Ecological Shipping to Promote Energy Efficiency and Balance the Marine Environment

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ABSTRACT:

Sustainable shipping is vital for reducing the environmental impact of global maritime transport while enhancing energy efficiency. As the shipping industry is a significant contributor to greenhouse gas emissions, marine pollution, and biodiversity loss, adopting sustainable practices is essential for safeguarding the marine environment. These practices not only focus on minimizing harmful emissions and waste but also prioritize the use of energy-efficient technologies and alternative fuels. By integrating innovation, stricter regulations, and eco-friendly shipping methods, the industry can help preserve marine ecosystems, reduce carbon footprints, and contribute to a greener future for global trade.

Keywords: Sustainable, Environment, Marine, Technologies, Greenhouse gas emission.

Introduction

In an effort to lower CO2 emissions, the IMO approved changes to MARPOL Annex VI in 2011 that included the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP). The 2023 IMO Strategy on decrease of GHG Emissions from Ships aims to achieve net zero GHG emissions soon and a minimum 40% decrease in the carbon intensity of international shipping by 2030. According to an OECD report, a total decarbonisation of the sector would be possible by 2035 if the Technological measures, Operational measures and Renewable energy measures are combined. The different stakeholders in each domain must work together in a multidisciplinary manner to accomplish this. The significance of sustainable shipping in addressing the climate change challenge has been emphasised once more in the advisory opinion of the International Tribunal for the Law of the Sea about the request made by the Commission of Small Island States on Climate Change and International Law. This essay examines the legislative advances in this field as well as the technology developments that have been implemented to support sustainable shipping. The Sustainable Development Goals are the subject of this essay, with particular attention paid to Goals 7- affordable and clean energy SGD 13 - climate action and SDG 14 - life offshore.

Concept of sustainable shipping

Sustainable shipping

Sustainable shipping is the concept of sustainable development applied to the shipping sector, incorporating environmental and social responsibility. It refers to the practice of minimizing the environmental impact of shipping while maintaining economic viability by reducing greenhouse gas emissions, using renewable energy sources, and improving efficiency in every aspect of ship operations. To achieve the transition of sustainable shipping,

cooperation is needed between the different stakeholders, either private or public, within the maritime logistics chain operation in terms of technical and environmental aspects.

Sustainable shipping methods

Alternative fuel adoption, Ship technology innovation, Role of digital technology, environmental and ship recycling practices are the major practices adopted by the stakeholders in response to IMO initiatives.

World Shipping Council prescribes six pathways such as Global Carbon price, New Building standards, Fuel life cycle, fuel supply development green corridors and R& D Development to achieve zero carbon shipping. The council aims to deliver net zero by 2050 with Green Balance mechanisms.

Fuels

One of the main causes of the enormous carbon footprints is marine or bunker fuels. Heavy fuel oils, marine diesel oil and intermediate fuel oils are the categories into which bunker fuels fall. The newest kind of fuel oil designed to reduce carbon emissions is low-sulphur fuel oil. The release of sulphur from bunker fuels is one of their main effects. The fuel's sulphur emissions have detrimental effects, such as raising the salinity and acidifying the water. 90,000 ships release about 20 million tonnes of sulphur oxides from 370 million tonnes of bunker fuel, which is 260 times more sulphur than the whole global automobile fleet.

In certain cases, a single large ship can produce 5,200 tonnes of sulphur oxide annually. By employing sustainable fuels like biofuels, blue fuels, and green fuels, bunker fuel pollution can be reduced. Biofuels are made from natural materials like wood, agricultural waste, or non-edible crops. Fuels made from fossil fuels that have carbon sequestered and stored during the production process are known as "blue fuels." Green fuels are created from hydrogen that has been electrolysed utilising renewable energy sources. Low-sulfur fuel oil, compressed hydrogen, methanol, ammonia, liquid nitrogen, and liquefied natural gas are a few examples of sustainable fuels. Ships' carbon footprint will be reduced by using renewable fuels.

Green Ship technologies

The concept of green shipping aims to design and operate a vessel that complies with the limitations of emission levels, thus leaving the lower amount of carbon footprint. These technologies can be categories in two strategies. First strategy aims to reduce the fuel consumption by minimising the power transmitted to the ship hull which results in reducing the ship resistance. The second strategy aims to reducing the emission by operating the ship with alternative fuels such as co2, no2 which produce less carbon footprint in comparison with the traditional fuels.

