Network India

OCEANS STEWARDSHIP PROGRAM
UN GLOBAL COMPACT NETWORK INDIA

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I. List of Abbreviations

CAG : Comptroller and Auditor General
CEFAS : Centre for Environment, Fisheries, and Aquaculture Sciences
CFSs : Container freight stations
CIOB : Central Indian Ocean Basin
CMSP : Coastal Marine Spatial Planning
EEZ : Exclusive Economic Zone
EPC : Engineering, Procurement, and Construction
GDP : Gross Domestic Product
GRI : Green Reporting Initiative
GTTP : Green Tug Transition Programme
ICD : Inland container depots
IFC-IOR : Information Fusion Centre Indian Ocean Region
IMAC : Information Management Centre
INCOIS : Indian National Centre for Ocean Information Services
ISBA : International Seabed Authority
IOC : International Oceanographic Commission
IOR : Indian Ocean Region
IOR-DCC : Indian Ocean Region - Decade Collaborative Centre
IoT : Internet of Things
LNG : Liquified Natural Gas
MIS : Market Intervention Scheme
MIV 2030 : Maritime India Vision 2030
MNRE : Ministry of New and Renewable Energy
MSP : Marine Spatial Planning
MoES : Ministry of Earth Sciences
MoPSW : Ministry of Ports, Shipping and Waterways
NAPCC : National Action Plan on Climate Change
NCCR : National Centre for Coastal Research
NCoEGPS : National Centre of Excellence in Green Port and Shipping
NTPC : National Thermal Power Corporation
NDCC : National Decade Coordination Committee
OTEC :Ocean Thermal Energy Conservation
PMN : Polymetallic Nodules
PPP : Public-Private Partnership
RFMOs : Regional Fisheries Management Organizations
SDGs : Sustainable Development Goals
SLR : Sea Level Rise
STI : Science, Technology and Innovation
TERI : The Energy and Resources Institute
UNCLOS : UN Convention on the Law of the Sea
UNEP : United Nations Environment Programme
VLCC : Very Large Crude Carriers

II. Executive Summary

The blue economy presents a significant opportunity for businesses in countries with coastal regions, such as India, to responsibly harness ocean resources for socio-economic advancement in-line with the United Nations' Sustainable Development Goals.

The Indian government's "New India by 2030" vision, outlined in the February 2019 budget speech, identified the blue economy as the sixth core dimension for growth and emphasized the need for a coordinated policy that integrates various sectors to improve the lives of coastal communities. The Draft National Blue Economy Policy outlines India's approach to harnessing the socio-economic potential of the blue economy. It covers areas such as national accounting framework, tourism, marine fisheries, aquaculture and fish processing, manufacturing and emerging industries, logistics and infrastructure, coastal and deep-sea mining, offshore energy, security, and international engagement. The Sagarmala Programme aims to accelerate port-led development along India's coastline. All sectors which have the potential to contribute toward India’s economic growth and sustainable management of ocean resources.

Overall, these policies and programs reflect the Indian government's commitment to promoting sustainable and inclusive growth in the blue economy, improving the livelihoods of coastal communities and preserving marine ecosystems.

Challenges and Sustainability Initiatives of the Indian Blue Economy

The Blue Economy in India has several emerging sectors, however, this report emphasises on the development of Ports, green shipping and fisheries & aquaculture sectors of India. The mentioned sectors in particular, and the Indian Blue Economy in general, faces several challenges. While the Ports and shipping sector faces safety barriers pertaining to the environment, infrastructure, decent work for all as well as governance, the fisheries sector faces similar challenges in addition to inadequate finance and technological advancement. The other Blue Economy sectors have several bottlenecks associated with physical infrastructure, logistics, investments and sustainability.

The government has launched several sustainability initiatives to help the Indian businesses harness its true economic potential, like the National Centre of Excellence in Green Port and Shipping (NCoEGPS), Maritime India Vision (MIV) 2030, Green Ports initiative, mechanization and port equipment electrification, promotion of coastal shipping etc to bring sustainable solutions for the development of the Indian ports including policies for increased investment to R&D. Further, Public-private partnerships are a key focus to bring synergy among the blue economy industries and enable them to be active contributors to the development of the ocean economy in India.

The schemes emphasise on financial incentives like green & blue bonds and initiatives like the recent Harit Sagar guidelines provisioning financial incentives for eco-friendly shipping vessels and port projects to promote and support carbon transition. The fisheries sector, being a major contributor to the GDP, has similar initiatives focusing on both economic and sustainable development, like the Blue Revolution, Pradhan Mantri Matsya Sampada Yojana and R&D initiatives by the Fishery Survey of India to help modernise the sector and address the sectoral challenges.

The Indian Blue Economy has the potential to become a key component of the Indian GDP and the way forward includes suggestions for increased private sector participation in the growth of the sector, coupled with the need to emphasise on technology, infrastructure, regulatory mechanism, sustainable financing and collaboration.

III. Chapter 1: Overview of the Industry and Indian Blue Economy

A. About the Indian Blue Economy

The Blue Economy is defined by the World Bank as "sustainable use of ocean resources for economic growth, improved livelihoods, and jobs while preserving the health of the ecosystem." The increase in demand for ocean-linked products and economic activities like seafood, renewable energy generation, marine construction etc. has led to the growth of the Blue Economy globally, with estimated global turnover ranging between US$ 3-6 trillion annually.

India's geographical location offers a unique advantage when it comes to maritime activities.

- The country boasts a coastline that spans 7517 km
- Is home to nine coastal states and 1382 islands
- There are 12 major ports and 187 non-major ports in the country
- These ports handle approximately 1400 million tonnes of cargo every year
- The coastal economy provides livelihood to more than 4 million fishermen and other coastal communities

With these vast maritime interests, the blue economy occupies a vital potential position in India's economic growth.

All 12 major domestic ports in India have now switched to renewable energy to meet their entire power requirements, making India the first country to have all government-owned ports running on solar and wind energy.

To make the most of these resources, India should focus on sustainable utilization and integration of ocean-related capabilities, capacities, and skills. Therefore, India's blue economy is understood as a subset of the national economy comprising an entire ocean resources system and human-made economic infrastructure in marine, maritime, and onshore coastal zones within the country's legal jurisdiction. The blue economy is a vast socio-economic opportunity for coastal nations like India to utilise ocean resources for socio-economic benefit responsibly aligned to the UN Sustainable Development Goals.

As per India's draft Blue Economy Policy 2020, there are the following seven priority areas for the oceans economy:

i. Priority Area 1: National Accounting Framework for Blue Economy and Ocean Governance
ii. Priority Area 2: Coastal Marine Spatial Planning and Tourism
iii. Priority Area 3: Marine Fisheries, Aquaculture and Fish Processing
iv. Priority Area 4: Manufacturing, Emerging Industries, Trade, Technology, Services and Skill Development
v. Priority Area 5: Logistics, Infrastructure and Shipping (including trans-shipments)
vi. Priority Area 6: Coastal and Deep-Sea Mining and Offshore Energy
vii. Priority Area 7: Security, Strategic Dimensions and International Engagement

This report will focus on the following two elements and their potential to drive India's blue economy: 1) Shipping and port facilities and 2) Marine Fisheries, Aquaculture and Fish Processing

B. Mapping few of the Government Policies and Initiatives

Draft National Blue Economy Policy

The Ministry of Earth Sciences (MoES), shared the Draft National Blue Economy Policy for public comment in February 2021. This policy is the result of working group reports developed under the Economic Advisory Council to the Prime Minister and is in the process of getting finalized. The Draft states that India's approach to harness the Blue Economy's socio-economic potential should focus on the seven priority areas listed in the section above.

A crucial part of the Draft National Blue Economy Policy includes an analysis in which India needs to understand the potential of the country's coastal areas. A critical understanding of the coastal areas will help the country decide which industries need to be established in these areas and their specific requirements for efficient operation.

Sagarmala Programme

In 2015, the Government of India launched the Sagarmala Programme. The program is aimed at accelerating port-led development along the country's long coastline. The program is customer-oriented and aims to make India's coast the gateway to the country's prosperity. The key areas of the Programme are: (a) Port Modernization and New Port Development including new greenfield ports; (b) Port Connectivity Enhancement; (c) Port-linked Industrialization and development of Coastal Economic Zones and industrial clusters; (d) Coastal Community Development.

Under this programme, the private companies are encouraged to collaborate with the government to implement green practices. For instance, the Coastal Berth Scheme under this programme offers financial support to private companies for the development of coastal berths, which enables efficient and eco-friendly coastal shipping operations. According to studies conducted as part of the Sagarmala Programme, it is projected that the cargo traffic at Indian ports will increase substantially. This requires concentrated sustainable interventions to ensure that profit from the ocean's industry isn't at the cost of the environment and people working and living in the coastal communities.

National Policy on Marine Fisheries

Pradhan Mantri Matsya Sampada Yojana (PMMSY), was launched on 10th September 2020 by the Government of India. The aim of the scheme is to bring about the Blue Revolution through sustainable development of the fisheries sector over a period of five years (2020-2025.) While aiming to enhance production and productivity, the PMMSY offers a wide range of activities for the benefit of fishers, fish farmers, youth, women, entrepreneurs etc.

The National Policy on Marine Fisheries (2017) aims to maintain the health of marine life and oceans in India's EEZ through sustainable harvest. The policy is built on seven pillars, including sustainable development, socio-economic upliftment of fishers, and precautionary approach. The vision of the policy is to maintain a healthy fisheries sector that meets present and future generations' needs, while the mission is to ensure the resources' sustainability.

