the Bay of Bengal and rendering shores and water unfit for fishing. Dead turtles washing ashore and the strong smell of oil reported by residents underscore the immediate impact on marine life and coastal communities.

Local fishermen, integral to the clean-up efforts, find themselves at the forefront of the battle against the oil spill. The lack of protective gear and the rudimentary methods employed by fishermen, such as using plastic jugs to scoop up oil, highlight the urgency of the situation and the need for immediate intervention.

Government Response and Accountability*:*

The role of the government in mitigating the impact of the oil spill and holding responsible parties accountable is crucial. The formation of a technical team to investigate the cause of the spill indicates a commitment to understanding the root causes of the incident. The TNPCB's directive to CPCL, outlining specific conditions for remedial measures and potential suspension of operations, demonstrates the government's intent to enforce accountability.

However, questions arise about the adequacy of existing regulations and the effectiveness of enforcement mechanisms. The National Green Tribunal's order in July 2022, instructing the Environment Department to develop a detailed project report for the protection of wetlands in the Ennore Creek, suggests a proactive stance. Still, the recurrence of the oil spill points to gaps in implementation.

VI. Legal Consequences and Compensation*:*

The TNPCB's assertion that CPCL may be liable to pay compensation and face suspension of operations if conditions are not complied with emphasizes the gravity of the situation. The potential economic repercussions for CPCL, including environmental compensation and damage to families adversely affected by the oil spills, underscore the financial consequences of environmental negligence.

The CPCL's obligations to undertake a comprehensive mapping study and implement measures to prevent future leaks demonstrate the legal and regulatory frameworks in place to prevent a recurrence. However, the effectiveness of these measures' hinges on their enforcement and the commitment of all stakeholders to environmental conservation.

Conclusion:

The Ennore oil spill of 2023 brings to light the intricate web of responsibility, accountability, and environmental impact in the aftermath of a catastrophic event. While the cyclone Michaung may have triggered the spill, inadequate infrastructure, conflicting reports, and regulatory shortcomings have amplified the environmental crisis. The CPCL, TNPCB, local authorities, and the government all share a degree of responsibility, and their collective response will determine the extent of environmental recovery and the prevention of future disasters.

As the clean-up efforts continue and legal battles unfold, the Ennore oil spill serves as a stark reminder of the delicate balance between industrial activities and environmental preservation.

It calls for a comprehensive reassessment of regulatory frameworks, industry practices, and community engagement to safeguard coastal ecosystems and the livelihoods of those dependent on

4.3 How oil spill affects the sea eco system:

Direct toxicity: Oil contains hydrocarbons, which are toxic to many marine organisms. Exposure can damage organs, impair immune systems, and even be lethal.

Insulation loss: For animals like sea otters and seabirds, fur and feathers are essential for staying warm in cold water. Oil mats these feathers and fur, destroying their insulating properties and leading to hypothermia.

Ingestion: Many creatures, particularly birds, can ingest oil while trying to preen themselves. This oil can poison them internally.

Habitat damage: Oil can smother vital habitats like coral reefs, mangroves, and seagrass beds. These areas provide food and shelter for a variety of marine life, and their destruction disrupts the entire ecosystem.

Chapter :5

Oil Spill Recovery Technology to be used by ports

5.1 Mechanical Containment of Oil Spills Recovery:

The two main steps involved in controlling oil spills are containment and recovery. This secti on provides an overview of some strategies and tools used to manage oil spills

1. Boom:

When used to process oil, the boom is usually supported by horizontal arms attached directly to one or both sides of the vessel. A boat sails at high speed through the worst part of the spill , collecting the oil and suspending it at an angle between the boom and the hull. In another va riation, the boom is anchored at the end of the boat's long arm, creating a U- or J shaped pocket where oil can collect. However, the oil can be stored in a storage tank and retu rned to shore for proper disposal or recycling

Figure -5.1 (Boom technology)

2. Oil Skimmer:

Oil skimmer is a device used to recover spilled oil from water. Skimmers can beselfcontained and operated from shore or operated from a boat. Skimmer operation depends on the w eather. In rough or choppy waters, skimmers are like loving skimmers. Suction oil skimmers return more water from the oil. There are three typ es of strippers: weir, lipophilic and suction. Each type has advantages and disadvantages depe nding on the type of oil being cleaned, sea condition at the time of the cleanup, and the presen ce of ice or debris in the water

Types of Skimmers:

1. Oleophilic skimmer

2.suction skimmer

Oleophilic skimmer:

An oleophilic skimmer is a device that removes oil from the surface of water. The word "oleophilic" comes from the Greek words "oleon" meaning oil and "philia" meaning love. So, an oleophilic skimmer literally means "oil loving" skimmer.