Ecological shipping and SDG's

Green Voyage 2050

The International Maritime Organisation (IMO) launched the Green Voyage 2050 program to promote sustainable practices and lessen the carbon footprint of the world's shipping industry. The program was started in 2019 with the goals of reducing greenhouse gas emissions by at least 50% by 2050, making the shipping sector carbon neutral by that year, and encouraging the use of alternative fuels, energy-efficient technologies, and best practices for operations. The creation and application of alternative fuels, enhancing ship energy efficiency using energy-saving technology, optimising ship design, smart shipping technologies, and battery-electric ships for short-distance travel are some of the main areas of study. The program also promotes the implementation of international laws and procedures to reward environmentally friendly shipping, such as the IMO's first plan to cut greenhouse gas emissions, the Energy Efficiency Existing Ship Index, the Carbon Intensity Indicator, and global carbon pricing mechanisms global systems for pricing carbon. By providing financial and technical support, training programs,

testing alternative fuels, energy efficiency, smart shipping, and hybrid power systems, Green Voyage 2050 promotes capacity-building and technical collaboration in developing nations.

National Action Plan

The National Action Plan initiative is one of the program's key components. It was resolved at the 75th Session of MEPC that IMO member states must submit a voluntary action plan. The proposed plan has to support the uptake of alternative low carbon and zero carbon fuels and comparable actions to reduce GHG emission from ships. The 79th Session of the MEPC updated the plan once again, adding references to help decarbonisation. NAP included the Maritime India Vision 2030, which was approved in 2021. According to the Green Voyage 2050 Accelerator, the pilot project's objective for India was to investigate low and zero alternatives for the Assamese ferry industry, including building new terminals and new passenger ferries. The financial support is given for India to develop this project.

Major Role of IMO in implementing an Ecological/Sustainable shipping

International Maritime Organization: A base for promoting sustainable shipping.

The international maritime organisation is a UN Specialized agency with responsibility for the safety and security of ships and the prevention of pollution. The organisation was established by the IMO Convention. IMO's work plays a vital role in supporting the UN SDG's. The main role of the Organisation is to create a fair and effective regulatory framework for the shipping industry which will have the ability to universal adoption and implementation. The following section will discuss about the measures taken by IMO to achieve sustainability and thereby supporting SDG's.

2023 IMO Strategy on reduction of GHG Emission from ships

To combat climate change and its impacts, IMO adopted this strategy to cut carbon footprint of ships. Tracing its history, the 72nd Session of MEPC adopted the Initial strategy for reduction of greenhouse gas emissions from ships which aims to phase out them within this century. In 80th session of MEPC, the 2023 strategy was adopted and guidelines have been given. The framework sets out future ambition for international shipping with the levels of reducing GHG emissions and guiding principles. It classifies the mid-term and long-term measures with adequate timelines and also identifies the barriers and supportive measures which includes capacity building, technical cooperation and research and development.

By 2030, the 2023 IMO GHG Strategy aims to reduce international shipping's carbon intensity by at least 40%. It also contains the plan for a new level of ambition for the adoption of technologies, fuels, and/or energy sources with zero or nearly zero GHG emissions, which are to account for at least 5%, with a goal of 10%, of the energy consumed by international shipping by 2030.

Levels of ambition directing the 2023 IMO GHG Strategy are as follows:

1. Declining the carbon intensity of the ship through further improvement of the energy efficiency for new ships
2. Decreasing the carbon intensity of international shipping
3. Increasing the uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources
4. Making GHG emissions from international shipping to net zero

Energy Efficiency Design index (EEDI)

The **Energy Efficiency Design Index (EEDI)** is a key regulatory measure introduced by the **International Maritime Organization (IMO)** under its **Marine Environmental Protection Committee (MEPC)** to promote energy efficiency in ship design. It is part of the broader efforts to reduce the carbon footprint of international shipping and help achieve the IMO's greenhouse gas (GHG) reduction targets.