The National Fisheries Policy 2020 offers a strategic way forward to develop, harness, manage and regulate capture and culture fisheries in a responsible and sustainable manner. The government's focus will be directed towards fishing effort management, fleet size optimization, mainstreaming biodiversity conservation in production processes, species-specific and area-specific management plans, including conservation of Ecologically and Biologically Significant Areas (EBSAs) and Vulnerable Marine Ecosystems (VMEs), protection of iconic and endangered and threatened (ETP) species, spatial and temporal measures for sustainable utilization of resources and creation of fish refugia through consultative processes.

National Centre of Excellence in Green Port and Shipping (NCoEGPS)

India has inaugurated its first National Centre of Excellence in Green Port and Shipping (NCoEGPS), a collaboration between the Ministry of Ports, Shipping and Waterways (MoPSW) and The Energy and Resources Institute (TERI). The initiative is expected to play a critical role in steering the shipping industry towards carbon neutrality and a circular economy. The NCoEGPS will focus on developing a regulatory framework and alternative technology adoption roadmap for green shipping in India.

Ocean Cleaning and Waste Management Initiatives

On World Environment Day in 2018, MoES also joined the United Nations' "Clean Seas Programme" to develop strategies to estimate and reduce marine litter/plastic in the oceans, which is also part of SDG14.

MoES is taking the lead on the issue of marine plastic waste and collaborating with the Centre for Environment, Fisheries, and Aquaculture Sciences (CEFAS) in the UK and Japanese institutions on a research project called "Assessment of Micro Plastic Impact on Marine Organism in Coastal and Estuarine Habitats." The National Centre for Coastal Research (NCCR) in Chennai is carrying out the program with the main goal of understanding the current distribution and abundance of marine litter and microplastics in Indian coastal sediment, water, and biota. This information is critical in developing effective management strategies that can prevent plastic waste at its source.

Blue Flag Certification

The Ministry of Environment, Forest and Climate Change (MoEFCC) has also introduced the "Blue Flag Certification" scheme in 13 selected pilot beaches across coastal States and Union Territories, in line with the Blue Flag Standards. This certification scheme aims to enhance beach clean-up and sustainable development to make beaches pollution-free and attract more tourists. India recognizes the potential of cruise tourism, marine tourism, and lighthouses, and plans are being formulated to capitalize on these opportunities.

Data Collection and Awareness Programs

In 2018, the Indian Government inaugurated the Information Fusion Centre – Indian Ocean Region (IFC-IOR) at the Information Management Centre (IMAC) in Gurugram. The main objective of the fusion center is to collaborate with partner nations and international agencies to establish a comprehensive maritime domain awareness system and exchange information on vessels that are of interest.

Marine Spatial Planning

An important area of work under Blue Economy is the Marine Spatial Planning (MSP). MSP is a method of analysis based on scientific knowledge that coastal states or regions within a country can use to deal with ocean management problems and opportunities, and to achieve goals such as sustainable development, inclusive growth, employment generation, and conservation of marine resources.

In January 2019, India and Norway entered into a Memorandum of Understanding (MoU) that established the India-Norway Ocean Dialogue. The Government of India's initial investments for undertaking the studies and planning are estimated to be around INR 8-10 crores per annum (Ministry of Earth Sciences, 2021). In 2023, Puducherry launched the country’s first MSP framework as part of a pact under the Indo-Norway Integrated Ocean Initiative, to balance growth alongside sustainable management of ocean resources and coastal environment preservation.

Deep Ocean Mission

India has a rich history of ocean-related activities. India has already surveyed 92% of its Exclusive Economic Zone (EEZ) and holds exploration contracts with the International Seabed Authority (ISBA) for polymetallic nodules (PMN) and hydrothermal sulphides in the central Indian Ocean. India has made significant progress since its three-decade-long experience, launching new ambitious missions like the "Deep Ocean Mission" with a budget of ₹4168 crore from 2021-26 to explore and harness marine resources sustainably. As per data, only 5% of the deep ocean has been explored so far while the rest remains unexplored.

Keeping this in mind, the Deep Ocean Mission will cover deep ocean survey exploration and projects for the conservation of deep sea biodiversity, it has the following six themes:

i. Development of Technologies for Deep Sea Mining, Manned Submersible, and Underwater Robotics
ii. Development of Ocean Climate Change Advisory Services
iii. Technological innovations for exploration and conservation of deep sea biodiversity
iv. Deep Ocean Survey and Exploration of Minerals from Hydrothermal Vents
v. Development of large-scale offshore plant in deep waters for energy and freshwater
vi. Advanced Marine Station for Ocean Biology

IV. Chapter 2: Stakeholders of the Indian Blue Economy

Blue economy is an all-encompassing concept requiring a multidisciplinary approach to each problem and the involvement of all stakeholders for successful implementation of solutions.

A. Size and Scope of Indian Industries For The Blue Economy

India's Blue Economy is dynamic and multi-faceted, thus, playing an important role in the country's economic growth. It supports 95% of the country's business via transportation and accounts for roughly 4% of the Indian GDP. The role of the Indian blue economy in the country's overall growth is expected to increase with further initiatives to facilitate trade and investment in the deep ocean ecosystem. The sector has stood strong despite the challenges caused by the Covid-19 pandemic and have recorded exports worth Rs. 56,200 (US$ 7.2 billion) between April 2021-February 2022.

- Ocean resources, physical infrastructure for maritime development, and coastal management services are all key to ensuring economic growth and sustainability, as well as national security
- Fisheries and minerals are key components of the blue economy in India. The coastal economy sustains 4 million fishermen and coastal towns of India[1]
- Further, India comprises 200 ports of which 12 are major ports that handled 541.76 million tonnes in FY21
- Shipbuilding and shipping are key contributors to India's blue economy. The modal share of coastal shipping has the potential to increase its share to 33% of the Indian blue economy by 2035. (IBEF, 2022)
- Most of the country's oil and gas are supplied by sea, leading to making the Indian Ocean region critical. to India's economic growth

The G20 programme took cognizance of the Blue Economy in India during a conference conducted by the Comptroller and Auditor General (CAG) , one of the key dimensions of vision 2030 for a modern India. The experts and leaders recognised the vital role of the blue economy in India's economic growth and projected it to be the next multiplier of GDP, well-being, provided sustainability and socio-economic welfare are contextualised to the discussion of India's industries and blue economy.

B. Emerging and current industries already working on Blue Economy

B.1 Ports Infrastructure, Shipping Services, Ship Building

The shipbuilding industry in India is currently facing tough competition from shipbuilding yards in Japan, South Korea, and China (FICCI-KAS - 2019). However, India has skilled and semi-skilled workers, technical support, and a thriving ancillary industry in shipbuilding. Additionally, there are now private shipyards in the domestic shipbuilding market. These strengths could be utilized to help India gain a competitive edge in the global shipbuilding market. The shipbuilding industry in India is set for expansion, providing multiple opportunities for the private sector. The need for around 200 vessels annually for inland water transport (IWT) has the potential to generate more tonnage and employment opportunities (FICCI-KAS, 2019).

The Indian government has already implemented a ten-year financial assistance policy for shipbuilding (2016-2026) to boost domestic shipbuilding (ibid.). This will have a positive impact on related industries and employment. The Indian government has also introduced regulations on ship

[1] Blue Economy: India's Pathway to Sustainable, Secure, and Resilient Economy, Book, 2022, Ganeshan, Swati

recycling and waste management, which aims to regulate the ship recycling industry and reduce its environmental impact.

'Transloading at sea' is an innovative and practical intervention in the transportation sector that can yield significant benefits by reducing logistics costs. In India, transloading has been carried out to some extent on both the west and east coasts. Examples of transloading include the use of floating cranes in Kandla Port and the utilization of barges in various small rivers. These instances involve the movement of cargo through different modes of transport. In 2013, a successful project was commissioned at Sand Heads in the Bay of Bengal to handle imported coal for NTPC's thermal power station at Farakka in Bengal. The Inland Waterways Authority of India (A Statutory body under the Ministry of Shipping in the Government of India) coordinated the project for NTPC (National Thermal Power Corporation), a public sector undertaking and the biggest thermal power generating company in India. It created an almost 15% reduction in the costs of handling coal by NTPC[2].

B.2 Fisheries and Aquaculture

The fishing industry employs over 14 million people in India's coastal states and is one of the most important sectors under the Oceans Economy. Improved monitoring, inspection, and regulation, as well as the induction of technology, is required to support sustainable growth of this industry.

India’s total fish production during 2016–17 was estimated at about 11.41 million metric tonnes. This constituted around 6% of the global production. The fisheries sector contributed to approximately 1% of the National GDP and more than 4% of the agricultural GDP. The marine fisheries sector of India contributed 3.6 million tonnes in 2016 making the country the sixth largest contributor to global marine capture fisheries production[3]. The National Fisheries Development Board is currently exploring opportunities for marine cage culture in India. With the development of captive breeding and mass production technologies for high-value marine fish species, mariculture through cage farming is being established all along the coastal waters of maritime states and Union Territories (UTs).

B.3 Ocean Energy

The anticipated increase in the global population will result in greater demands for fuels, and many countries are already adopting renewable energy sources such as wind and solar power. In India, there is a huge untapped potential for renewable energy derived from the ocean, known as "blue energy." The ocean provides abundant opportunities for generating power from wind, waves, tides, thermal energy, and biomass.