Oleophilic skimmers are a versatile tool that can be used to clean up oil spills of varying thicknesses on both calm and rough water. They are also effective in environments with debris

[26]disk skimmer

Figure-5.2

Drum skimmer

figure -5.3

[26] https://doi.org/10.1021/es061842m

Suction skimmer:

Concept:

This is a new technology A suction skimmer is a device that removes floating oil, debris, or other contaminants from the surface of a liquid. They are often used in industrial settings to remove oil from coolant tanks, wastewater treatment plants, and other locations where oil spills can occur. Suction skimmers can also be used in ponds, lakes, and other bodies of water to remove leaves, algae, and other debris.

Figure-5.4 (Suction skimmer)

27

[27] https://doi.org/10.1021/es061842m

3.Dual-layer mesh roller coupled with an induction heating technique:

Here's a summary of the dual-layer mesh roller with induction heating for oil spill clean-up

- designed to improve oil spill clean-up efficiency.

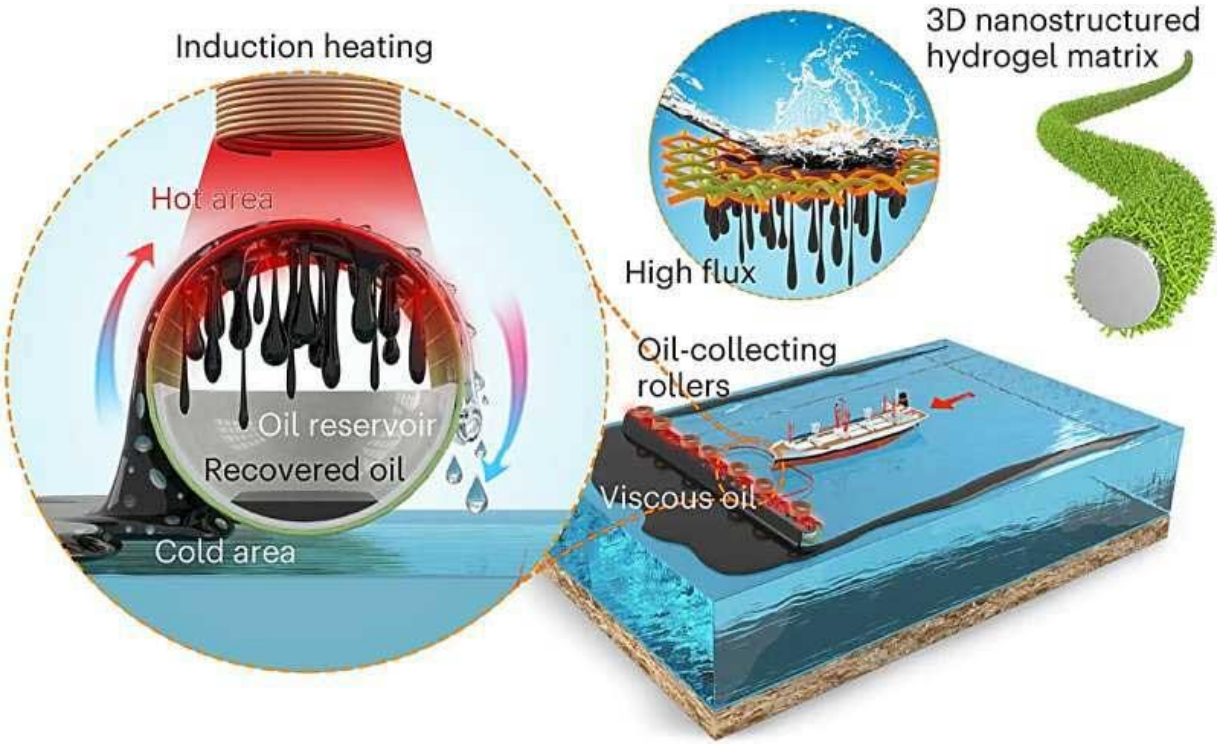
Components:

- **Dual-layer mesh roller:**
    - The mesh has specific material properties that attract oil at the water interface.
    - One layer separates oil from water in cold seawater (bottom layer).
    - The other separates viscous oil-water mixtures (top layer).
- **Induction heating:**
    - Applied to the top layer to enhance the oil-water separation process.

Benefits:

- **Highly efficient:** Experiments suggest it can recover oil 10 times faster than current methods.
- **High separation efficiency:** Potential for over 99% separation, leading to cleaner collected oil for recycling.
- **Scalability:** The rollers can be built in various sizes for different spill scenarios.