Key Factors Affecting EEDI

Several ship design factors are taken into account in the EEDI calculation, including:

1. **Engine Power**: The installed engine power directly influences fuel consumption and CO_2 emissions. More efficient engines or alternative fuel systems can improve the EEDI score.
2. **Ship Design**: The hull form, propulsion systems, and design optimization can significantly impact energy efficiency. For example, smoother hulls and better hydrodynamics reduce resistance and fuel consumption.
3. **Fuel Type**: The type of fuel used by the ship also plays a crucial role. Ships that use lower-carbon fuels (e.g., LNG, biofuels) will have a lower EEDI compared to those using conventional heavy fuel oil (HFO).
4. **Ship Size and Type**: Different ship types (e.g., bulk carriers, container ships, tankers) have different operational profiles, and the EEDI threshold varies according to the type and size of the vessel. Larger ships may have lower EEDI values per unit of cargo because of economies of scale.
5. **Speed**: Ship speed is also considered. Operating ships at lower speeds, often referred to as **slow steaming**, can reduce fuel consumption and CO_2 emissions.

The International Maritime Organization (IMO)'s Energy Efficiency Directive (EEDI) is part of the International Convention for the Prevention of Pollution from Ships (MARPOL Annex VI). It sets minimum energy efficiency standards for ships based on their type, size, and year of construction. The EEDI targets are updated every 5 years, with the first set of reductions applied to new ships built after January 1, 2013. Ship-owners must verify their vessels' EEDI at the time of construction, and those that don't meet the thresholds may face restrictions. The EEDI has influenced ship design by incentivizing the adoption of energy-efficient technologies, such as improved hull design, alternative propulsion systems, energy-saving devices, and slow steaming practices.

Energy Efficiency Existing Ship Index (EEXI)

One metric used to assess the energy efficiency of current ships is the Energy Efficiency Existing Ship Index (EEXI). The index is a component of the IMO's plan to reduce greenhouse gas emissions from shipping and is applicable to all ships with a gross tonnage of 400 tonnes or more. Although EEXI is applied retroactively to the current fleet, it is comparable to EEDI. After calculation, the required and attained EEXIs are compared. When the achieved EEXI meets or exceeds the necessary EEXI, the ship is deemed safe. recommendations on the process of calculating the obtained EEXI, recommendations on surveying and certifying the attained EEXI, and guidelines on the shaft/engine power limitation system are some of the EEXI-related guidelines.

If the vessel does not meet the required EEXI, the ship may need to adjust the factors such as Engine power limitation, permanent power limitation, improving energy efficient technologies, operational changes and technical innovations

Ship Energy Efficiency Management Plan (SEEMP)

A Ship Energy Efficiency Management Plan (SEEMP) is a regulatory framework designed to reduce ship energy consumption, lower greenhouse gas emissions, and operational costs. It is a requirement under the International

Maritime Organization (IMO) regulations and aims to improve energy efficiency through better management and operational practices. The SEEMP includes key components such as an energy efficiency policy, technical measures like hull modifications, operational measures like speed reduction, voyage planning, optimizing ballast management, reduced idle time in ports, and using renewable energy. The SEEMP should include performance indicators to track and measure energy efficiency, such as specific fuel consumption, EEOI, and performance index. The action plan should include short-term, medium-term, and long-term goals for improving energy efficiency. Regular monitoring, review, and reporting are required, including data collection on fuel consumption, CO2 emissions, and efficiency metrics. Crew training and awareness programs are essential for implementing the SEEMP, and proper documentation of the SEEMP is required.

The IMO mandates the creation of SEEMPs for all ships over 400 gross tons, with Part I (Ship-Specific Plan) and Part II (Ship Energy Efficiency Performance) being required. The SEEMP plays a role in meeting the Carbon Intensity Indicator (CII) standards and Energy Efficiency Existing Ship Index (EEXI) regulations under the IMO's 2030 and 2050 de-carbonization goals. Benefits of a well-structured SEEMP include reduced carbon footprint, economic savings, compliance with regulations, and market competitiveness. By focusing on continuous monitoring, adoption of energy-saving technologies, and optimizing ship operations, the SEEMP helps minimize environmental impact while promoting cost savings for ship owners and operators.

DCS

In its 70th meeting of MEPC, resolution was adopted to have mandatory MARPOL Annex VI requirements for ships to record and report their fuel consumption. This data will help to make decisions for improving the energy efficiency of ships. This data is used to calculate the CII of ships. The database has been added to the module of Global Integrated shipping Information system. But currently, the option is not accessible by public on the website.