The offshore wind energy potential in the country reportedly lies somewhere between 200 GW and 500 GW (Mani and Dhingra 2013a). To drive the offshore wind energy development in the country, the Ministry of New and Renewable Energy (MNRE) issued a dedicated policy called the National Offshore Wind Energy Policy in 2015. The most recent development was the MNRE’s declaration of the Draft Offshore Wind Energy Lease Rules, 2019, which spells out mechanisms to lease out blocks for offshore wind energy projects[4].

In India, though some crucial developments have taken place in offshore wind energy, implementation is still in the nascent stage and we need more research on 1.) how to deploy infrastructure to tap the potential of off-shore wind energy, 2.) financing of projects, 3.) Technology

[2] Transloading: A Port Capacity Multiplier, By Vishwapati Trivedi, Former Secretary to GoI, Ministry of Shipping.

[3] Marine Fisheries, Aquaculture and Fish Processing. <https://eacpm.gov.in/index.php/reportspapers/eac-reports-papers/>. Blue Economy Working Group: 3 Repot

[4] https://doi.org/10.56506/HDLZ1912

4.) reducing the cost of production and cost to the consumer, 5.) building relevant human capacities and skill set, etc.

B.4 Marine Tourism

Marine tourism, including activities like cruise tourism, is a fast-growing industry that contributes significantly to the economy and employment of countries. However, it is crucial to manage these activities in a sustainable manner to prevent harm to the marine environment and biodiversity.

India's Draft National Blue Economy Policy states that it is essential to observe the concept of carrying capacity when creating coastal tourist spots and marine ventures. It recommends, in order to promote the well-being of both people and the environment, to connect tourism with Coastal Marine Spatial Planning (CMSP), which should be closely supervised by the national-level authority being proposed.

Under the Sagarmala Programme, projects have been identified in convergence with the Ministry of Tourism and tourism development departments of maritime state governments for promoting tourism in maritime states. Key coastal tourism projects include:

- Development of Coastal Circuits under Swadesh Darshan Scheme of Ministry of Tourism
- Development of infrastructure for promoting Cruise tourism
- Development of lighthouses
- National Maritime Heritage Museum Complex at Lothal
- Underwater viewing gallery and restaurant at Beyt Dwarka

Kochi port is currently the leader in cruise tourism in India, but the sector is still in its early stages and has great potential for growth (ibid.). To realize this potential, public-private partnerships are necessary to establish seamless connections between the cruise and land-based tourism sectors, as well as improve coastal crafts and create obstruction-free routes along the coast (ibid.).

C. Educational and Research Institutes

In India, there are several educational institutions that focus on maritime research and provide training for students and sailors.

- The Indian Maritime University (IMU) was established as a Central University through an Act of Parliament on November 14, 2008. Headquartered in Chennai, IMU plays a crucial role in developing skilled human resources for the maritime sector.
- Tolani Maritime Institute (TMI) is a well-known maritime educational institution located in Pune, Maharashtra. TMI is a member of the Association of Maritime Education and Training Institutions in Asia-Pacific (AMETIAP), an organization comprising over 85 maritime training institutions in the Asia-Pacific region.
- National Technology Centre for Ports, Waterways, and Coasts (NTCPWC) is being established at IIT Madras. It will serve as the technological support arm of the Ministry of Shipping, providing necessary assistance to ports, the Inland Waterways Authority of India (IWAI), and other relevant institutions.
- Cochin University of Science and Technology (CUSAT) is another significant institute in the maritime field. It also engages in consultancy and extension activities related to water quality analysis and analytical testing.
- The Marine Engineering and Research Institute (MERI), now known as Indian Maritime University - Kolkata Campus and Mumbai Port Campus, is the national institute for training marine engineers and polyvalent officers in India.

- The International Maritime Institute, located in Greater Noida, Uttar Pradesh, is a private maritime training institute. It offers a comprehensive range of Pre-Sea and Post-Sea courses approved by the Directorate General of Shipping (DG Shipping) in affiliation with the Indian Maritime University.

The above educational institutions mainly focus on a wide range of skills required by the Oceans Industry like: marine engineering, nautical science, maritime management, maritime studies, marine geology and marine geophysics, training, research with a special emphasis on emerging fields such as oceanography, ports, waterways, maritime history, maritime laws, maritime security, search and rescue, transportation of dangerous cargo, environmental studies. Some institutes also foster cross-border cooperation and improve the quality of maritime training and education.

Educational institutions that specialize in maritime research and training are essential for the development of the blue economy in India. They play a vital role in various aspects, including the cultivation of skilled professionals, ensuring safety and security, driving technological progress, and promoting environmental sustainability. These institutes are crucial in equipping individuals with the required expertise, understanding, and capabilities, enabling them to responsibly and sustainably harness ocean resources. This will ensure a 'Just Transition' from a 'brown economy to the blue economy' where sustainable development is inclusive, creating decent work for all and leaving no one behind.

D. Key Regulatory Bodies

This section lists some of the key regulatory bodies involved in ensuring safety in the blue economy in India. They work together to establish and enforce safety standards, promote maritime security, and respond to emergency situations to ensure the well-being of individuals and sustainable development of the maritime sector.

Ministry of Ports, Shipping and Waterways: They are tasked with formulating and implementing regulations, policies, and laws pertaining to ports, shipping, and waterways. Its primary objective is to establish a supervisory and regulatory framework that promotes safe, efficient, and secure shipping while safeguarding the marine environment, developing measures that ensure compliance with international conventions related to ship safety, security, environmental protection, and the welfare of seafarers.

Indian Coast Guard (ICG): Indian Coast Guard ships and aircraft undertake regular patrols to enforce maritime laws, and other regulations and international treaties to which India is a signatory. The ICG also engages in Community Interaction Programmes (CIPs) to educate fishermen about safety measures at sea, including the upkeep and maintenance of boats and fishing gear. Additionally, the ICG works closely with environmentalists to preserve and protect the marine environment, including its flora and fauna. The ICG provides training to stakeholders and oil agencies, continuously validating contingency plans to prevent environmental damage in the event of marine oil spills. It has developed the capability to be the "first-responder" for oil spills in Indian waters. Through its operations, including ship and aircraft activities, the ICG plays a crucial role in mitigating the effects of maritime accidents and ensuring safety and security from both natural and man-made disasters.

Indian National Centre for Ocean Information Services (INCOIS): Indian National Center for Ocean Information Services (INCOIS) is an autonomous organization of the Government of India, under the Ministry of Earth Sciences. It provides oceanographic information and advisory services to support safe and efficient maritime operations, including weather and tsunami warnings.

Indian Register of Shipping: Indian Register of Shipping (IRClass) is an internationally recognised, independent ship classification society, founded in India in 1975. IRClass acts on behalf of the Maritime Administration of the Government of India as the sole authority for final assignment of Load Lines in Indian flag vessels and also as the security organisation that determines compliance under the International Ship and Port Facility Security Code (ISPS) code for Indian flag ships and port facilities. Furthermore, IRClass sets standards and develops regulations concerning ship construction and maintenance, as well as marine equipment and general engineering equipment.

V. Chapter 3: Challenges of the Indian Blue Economy

The Indian blue economy is threatened by several challenges to its growth including climate change, overexploitation of marine resources, governance and technology centered challenges as well as infrastructural concerns. Fuel transition, lack of efficient and robust port infrastructure, an inadequate knowledge- sharing platform among stakeholders and skill shortage in the maritime sector are some of the pressing challenges faced by the Indian industry today.

Further, the Indian blue economy needs to lay emphasis on system-level thinking and integrate technologies across blue economy sectors to develop a sustainable blue economy framework, rooted in collaboration and cooperation among stakeholders, especially to facilitate Just Transition and Decent Work for All.

A. Sectoral Challenges for Ports and Marine Logistics

Development of a robust and sustainable port infrastructure is crucial to promoting developmental activities in the deep ocean, especially trade. The FICCI (2017) report emphasises the absence of private sector participation in several major shipyards. There is a need for an effective and efficient Public Private Partnership model, where both MSMEs and large enterprises can participate across major and non-major Indian shipyards.

A.1 Safety Challenges for Ports:

Ports face several challenges due to infrastructure, global trade, production capacity, finance and compliances, governance, digitalization etc, and these concerns impact the safety of ports. The increase in globalisation and dependency on maritime trade may expedite the impact of these challenges and the impact of port safety will become more apparent over time. Few of the safety challenges associated with Indian ports may be articulated as follows:

i. Environmental Safety related challenges: Air Pollution at dock: 70% of air pollution at major ports is caused when ships are anchored at ports. During this period when ships with EXIM (Export-Import) cargo aren't moving, their engines are running as several routine activities are going on. If the ships are provided clean/green fuel by the port authorities, concerns associated with air pollution may be addressed.

ii. Bilge and Ballast water[5]: The water discharged during the cleaning of a ship and the discharge of ballast water is a threat to marine ecosystems. Ballast water also leads to the introduction of invasive marine species to new environments which is a major threat to the global oceans.

iii. Dredging: Capital and maintenance dredging causes environmental problems (increased sedimentation) affecting local productivity of the local waters and its fisheries. The increased sedimentation has far-reaching shoreline impacts which affect the safety of ports.

iv. Carbon emissions: The carbon emissions of the maritime industry, excluding military operations, contributes to 1% of the overall transport sector emissions. The usage of sustainable fuels and biofuel and its blends in Indian ships will help address the challenge of carbon emissions, and help the industry advance towards carbon neutrality.

v. Construction/ Expansion of ports: Extensive construction of ports causes changes in coastal morphology and affects the marine ecosystem. The port power plants, often, use the river as the coolant system and dump their hot coolant water in the creek, which leads to algal bloom, thus, affecting fisheries and the people dependent on marine life. These activities, more than often, bypass the environmental regulations.