Overall, this technology has the potential to revolutionize oil spill clean-up by significantly increasing efficiency and effectiveness.



(Dual-layer mesh roller coupled)

Figure-5.5

28

5.2 Summary of the effect of collision:

1. 2017 Collision:

On January 28, 2017, two merchant ships collided near Ennore Port in Chennai, causing an oi l spill. Advisory issued to the Indian Coast Guard regarding the collision and spill of 20 tonne s of HFO between 28 January and 5 February 2017 based on available estimates and projectio ns. gov.in) (**GNU Network Object Model Environment**) For evaluation purposes, the simul ation was updated with the actual HFO (heavy oil) volume (196.4 MT). Upgraded (incois.gov .in) GODAS analysis/forecast ocean current and ECMWF (European Center for Medium-Range Weather Forecasts) (ECMWF) winds are used to force the model orbit. The simulated

[28] https://doi.org/10.1021/es061842m

trajectories are in good agreement with SAR (**Specific Absorption Rate**) and ICG (Indian C oast Guard) observations. GNOME, when forced to analyze GM4p1 ocean currents, captures the apparent spread of oil spills along the coast and offshore well. FOB spread is slightly low er using current GMestimate

2. 2023 Cyclone Damage: In December 2023, Cyclone Michaung caused flooding that reportedly led to oil leaking from the Chennai Petroleum Corporation Limited (CPCL) refinery. The full extent of the environmental impact from this spill is still being assessed, but it negatively affected the livelihoods of fishermen and caused marine life die-off.The Ennore oil spill of 2023 brings to light the intricate web of responsibility, accountability, and environmental impact in the aftermath of a catastrophic event. While the cyclone Michaung may have triggered the spill, inadequate infrastructure, conflicting reports, and regulatory shortcomings have amplified the environmental crisis. The CPCL, TNPCB, local authorities, and the government all share a degree of responsibility, and their collective response will determine the extent of environmental recovery and the prevention of future disasters.

As the clean-up efforts continue and legal battles unfold, the Ennore oil spill serves as a stark reminder of the delicate balance between industrial activities and environmental preservation. It calls for a comprehensive reassessment of regulatory frameworks, industry practices, and community engagement to safeguard coastal ecosystems and the livelihoods of those dependent on them

Chapter:6

FINDINGS AND CONCLUSION

Key points:

Reducing the impact of oil spills and effectively recovering from them involves a multi-faceted approach

1.Tanker vessel responsibilities:

Prevention: The best way to deal with oil spills is to prevent them from happening in the first place. This involves implementing rigorous safety measures and regulations for oil drilling, transportation, and storage. Regular inspections and maintenance of oil rigs, pipelines, and tankers are essential.

Response Planning: Developing comprehensive oil spill response plans is crucial. These plans should outline the actions to be taken in the event of a spill, including containment, clean-up strategies, and coordination with relevant authorities

Early Detection: Detecting oil spills as soon as possible is vital for minimizing their impact. This can be achieved through the use of **satellite monitoring**, aerial surveillance, and remote sensing technologies.

Containment: Once a spill occurs, containing the oil to prevent it from spreading further is a priority. This can involve deploying booms and barriers to corral the oil and prevent it from reaching sensitive areas such as shorelines and wildlife habitats.

2.Port responsibility:

Clean-up: Various techniques can be employed to clean up oil spills, including skimming, sorbent materials, dispersants, and bioremediation. The most appropriate method depends on factors such as the type of oil, weather conditions, and the affected environment

Environmental Assessment: Assessing the environmental impact of an oil spill is essential for guiding clean-up efforts and determining long-term ecological consequences. This may involve monitoring water quality, assessing habitat damage, and evaluating the health of affected wildlife.

Community Engagement: Engaging with affected communities and stakeholders is crucial throughout the response and recovery process. Providing accurate information, addressing concerns, and involving local residents in decision-making can help build trust and facilitate a more effective response

3.Government responsibility:

Research and Development: Continued research and development are essential for improving oil spill response technologies and techniques. This includes developing more efficient clean-up methods, better understanding the behaviour of oil in different environments, and exploring innovative approaches to mitigate the impacts of spills.

Legal and Regulatory Frameworks: Strong legal and regulatory frameworks are needed to hold responsible parties accountable for oil spills and ensure that adequate measures are in place to prevent and respond to future incidents. This may include liability provisions, permitting requirements, and enforcement mechanisms.

https://doi.org/10.7769/gesec.v14i8.2558

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