Carbon intensity indicator (CII)

The annual reduction factor required to guarantee ongoing improvement of a ship's operating carbon intensity within a given rating level is fixed by the Carbon Intensity Indicator. The required annual operational CII will be compared with the actual annual operational CII that was attained, which needs to be recorded. A "Statement of Compliance" detailing the ship's achieved performance level will be included in the Ship Energy Efficiency Management Plan (SEEMP).

MEPC

The Marine Environment Protection Committee (MEPC) addresses environmental issues which includes the control and prevention of ship-source pollution covered by the MARPOL treaty under the remit of IMO. The Committee conducts regular sessions with various stakeholders of the maritime industry and take necessary action to achieve the Goal of de carbonization. The outcomes of each session will be published to create transparency in the shipping industry.

In the 81st Session of MEPC, the IMO has agreed to have an IMO net zero framework which will amend the Annex VI of MARPOL. The development of this framework will be expected to be end at 2025 and enter into force on 2027. The ongoing negotiations regarding the framework consist of two parts namely a technical element which will mandate the usage of fuels with low GHG emissions and an economic element that deals with pricing mechanism of the fuels.

Measures Taken by India to promote sustainable shipping

India has implemented several measures to promote sustainable shipping and reduce its environmental impact. These include adhering to the International Maritime Organization (IMO) regulations, implementing the National Maritime Development Policy, promoting green ports, and promoting LNG as a cleaner marine fuel. India's major ports, including Jawaharlal Nehru Port Trust and Kochi Port, have implemented sustainable practices, such as shifting to renewable energy sources, installing energy-efficient lighting, and reducing water consumption. The country has also developed a National Ship Recycling Policy to manage ship decommissioning in an environmentally responsible manner. Major Indian ports have started adopting renewable energy solutions, including solar panels and wind turbines, and integrating electric vehicles for port operations and internal transportation.

India is encouraging the adoption of green shipping practices by offering incentives and support to ship owners who implement cleaner technologies. The Indian Register of Shipping (IRS) has been proactive in promoting and certifying ships that meet international standards for energy efficiency and environmental sustainability. India has also collaborated with global organizations like the IMO and UNCTAD to develop sustainable shipping practices. The country is also part of the IMO's Green Voyage 2050 initiative, which aims to significantly reduce the carbon footprint of the global shipping industry. India's maritime sector is investing in research and development to explore alternative fuels, autonomous vessels, and digital solutions to improve the efficiency and sustainability of the shipping industry.

Policy documents

India having a predominant position and share in the global shipping aims to achieve the Sustainable goals by introducing new policies and promoting activities that will reduce the emission. Two major sources that are navigating the greener route are Maritime India vision 2030 and Maritime Amrit kaal vision 2047.

CONCLUSION

While adopting sustainable measure is appreciated but at the same tome the safety of shop has to be taken into consideration. The innovative technologies must check the safety of the ships and the capability to sail in rough weather. The expenditure to make transition is huge and the cost has to be shared equally within the stakeholders. The budget for Research h and development of sustainable shipping methods has to be increased. At the request of the Commission of Small Island States on Climate Change and International Law, the International Tribunal for the Law of the Sea issued an advisory opinion that added an optional obligation on the state parties to UNCLOS. The unanimous opinion of the tribunal held that:

- Article 194(1) of UNCLOS imposes a specific duty of due diligence on state parties to the convention to take all necessary steps to prevent, reduce, and control marine pollution from anthropogenic GHG emissions
- Article 1(1)(4) of UNCLOS states that anthropogenic GHG emissions into the atmosphere constitute pollution of the marine environment;
- Article 194(5) requires state parties to protect the marine ecosystem from the effects of climate change and ocean acidification.
- Articles 61 and 119, states parties are required to take the necessary steps to safeguard living marine resources while taking into account the best available scientific information. The state parties must use the precautionary and ecological approaches when implementing such actions.

- Articles 118 and 63, respectively, state parties are specifically required to have the required coordination and consultation in good faith.
- According to Article 196, the state parties must take particular action to stop, lessen, and manage pollution caused by the introduction of non-native species that harm the marine ecosystem. The precautionary approach is the term for this. Human efforts to address the climate change challenge will accelerate if this recommended measure is implemented.

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