[5] Harbouring trouble - The social and environmental upshot of port growth in India – A report by Dakshin Foundation

A.2 Decent Work and Skills related safety challenges

i. Health Hazards: Ports face security and safety issues, especially in case of workers engaging with large equipment and machinery as well as operating in the areas of sulphuric plants where, potentially, toxic gas leakage may take place. Thus, marine workers are exposed to potential health hazards (Sinay, 2021).
ii. Job Security: Privatization in the industry has led to considerable changes in the organization of ports and the employment of people in them, including increased use of nonpermanent workers. This has a direct impact on job security and Just Transition for the marine ecosystem.
iii. Skills: The Indian Blue Economy lacks upskilling which is key to adopting changing technology and carbon-neutral requirements. The lack of adequate training, falling manpower quality, and opposition to reform are major issues in the human resources.

A.3 Infrastructure related safety challenges:

i. Cargo capacity: Indian ports are facing the issues of reduced capacity to handle large cargo, owing to which current activities are focused on port expansion and construction which raise environmental concerns like dredging.
ii. Inadequate road networks and infrastructure within the port area: Lack of expressway connectivity between major ports as well as industrial clusters, and high fuel cost make hinterland transportation inefficient and slow.
iii. Poor infrastructure accounts for more than 40% of estimated transport cost. The shipping cost could be reduced up to 12% by improving the port efficiency. For instance, increasing turnover efficiency and customs process time would reduce freight costs, and increase customer service.
iv. Sub-optimal Transport Modal Mix – Lack of requisite infrastructure for evacuation from major and non-major ports leads to sub-optimal transport modal mix (Multimodal Mix is using two or more different modes of transport for carrying cargo). The lack of expressway connectivity between major ports as well as industrial clusters, and high fuel cost make hinterland transportation inefficient and slow.
v. Need for Digitization/technology & innovation: registration of flagged ships, ship registration process under a unified portal, Life Saving appliances module, Several EXIM processes are not digitized, impacting efficiency of logistics, river information system etc. As these slow down various processes.
vi. Ship breaking[6]: Unsustainable ship recycling, hazardous working practices, and pollution coupled with a weak ethics infrastructure implying a lack of transparency in the industry, both from the yard owners and authorities raise major concerns for the Indian BE.

A.4 Security related safety challenges:

Cyber-Attacks: The shipping and port sector are increasingly integrating digitization, integration and automation, in their operations which in turn poses a threat of cyber-attacks for marine security. A state-operated container terminal at Jawaharlal Nehru Port Trust (JNPT) experienced a ransomware attack on 21st February 2022, that affected its management information system (MIS). Cyberattacks are increasingly becoming a matter of concern in the maritime industry[7].

The challenge calls for robust cyber risk management on board using Information Technology (IT) and operational Technology (OT).

[6] The problems of ship breaking in India: An overview.

[7] India's Jawaharlal Nehru Port Container Terminal hit by cyberattack. Ship Technology.

A.5 Corruption and Governance related risks and safety Challenges in ports:

The Indian marine industry is plagued with several governance and corruption challenges like: facilitation payments, commercial extortion by shipping companies, and weak ethics infrastructure in port agencies, to name a few. A weak ethics infrastructure implies a lack of a code of conduct for port personnel, no effective system for handling grievances and protecting whistleblowers.

In 2023, Maritime Anti-Corruption Network (MACN) partnered with the International Seafarers' Welfare and Assistance Network (ISWAN) to provide the new helpline service in India, to tackle maritime bribery and other corruption incidents (both in cash and kind) on the seaside in India. Yet, merchant vessels and allied stakeholders continue to face corruption challenges in the maritime value chain when ships call at Indian ports.

A.6 Sustainability and Regulation related bottlenecks

The custom and regulation procedures are specific functions that result in maritime trade lagging. Further, The cost of moving containers through Indian ports is much higher than other regional ports like Bangkok, Singapore, etc. Methanol and ammonia engines are fast developing; the regulations and policies required to support the ammonia and hydrogen based technology aren't progressing at the same rate, thus posing a potential bottleneck.(Chandrasekaran & Kumar, n.d.)

Sustainability Bottleneck: Ports generate direct and indirect employment, thus, port operations have an impact on livelihoods and common infrastructure. Upskilling of the human resource dependent on the marine economy is essential to facilitate Just Transition for all and adopt green technology. Further, The World Shipping Council considers fuel supply development as a key pathway to zero-carbon shipping. Decarbonisation of ships, by introducing emerging alternative fuels to replace heavy fuel oil, requires R&D intervention and investment.(Chandrasekaran & Kumar, n.d.)

B. Marine Fisheries - Livelihood

India is emerging as a global player in the fisheries sector, with an emphasis on aquaculture. India has significant expertise in satellite launching, fabrication and application of similar systems. This facility is especially of utility in the IORA region for identifying and locating fish clusters.

India being one of the top seafood exporters globally, the marine fisheries sector has been a significant contributor to the foreign exchange earnings for the Blue Economy[8]. However, unregulated fishing and the impact of climate change (discussed in further sections) like ocean acidification impact the marine fishing industry.

There are several challenges faced by the Indian fisheries sector[9]:

- **Livelihood and economic loss**: As per the National Fisheries Development Board of the Ministry of Fisheries, Animal Husbandry and Dairying, the fisheries and aquaculture industry employs around 14 million people. Further, approximately 30% of India's population lives in coastal areas and relies on the fisheries industry for food and livelihood. A declining marine biodiversity, specifically fish population, will significantly impact the coastal livelihoods and nation's food security.
- **Inadequate Infrastructure:** The lack of adequate infrastructure especially fishing harbours, landing centres, cold chain and distribution systems, limits the business and sectoral growth. An infrastructural gap stagnates the sectoral growth leading to an estimated Rs.61000 crore post-harvest loss.

[8] The Fisheries & Aquaculture Sector of India | IBEF, 2022

[9] GROWTH AND TRADE PERFORMANCE OF INDIAN FISHERIES: TRENDS AND CONSTRAINTS. Department of Economic Analysis and Research, NABARD

- **Inadequate Finance:** The fisheries sector faces challenges associated with low levels of investments. Inadequate access to institutional credit coupled with high cost of credit makes finance a major challenge for sectoral development.
- **Inadequate Regulatory mechanism:** The lack of traceability and certification coupled with inadequate regulatory mechanisms poses a significant challenge for the marine fisheries sector. Processing and value additions with compliance to food norms is a key constraint in the fishery sector, especially to enter the export market. All of these have a direct impact on the revenue potential of the Indian fisheries sector.
- **Obsolete Technology:** The use of inadequate technology in the harvesting of fish impacts the productivity of the sector. Further, a lack of technological advancement in the sector affects the ability to collect more data on fish stocks, facilitate better monitoring, as well as enforce and evaluate the environmental impact of sectoral activities on the marine ecosystem.

C. Other Sectoral Challenges

C.1 Marine Biotechnology

Marine Biotechnology offers ample business opportunities to MSMEs and conglomerates in multiple sectors. However, the sector faces challenges associated with identification of new sources of marine bio products, sustainable supply chains, optimisation of production and recovery of bio products.

C.2 Offshore and Deep-Sea Mining

Offshore mining is specifically important to open up avenues for additional resources, however, it leads to negative externalities by resulting in adverse impact on the marine environment. The impact, when assessed and quantified, translates into a substantial cost of operations for the sector.

C.3 Marine Litter

Marine Litter is a significant ocean ecosystem challenge, posing environmental, economic, human health and aesthetic concerns. The major sources of it are land-based activities, including: waste released from dumpsites near the coast or river banks, the littering of beaches, tourism and recreational use of the coasts, fishing industry activities and ship-breaking yards. Key sea-based sources for marine litter include - abandoned and discarded fishing gear, shipping activities and illegal activities. The categories of marine litter identified along indian coasts, posing a challenge to the BE and other sectors of the economy, are: Plastics- Single use of Plastics i.e., Bottles, food Wrappers, Cutlery items, polythene bags, fishing nets, glass - liquor bottles, rubber- footwears. Clothes - face masks and religious activities, paper, metals and miscellaneous items – diapers and household materials.

C.4 Marine Renewable Energy (MRE)

The forms of MRE are (1) offshore solar energy, (2) offshore wind energy, (3) wave energy, (4) tidal energy, (5) ocean thermal energy, (6) salinity gradient, (7) ocean current energy, and (8) energy from marine biomass.

The full-scale development of this industry is yet to be achieved owing to environmental concerns and the quantum of investment required. Further, commercial viability has not been fully achieved owing to technology-related constraints. However, financing remains a major constraint for the development of the MRE sector for India's Blue economy.

Some of the specific challenges identified for the Indian blue economy with regards to offshore wind energy relates to resource characterization, subsea cabling, turbine foundation, installation

of turbines including logistics, grid interconnection and operation, development of transmission infrastructure and coastal security during construction and operation period. Further, significant integration of the power system to the national grid is essential for developing the offshore wind generation for India and boosting the blue economy.

C. 5 Marine Manufacturing

Marine manufacturing is a dynamic sector and essential part of the Blue Economy. The sector includes several activities such as ship building, maintenance, refurbishment, repair of vessels and oil rigs, and manufacture of technology used in the marine industry such as navigation equipment. India specifically has a strong ship breaking industry and is emerging as one of the largest global markets alongside Bangladesh for the ship breaking sector, however, the industry is highly polluting in nature (contributes to marine litter) and raises severe environmental and social concerns.

Further, marine manufacturing as an industry has strong entry barriers and high-risk factors associated with its operations. The industry identifies the following challenges as key obstacles for sectoral growth: Intrinsic constraints of the domestic market, Issue of scalability, Sensitivity to economic conditions and Port Infrastructure

D. Climate Change and Marine Security Threats to the Blue Economy

While the business case for SBTs is increasingly established, forward-thinking corporate leadership is still often required in the absence of clear decarbonization pathways. Defining a long-term, net-zero pathway can be supported by interim target-setting and leveraging cross-sectoral value chain collaboration by Businesses in India.

Climate Change has raised concerns like rising ocean temperatures, ocean acidification which impacts marine biodiversity and extreme weather events that damage coastal infrastructure and ecosystems. These challenges pose a threat to food, economic, and human security of the country. Further, these challenges have a domino effect and impact several sectors dependent on the deep oceans like tourism, fisheries and aquaculture, biotechnology and offshore renewable energy.

Therefore, the envisaged blue economy framework, by the government, calls for focused action plans emphasising the mitigation of environmental challenges. The blue economy must address issues beyond economic aspects, and account for the value added by natural coastal and marine ecosystems. The major, climate change based, threats to maritime security are:

D.1 Sea Level Rise

Sea level rise (SLR) is one of the key concerns of climate change, for several reasons (i) SLR is irreversible through natural processes on timescales of hundreds of thousands of years; (ii) there is no practical, economically feasible way to protect the coastlines from SLR – the only 'adaptation' measure for the immediate coastline population is to retreat to a higher ground; and (iii) the current rate of SLR is already far greater than ever observed in recent paleoclimatic history.

In recent times, the relatively small quantum of SLR when combined with increasing cyclonic storms, flooding and storm surges pose a direct threat to the coastal infrastructure and population:

- According to estimates from a 2019 study, nearly 35 million Indians will be exposed to annual flooding by 2050 and coastal regions that are currently inhabited by 21 million Indians will be permanently inundated by mid-century (Kulp and Strauss 2019).
- Has a significant impact on maritime security and every fraction of a metre of rise in sea level, compounded by an increase in probability of extreme sea-level events poses a direct threat to the Port infrastructure (destruction or submerging) and facilities like communication and

power lines, which in turn impacts the ability of marine security agencies to provide timely assistance during humanitarian crises and emergencies (Dr Pushp Bajaj, 2020).

- The delays and increased costs for repair, restoration, and relocation of port facilities lead to additional operational costs which in turn affect profitability of the port sector in India. A recent global study claimed, the annual economic losses owing to coastal flooding (a direct impact of SLR), could range between 1.5% - 2% of the annual GDP by end of the century, further exacerbated by global warming.
- Affects the food and water security in India in general and the coastal residents in particular through indirect ways such as saltwater intrusion into land which leads to a significant increase in the salinity levels in agricultural soils, thus, damaging crops. It also contaminates potable water aquifers

D.2 Rising Ocean Temperature

The rising ocean temperatures and heat content are resulting in the occurrence of intense marine heat waves and tropical revolving storms. Unequal warming of land and ocean has resulted in decreased temperature gradient between the Indian Ocean and mainland India which has changed air-circulation patterns and made monsoonal rains more erratic and unpredictable. In the backdrop of continuous SLR, these erratic and extreme weather changes pose a serious threat to India's maritime security.

Extreme weather conditions significantly contribute to heavy socio-economic losses over both the short and long term time period. The fisheries sector deals with its own challenges that are being exacerbated by climate change-induced extreme weather events. Marine heat waves in the Indian Ocean have resulted in detrimental effects on fisheries, coral reefs, and phytoplankton. To the extent, coral reefs of the Indian Ocean have experienced an average of 46% decline of coral cover in the region. The cascading effect of such a rise in ocean temperatures results in declining marine biodiversity, which has direct consequences on the productivity of emerging sectors like fisheries and ocean tourism.

D.3 Declining Marine Biodiversity

The impact of climate change has intensified the existing issues regarding declining marine biodiversity in the Indian Ocean, and poses a challenge to achieving the sustainable blue economy agenda. Extreme weather events result in instability in marine ecosystems and freshwater resources by impacting food web processes (Anagha, 2022).

The loss of marine biodiversity has a far-reaching impact, for both, traditional and non-traditional security for India:

- **Impact on Tourism:** The ocean tourism industry accounts for 26% of the total global blue economy. The tourism sector is predominantly dependent on marine biodiversity, and a declining ocean diversity is bound to impact the development of this emerging sector.
- **Legal Impact:** India is a signatory to several international instruments and conventions associated with the marine environment, namely: UNCLOS, IWC, CBD, CMS, Tuna Commission, International Oceanographic Commission, Antarctica treaty etc. Thus, India has an obligation to develop robust conservation and management plans for marine habits. Declining marine ecosystems may result in legal implications for the Indian Blue Economy (Saxena, 2012).

E. Technology Challenges

India's Blue Economy faces critical challenges in adopting and investing in technology for ports and marine infrastructure. For instance, scientific exploration of the oceans for deep-sea mining using engineering technology, requires significant financing and skills which are contemporary challenges for India. The development of manned submersibles is a major requirement before mining is commenced and India is planning on undertaking a manned submersible mission in 2023.

Technology needs to be leveraged for the production of modern fishing nets and techniques, desalination plants, as well as to bring cost-effective and efficient marine energy solutions. Further, lack of technological advancement impacts the ability of the Blue Economy to harness the potential of renewable ocean energy (wave, tidal, hydrokinetic, thermal). Technological challenges like lack of expertise to assess damages due to oil spill etc and their impact, results in a general slowdown in the growth of the Blue Economy. The Indian Blue Economy is facing technological challenges to upgrade and enhance its sectors and their productivity.

F. Human Resource and Skill Upgradation

It is imperative to be able to adapt to evolving training and upskilling requirements to ensure a 'Just Transition' toward the blue economy and supporting oceans based sustained livelihood of the local communities. There is a need to bridge the gap between industry and academia and provide the people working with the ocean ecosystem significant skills to meet future requirements as decarbonization and digitalisation in the marine industry are rapidly progressing.

India's blue economy, specifically, deals with the challenge of skill shortage in handling alternative solutions and sustainable practices. The need of the hour is to adapt to evolving training requirements and equip the human resource to meet future requirements, such as, decarbonization and digitalisation. Further, potential change in the work and employment patterns result in challenges for the maritime industry, requiring policymakers to invest in the workforce with future-proof skills, especially of relevance to the shipping and ports sector.

There is a need for targeted investment in infrastructure, regional redevelopment and comprehensive social protection, emphasizing the need for synergy between government and industry to ensure the development is sustainable and inclusive. .

G. Financing of the India Blue Economy

The Indian Blue Economy potential is unharnessed primarily owing to lack of investments for technology & innovation in the blue economy in the context of financial and human capital. The impact of the financial deficit is not limited to industry but extends to the coastal communities and workers dependent on it for livelihood. The lack of innovative financing tools emphasises on the need for India to expand the blue economy through innovative 'blue financing products' like blue bonds and loans, and blue derivative products will need to be designed, to finance SDG 14. Further, the G20 Presidency creates an environment conducive to prioritising India's Blue Economy and its required investments for the purpose of transitioning to a sustainable green economy (Ghosh & Sridharan, 2023).

Financial inclusion is a key challenge for the Indian Blue Economy. Developing countries face a range of challenges when it comes to blue financing. These include:

- Lack of specialist capacity to bridge the sectors of finance and economics with ocean science and management
- Limited private sector investments, low levels of awareness and capacity building
- Lack of understanding regarding the potential risks associated with blue economy issues

- Insufficient investment in innovation, both in terms of financial resources and human capital

These challenges collectively pose hurdles to the successful implementation and growth of sustainable financing in the blue sector.

A recent survey conducted by KPMG highlights that the UN Sustainable Development Goal (SDG) 14, which focuses on Life Below Water, is among the least prioritized SDGs by the private sector, with only 18% of companies considering it a priority area of focus. The success of the transition to a blue economy depends on the availability of financing and reasonable returns on investments, which would mostly come from public-private partnerships and traditional channels of financing such as budgetary allocations, private and public investments, and foreign direct investment. Further, In 2018, the United Nations Environment Programme (UNEP) introduced the Sustainable Blue Economy Finance Principles, providing investors with a framework to support ocean-related sectors. This reference point enables financiers to assess the potential impact of marine investments on improving livelihoods and eradicating poverty.

India has been consistently investing in Science, Technology and Innovation (STI) related to the oceans, yet the gaps in financing and investment are evident and vast compared to other countries with emergent blue economies. Further, in 2020, India ranked 48 in the Global Innovation Index[10], emphasising the investment gap it needs to address for the STI sector in context to the blue economy.

Further, micro-finance institutions are yet to popularise micro-finance among coastal communities dependent on the Blue Economy for their livelihood. The financing of the Indian blue economy faces ancillary challenges like introducing insurance products to cover multiple risks faced by the fishermen, including loss of life, loss of craft and gear, other assets or means of livelihood and introducing Market Intervention Scheme (MIS) in marine fisheries[11].

H. Corruption and Governance

Corruption poses a significant threat to the shipping and ports industry. Many developing nations have import/export regulations and other regulatory requirements that lack transparency and create time-consuming, burdensome, and costly procedures for moving goods into and out of their countries. In these countries, where local officials may be underpaid and corruption is prevalent, there is a strong temptation to offer bribes to expedite the import/export process (Deloitte, 2015).

Shipping is a global enterprise involving multiple stakeholders and jurisdictions, making each shipment susceptible to numerous potential pitfalls for unscrupulous actors seeking personal gain. Additionally, large shipping and commercial vessel companies frequently compete for long-term contracts with major manufacturers and exporters. This bidding process can create opportunities for corruption, as exporters may be inclined to show favoritism toward certain bidders. Another significant challenge in the shipping industry is the frequent demands for small bribes, known as "facilitation payments," made by officials to expedite port operations.

[10] https://www.makeinindia.com/global-innovation-index#:~:text=The%20Global%20Innovation%20Index%20(GII,nations%20for%20the%20first%20time.

[11] ESSO-INCOIS-Indian National Centre for Ocean Information Services. (2020)

VI. Chapter 4: Sustainability Initiatives Under the Blue Economy

The Blue Economy links production and consumption to capacity and assists in developing an integrated approach towards economic development and environmental sustainability. The key approaches to sustainability linked to the Indian Blue Economy are:

A. Sustainability Initiatives in India

India is strengthening its commitment to a robust, sustainable and profitable Blue Economy by launching various policies, guidelines and initiatives to ensure that the development is effective, efficient and inclusive. Programs like the 'Sagarmala Program' are undertaking massive, capital intensive initiatives to develop and upgrade all Ports in the country. Such programs are now encouraging private companies to collaborate with the government to implement green practices.

Under the G20 presidency held in March 2023 in Bengaluru, India has recognised marine litter as a key priority under the broader ambit of the Blue Economy. Further, India has identified conservation and restoration of coastal and marine ecosystems and Marine Spatial Planning as key priorities under the sustainability dialogue. Integrated MSP is a focus of the Blue Economy agenda and the Indian presidency is strongly advocating resilience against climate change as a prerequisite for building a sustainable Blue Economy[12].

A sustainable blue economy speaks of just-transition of the workforce. Aligned along UN Global Compact's Sustainable Ocean Principles, it is imperative to respect human, labour and indigenous peoples' rights in the company's ocean related activities, including exercise appropriate due diligence in their supply-chain, consult and engage with relevant stakeholders and communities in a timely, transparent and inclusive manner, and address identified impacts (Principle 7).

B. Sustainability Initiatives in Indian Ports and Fisheries sector

B.1 Ports and Shipping sector

As per India's 'Harit Sagar' Green Ports Guidelines 2023, Indian Ports will play an important role in contributing towards de-carbonization efforts of the country. Ports are, therefore, required to undertake green initiatives in line with the broad vision of the country and contribute to the efforts being made by the country in moving towards achieving India's long term goal of reaching net-zero emission by 2070. This will also help in contributing towards moving closer to the UN SDGs which includes obligations on developing resilient infrastructure for safe, efficient and sustainable ports.

Green shipping refers to the use of environmentally sustainable practices and technologies in the shipping industry to reduce its impact on the environment. The ocean infrastructure, instrumental to achieving the UN Global Compact's mandate for ocean stewardship and management, relies on ocean engineering. Ocean engineering connects the requirements around equipment and infrastructure with the ocean environment, the protection of people working or travelling at sea, and other activities that involve the ocean as a site of interest. It is a blend of science, technology, innovation, knowledge systems, skills, communities, human resources and the symbiotic relationship between the stakeholders of the blue economy and the deep ocean ecosystem. The application of ocean engineering includes design, construction, maintenance and decommissioning of human activities in the oceans. Further, ocean engineering plays a key role in mitigating the impact of climate change on the marine ecosystem by accommodating the effect of climate change

[12] "Ensuring a sustainable Blue Economy is essential to achieve social and economic development goals of G20 countries." The Hindu.

and human activities while designing infrastructure for vulnerable coastal communities and ocean industries, facilitating access to energy and developing solutions for sustainability and resilience.

Some of the sustainability initiatives and best practices in India, directed towards sustainability of the sector, in India on Ports and green shipping include:

B.1.1 National Centre of Excellence in Green Port and Shipping (NCoEGPS)

Recently, the country's first National Centre of Excellence in Green Port and Shipping (NCoEGPS), a collaboration between the Ministry of Ports, Shipping and Waterways (MoPSW) and The Energy and Resources Institute (TERI), was inaugurated. The newly launched NCoEGPS is expected to have a significant role in promoting sustainability in the shipping industry by leading efforts to achieve carbon neutrality and a circular economy. The NCoEGPS will be responsible for creating a regulatory framework and roadmap for the adoption of alternative technologies in green shipping in India, this can be used by Businesses operating in the Ocean's Industry. The NCoEGPS will focus on five broad areas:

- Policy, Regulatory and Research
- Human Resource development
- Network- Key Partners and Strategic collaborators
- Explore- Area of work, outcomes, projects and resources
- Engage- Past events, upcoming events, dissemination

The Center will be a host of several technological arms to support the port and shipping sector and will provide solutions to a variety of problems faced in the industry through scientific research.

B.1.2 Maritime India Vision (MIV) 2030

To advance India's position in the global maritime sector, the Ministry of Ports, Shipping, and Waterways has developed the Maritime India Vision 2030 (MIV 2030). The objective of MIV 2030 is to promote coordinated and accelerated growth of India's maritime sector over the next decade while adhering to international safe and sustainable practices. The exercise involved extensive consultations and discussions with both public and private sector stakeholders.

Key interventions identified under MIV 2030 include increasing the use of renewable energy, reducing air emissions, optimizing water usage, improving solid waste management, implementing a Zero accident safety program, and establishing a centralized monitoring system. MIV also envisions modernization of major ports infrastructure through the Public Private Partnership model.

The Maritime India Vision-2030 promotes waste to wealth through sustainable dredging and domestic ship recycling and aims at reaching the target of Zero Accident Ports by 2022. It also aims to increase the share of renewable energy to over 60% by 2030 from current levels of less than 10%.

B.1.3 Green Ports Initiative

The Ministry of Shipping has launched the Green Port Initiative to promote environmentally sustainable practices in ports. To enhance the environmental performance of major ports, the government has implemented several green port initiatives. These initiatives involve acquiring equipment to monitor environmental pollution, dust suppression systems, sewage and wastewater treatment plants, and garbage disposal systems for ports and ships. The government is also creating sustainable practices that are being incorporated in terminal design, development, and operation and efforts are being made to increase green cover within port premises to reduce impact of pollution and noise.

Additionally, in order to mitigate environmental pollution, Indian ports have implemented various initiatives such as driving solar and wind energy adoption, Swachh Bharat Abhiyan, Swachh Sagar portal for waste management, etc. Additionally, Indian ports are actively working towards enhancing safety measures to prevent accidents and incidents and create a secure working environment.

B.1.4 Cold Ironing: In 2016, ABB India commissioned India's first shore-to-ship power supply for V.O.Chidambaranar port, formerly Tuticorin port, to reduce carbon footprint. ABB Shore-to-Ship technology supplies ships that are docked with electricity from shore, so they can turn off the diesel engines that provide electricity for systems like heating, lighting and refrigeration of the vessel, and reduce greenhouse gas and noise emissions in port. The technology, also called cold ironing, also helps reduce low-frequency noise and vibrations, and allows the crew to maintain diesel engines while the ship is berthed.

B.1.5 Harit Sagar Guidelines 2023

Recently, the Union Minister Shri Sarbananda Sonowal launched 'Harit Sagar', the Green Port Guidelines 2023. The guidelines emphasize the use of clean and green energy, storage, handling, and bunkering of greener fuels such as green hydrogen, green ammonia, green methanol/ethanol. These guidelines provide a framework for major ports to achieve targeted outcomes for reducing carbon emissions and achieving Sustainable Development Goals (SDG) through focused implementation and monitoring of green initiatives. They aim to minimize waste discharge from port operations and promote monitoring based on Environmental Performance Indicators. Additionally, the guidelines cover aspects of the National Green Hydrogen Mission, LNG bunkering, offshore wind energy, and adopting the global Green Reporting Initiative (GRI) standard.

B.1.6 Mechanization and Port Equipment Electrification

Over the past ten years, there have been significant advancements in the drive train technology used for mobile equipment in container terminals (Ministry of Ports, Shipping and Waterways Government of India, 2021). Nowadays, electric drives power the majority of container handling cranes at Indian ports (ibid.). Furthermore, in liquid cargo terminals, almost all pumping, conveying, storage, and product evacuation systems, including pumps and motors, are powered by electricity, accounting for 90% of such systems (ibid.). Furthermore, the approval has been granted for the development and mechanization of the existing East Quay-6 (EQ-6) Berth located in the Inner Harbour of Visakhapatnam Port. This project aims to facilitate the handling of various types of cargoes and will be implemented under the public-private partnership (PPP) mode. The estimated project cost is Rs. 69.69 Crore for a period of 30 years.

B.1.7 Green Tug Transition Programme

In 2023, the Ministry of Ports, Shipping, and Waterways launched the 'Green Tug Transition Programme' (GTTP) with the objective of establishing India as a global hub for constructing environmentally friendly ships. Under this program, all tugboats operating in the country will be converted into 'Green Hybrid Tugs' that run on non-fossil fuels such as Methanol, Ammonia, and Hydrogen (Press Information Bureau, 2023). The plan is to not only convert existing tugboats but also establish domestic manufacturing capabilities for these crucial vessels, which play a vital role in the mooring and berthing operations of ships in ports.

The ministry has set a target for the initial deployment of green tugs in all major ports by 2025. By 2030, it is expected that at least 50% of all tugboats will be converted into green tugs, leading to significant emission reductions as the country progresses towards sustainable development.

B.1.8 Promotion of Coastal Shipping

Coastal and inland waterway transportation are recognized for their energy efficiency, environmental friendliness, and cost-effective nature in handling domestic freight. In the Budget for the fiscal year 2023-24, the government unveiled its plans to leverage the expansive and underutilized coastal regions along the eastern and western seaboard of India. The objective is to foster an energy-efficient and affordable transportation mode for both goods and passengers through partnerships between the public and private sectors, supported by viability gap funding (Press Information Bureau, 2023).

B.1.9 Waste to Wealth – Revamped dredging guidelines

The revised guidelines require Major Ports and the Inland Waterways Authority of India (IWAI) to include appropriate provisions in their Dredging Contracts to promote the reuse and recycling of dredged materials. This approach aims to optimize the cost of dredging by monetizing the dredged material, thereby transforming waste into valuable resources and contributing to the conservation of fresh resources. The objective is to promote the concept of "Waste to Wealth" and encourage the recycling of waste materials in the dredging process.

B.1.10 Private Sector Initiatives

India has witnessed numerous public-private partnership (PPP) initiatives that promote sustainable practices in the shipping sector. The Minister of Ports, Shipping and Waterways, Sarbananda Sonowal, recently revealed a pipeline of 81 PPP projects worth ₹42,300 crore[13]. These projects are focused on developing berths and terminals in major ports until 2024-25. The PPP model has played a pivotal role in expanding capacity and improving productivity in Indian ports over the past 25 years, starting with Jawaharlal Nehru Port (JNP). As a significant milestone, JNP has become the first major port in the country to operate as a 100% Landlord port, with all berths functioning under the PPP model.

In March 2023, Cochin Shipyard Limited (CSL) was awarded the contract to design and build the world's first Zero Emission Feeder Container Vessels. These vessels will be powered by Hydrogen Fuel Cells using Green Hydrogen. The total cost of the project for the confirmed order is approximately Rs. 550 crore. CSL also commissioned a 600KVA, 750 Amps state-of-the-art energy efficient static frequency converter.

Under MIV 2030, key cluster compositions were identified to enhance domestic for indian shipbuilding, ship repair and recycling. Key players in the Indian coastal shipping ecosystem are shipowners, ship operators, cargo owners, shipyards, and equipment suppliers. Other industry players include fuel suppliers, ports, and service providers like financial institutions, insurance companies, classification societies, consultancy services, and research and educational institutions. Industry players such as cargo owners, logistics companies, buyers of transport services, and government authorities are premise providers to the industry. Thus, the private sector being a key stakeholder to the blue economy, emphasises on the role of PPPs to bring synergy and help develop collaborative action for the Indian blue economy.

B.2 Fisheries Sector

The initiatives and strategies applied for the sustainable development of the fisheries sector in the Indian Blue Economy may be articulated as follows:

[13] https://economictimes.indiatimes.com/

B.2.1 Blue Revolution

Blue Revolution, a flagship scheme of the Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, Government of India, launched in the year 2015, aimed to achieve economic prosperity of the country and associated marine communities while contributing to food security. The Blue Revolution aimed to utilise the complete potential of water resources for fisheries development in a sustainable manner being mindful of bio-security and environmental concerns. As a part of the scheme, significant funds were released as central assistance to state and UTs. Further, the scheme promoted the adoption of environmental-friendly technologies for aquaculture and safeguarding of the aquatic ecosystem.

B.2.2 Pradhan Mantri Matsya Sampada Yojana (PMMSY)

The PMMSY, launched in May 2020 by the Government of India, built on the success of the Blue Revolution and provided investment of Rs. 20,050 crore under the Atmanirbhar Bharat package. Project proposals with total outlay of Rs. 2881 crore have been approved under PMMSY during 2020-21 for sustainable development of fisheries and fisheries related infrastructure including fishers' welfare.

PMMSY aims at achieving sustainable and responsible development of the fisheries sector in India with an emphasis on infrastructure, species diversification, livelihood generation, aquatic health management, innovation and technology. The scheme includes the implementation of bio-flocs, Recirculatory Aquaculture System (RAS) with special focus, Reservoir cage culture, open sea cage culture for conservation of marine fisheries and risk mitigation to marine fishers, seaweed cultivation for supporting livelihood and ushering prosperity for coastal communities especially women in sustainable environment friendly manner.

B.2.3 Fishery Survey of India (FSI)

Alongside the Blue Revolution and PMMSY, the FSI is developing new fishing techniques and gears to help minimise degradation of the marine ecosystem. Diversified fishing methods like trap fishing, hook and line, bottom set vertical long-time. have been introduced and successfully implemented with zero damage to the marine ecosystem.

C. Sustainable Financing Initiatives by India

In response to the growing public demand for sustainability, global financial institutions have launched a significant campaign to promote green and sustainable investments. The World Bank Group took the lead in this effort by introducing the pioneering concept of Green Bonds in 2008, channelling investments into sustainable ventures. This initiative laid the foundation for the current green bond market.

India has also witnessed significant initiatives in raising funds through green bonds by domestic banks and private companies. The "Bonds and Climate Change: The State of the Market 2018" report reveals that India's cumulative green bond issuance between 2015 and 2018 reached $6.5 billion. In 2017, Indian public and private sector companies issued green bonds worth $3.9 billion, a significant increase of 2.5 times compared to 2016. The majority of these bonds (51%) were issued by public sector entities (FICCI-KAS, 2019). Several notable foreign currencies denominated green bonds have been issued by Indian entities, including SBI for $650 million in 2018, Hero Future Energies Group for financing their clean energy projects, YES Bank for $600 million in 2019, and Adani Group for $500 million in 2019 to support clean energy initiatives (FICCI-KAS, 2019). SEBI has introduced blue bonds that would support the sustainable use of ocean resources and improve livelihood and development while preserving the ocean ecosystem.

The investments directed towards marine science and technology are relatively small as compared to major research fields. To deepen the knowledge base on ocean sciences, approximately, Rs. 5,500 crores were budgeted for science and technology in the Union Budget 2019-2020, which was increased to Rs. 6,300 crores in 2020-21 (MoST 2020), showcasing the increased commitment of India towards developing the blue economy using STI (Giriyan et al., 2020).

In the Blue Economy sectors, there are various obligations to safeguard the marine environment, such as those found in the UN Convention on the Law of the Sea (UNCLOS), International Maritime Organization (IMO-MARPOL), and Regional Fisheries Management Organizations (RFMOs). Due to these policies and regulations, sustainable business activities are likely to become more favorable and attract more funding.

The Union Government, as an extension to the Harit Sagar green port guidelines, is in the process of provisioning financial incentives for eco-friendly shipping vessels and port projects to promote and support carbon transition. The proposed incentives for the Green-Ship scheme may include viability gap funding (VGF), tax breaks and rebates, as well as priority for green ships during port calls. Although VGF and other incentives are currently under consideration and being conceptualised, the government intends to bring them into operation in the near future (Narayan, 2023).

D. International Cooperation

The International Cooperation Division of the Ministry of Ports,Shipping and Waterways deals with maritime engagements with foreign maritime nations, including signing of Agreements/ MoU for bilateral cooperation in the Maritime sector. India became a member of the International Maritime Organization (IMO) in 1959, which is the global standard setting authority for the safety, security and environmental performance of shipping and ensures that such standards are fair and effective and are universally adopted and implemented.

In 2018, the Indian Government inaugurated the Information Fusion Centre – Indian Ocean Region (IFC-IOR) at the Information Management Centre (IMAC) in Gurugram. The main objective of the fusion center is to collaborate with partner nations and international agencies to establish a comprehensive maritime domain awareness system and exchange information on vessels that are of interest.

In terms of cross-border collaboration, the Indo-Pacific has emerged as a major interface for scientific collaboration and fostering innovation. For instance, India and the USA are making efforts to engage with Indo-Pacific countries in the areas of renewable energy. In the past decade, joint or bilateral scientific research collaborations have increased exponentially in India that focus on specific mutual research interests such as the Indo-German Science and Technology Centre.

The Ministry of Ports, Shipping and Waterways propelled the MIV 2030 by collaborating with Norway to develop a green shipping future through bilateral dialogue.

E. Anti-Corruption and Governance

Companies that adopt strict internal policies against bribery and facilitation payments may face the risk of losing business or experiencing delays unless their competitors implement similar measures. To overcome this, ‘collective action’ is required, which allows businesses to collaborate, share information, coordinate actions, and engage with governments and civil society without compromising their competitive advantage or freedom to operate.

One notable example of successful collective action is the Maritime Anti-Corruption Network (MACN). Established in 2011, MACN is an industry-led initiative dedicated to creating a corruption-free maritime industry that fosters fair trade for the benefit of society. MACN consists of various stakeholders within the maritime industry, including vessel owners, cargo owners, and service providers. Since its inception, MACN has worked diligently to enhance the anti-corruption programs of its member companies. It provides them with systems, tools, policies, and best practices, specifically targeting the ability of captains arriving in ports to reject demands for facilitation payments.

In 2023, the Maritime Anti-Corruption Network (MACN) joined forces with the International Seafarers' Welfare and Assistance Network (ISWAN) to introduce a helpline service as an important initiative to combat maritime bribery and other forms of corruption on the seaside in India. This collaboration serves as a vital component of MACN's ongoing efforts to address incidents of bribery and corruption, whether involving monetary transactions or non-monetary favours. Notably, in 2019, MACN had launched its Port Integrity Campaign in India, aiming to minimize and ultimately eliminate integrity issues and trade obstacles during operations conducted at Indian ports. UNGC and MACN work very closely to promote collective action for anti-corruption, governance, transparency and ethics.

VII. Chapter 5: Science, Technology and Innovation

A. Sustainable technologies, innovation (STI) and trends

Science, Technology and Innovation (STI) play a central role in assisting the much-needed transition of intense ocean utilisation to sustainable practices. It has been a focus point for the Indian blue economy over the past few decades. Ocean security and safety makes development of dual-use technologies (such as nuclear technology, space and ocean exploration) a high priority. The Indian blue economy innovation and initiatives have primarily concerned port facilities and building partnerships with IOR member countries.

In terms of ocean technology, India has made significant progress in the domains of marine biology and biotechnology, supported by projections expecting the Indian blue economy to generate USD 100 Million by 2025 through biological and bio-technology industrial growth (Giriyan et al., 2020).

India has undertaken substantial efforts to develop a blue economy framework and this initiative may be fuelled by consistent development and investments in the domain of science and technology of the blue economy sectors including ports, fisheries, shipping, deep sea mining and blue biotechnology among others. The emphasis to enhance emerging sectors in the blue economy would entail constant progress in India's S&T framework and aligning strategies and policies to foster an environment conducive for innovation to thrive.

Ocean mapping, GIS mapping, real time data analysis, data visualisation etc are integral STI tools to support sustainable development of sectors related to oceans, especially shipping, energy, logistics, fishing industry and offshore energy. India has the third largest Science and technology (S&T) manpower in the world but the gross domestic expenditure on R&D stood at 0.65%, according to Economic Survey 2021.

In order to enhance the "Ease of Doing Business," the SAGAR-SETU mobile app, part of the national Logistics Portal (Marine), was introduced by the Minister of Ports, Shipping, and Waterways on March 31, 2023. This app aims to enable real-time operations and monitoring within ports, providing various services for the port community to access data and services related to vessels, cargo, containers, finance, and regulatory authorities. The goal is to enhance the overall customer experience in the maritime industry.

Additionally, India has launched programs such as "Oceanography from space" and "Launching of the data buoys" along the Indian coastline. The implementation of these measures has facilitated the transmission of information regarding diverse oceanographic aspects, such as weather, through satellites, enabling their scientific analysis.

B. The role of STI in Ports, Fisheries and other sectors of the Indian Blue Economy

The role of STI in assisting emerging sectors of the Indian Blue Economy to becoming more efficient and productive may be articulated as:

B.1 Fishing Industry and Aquaculture

The advancement in fishing technology has given an impetus to the demand for fishery, as a source of food and livelihood in India.

Several techniques are deployed for fishing. For instance, artisanal fishing makes use of fishing gears that include boats, motors, nets, and lines while coastal states extensively still rely on traditional fishing methods using nets and mesh. Currently, the Indian fishing sector houses 58911

mechanized vessels, 75591 motorized vessels and 104270 non-motorized vessels[14], thus showing a shift towards mechanization in the recent past. The use of non-mechanised boats has recorded a sharp drop over the last two decades, coupled with a substantial increase in the use of mechanized and motorised boats. The rapid development of harbours and landing jetties, motorization of artisanal crafts and mechanised fishing has significantly contributed towards an increase in fish production, employment generation and revenue.

Aquaculture, an emergent sector of the fishing industry, has grown manifolds in the recent decade. Technology associated with induced carp breeding and polyculture in static ponds and tanks have contributed to the growth of aquaculture productivity. The sector boasts of significant technological developments both for fish seed development and production of aquaculture. Major freshwater culture technologies may be classified as polyculture of Indian carps, mono and polyculture of air-breathing fish, mono and polyculture of freshwater prawns, integrated fish farming, cage culture, and pearl culture. This emergent sector calls for investments in the near future emphasising sustainability principles and conservation of the ocean's marine ecosystem with responsible fish and pearl harvesting.

Mariculture has huge potential to create sustainable livelihoods for marine fishers. Collection and analysis of data by using transponders, satellites and drones is one of the crucial aspects for managing the marine fish population, and will also help in precision fishing. Adoption of emerging technologies like big data, blockchain, automatic identification system (AIS) and IoT-based supply chain systems can help in minimising losses, improving traceability and achieving sustainability.

B.2 Shipping and Ports

STI finds extensive application in the shipping and port industry of India. The government has signed several MoUs with countries like Egypt and Korea to develop cooperation in the development of ports, sharing of technology, enabling manpower training, and stimulating the steady growth of maritime traffic. Digitization of various processes in small and major ports has enabled seamless coordination in the logistics while ushering in the regulation of activities at various container freight stations (CFSs), inland container depots (ICDs), and port terminals. Further, India has also signed the Hong Kong Convention, which emphasises on enhancing technological adaptations and sustainable innovation for the shipping sector. The MoUs and convention, to which India is a participant, further the goal of creating a green economy with STI at its helm, supported by decent work opportunities facilitating a just transition for all.

The introduction of technology has helped reduce cost of operation for the industry and contributed to the revenue. Intelligent port systems focusing on data-based analytics and tools for operation, are an essential part of the Vision 2030 initiative, therefore setting the momentum for sustainable innovation and technology in the shipping and port industry.

The Indian shipping and port industry's innovations are expected to incorporate a holistic plan for greenfield indigenous shipyards under the Atmanirbhar initiative to boost the shipping sector.

Innovation incorporates design and energy efficient design index standards as per the following categories: Very Large Crude Carriers (VLCC), Liquified Natural Gas (LNG) Carriers, Container carriers, Cruise ships, Medium sized ships for coastal shipping, Dredgers and yard craft, Deep Sea Fishing Vessels, Research Ships, Solar powered fishing boats, Electric driven passenger ferries for inland waterways.

[14] https://mesasmabicollege.edu.in/public/uploads/facultyfile/1680158522.pdf

Further, sustainable port development in India requires, both the ports and the shipping traffic to be compliant with current environmental regulations. The application of renewable energy, water conservation, and energy efficiency should form critical components of the sustainable development model. STI in port development can help further the goal of creating a zero waste and circular economy approach.

The rapid advancement in global engineering technologies over the last half century found several applications in the maritime sector, which led to the modernisation of ports, improved efficiency in ship turnaround times, containerisation and enhanced port security. The shipping industry is adapting rapidly to modern technologies with a focus on autonomy the IoT and Data Analytics. These 'smart' ship technologies are transforming the existing paradigm with the entire maritime industry and ecosystem moving in this direction (Commodore Singh, 2021).

B.3 Marine Biotechnology

Marine biotechnology is positioned to contribute approximately USD 100 million by 2025 to the Indian economy. Marine biotechnology plays a crucial role in the extraction of marine species which, subsequently, finds application in several sectors like biotechnologies, nanotechnology, biomaterials and in the introduction of genetically modified fish for the Aquaculture sector. Further, the ambitious 'Sagar Mala' programme emphasises on maritime infrastructure and will indirectly benefit the marine biotechnology sector as well by enhancing facilities, amenities and technological innovation. India is focusing on deep sea mining and deep sea exploration using advanced technological solutions, for biological materials which in turn will prove beneficial for several sectors including pharmaceuticals and beauty industry.

B.4 Offshore Energy Sources (Marine Renewable Energy)

STI has been instrumental in exploring and developing offshore energy sources. Technology associated with harnessing wind, tidal, wave and even hybrid energy from oceans like Ocean Thermal Energy Conservation (OTEC) helps reap benefits of oceanic energy.

Renewable energy generation has been a focus for the government since, National Action Plan on Climate Change (NAPCC) announced in the year 2008. India is committed to developing technological and implementation capabilities for offshore energy sources with the National Offshore Wind Energy Policy 2015. Gujarat and Tamil Nadu, specifically, have the potential to contribute to India's offshore energy sources.

C. Technological Solutions and Investments for the Blue Economy

Technological instruments like radars, acoustics and optics, are extensively used to extract data from the ocean and explore the uncharted resources. Remotely Operated Underwater Vehicles, Satellite Oceanography, GIS, SONAR and Animal Telemetry, among others, also help in mapping varied ocean resource bases. Further, India has been conferred the status of pioneer investor and been allotted a site in the Central Indian Ocean Basin (CIOB) by the International Sea Bed Authority to promote exploration and technology enhancement for polymetallic nodule mining. The Indian budget has earmarked an investment of 4000 crore over five years, spanning 2021-2026, to help foster an environment conducive to undertake R&D in the deep ocean domain. Further, the state budgets also allocate investments for ocean related activities and allied research. To this end, the private sector also, although sparingly, contributes to the R&D of this domain alongside other innovative financing tools.

C.1 Marine Spatial Planning

MSP holds great importance as a key facilitator for unlocking the potential of Blue Growth in the future. India possesses the necessary technical expertise to generate and analyze crucial data and information using space applications, ICT, navigational tools, AIS systems, bioprospecting, and various other marine domain awareness capabilities. These capabilities are vital for the development of MSPs. India should not only leverage these capabilities to establish its own MSPs but also provide support to other regional partners in achieving similar objectives. India's first MSP Framework was launched in Puducherry in 2023 and the authorities have already begun work on launching similar frameworks for other coastal states.

VIII. Chapter 6: Conclusion and Recommendation

Businesses play a vital role to catalyse the development of India's Blue Economy as per the vision laid out by the Government of India in its various maritime policies and also the SDGs, thereby leading to a net-zero, equitable and climate-resilient ocean economy. The prioritisation of oceans from an economic and environmental perspective entails synergy among various industries (businesses) and stakeholders of the blue economy sectors to map their impact, trade-offs and role.

Climate Smart Oceans Business Operations[15]:

- Ocean-based industries — such as maritime transport, aquaculture and fisheries — are taking mitigation action by setting science-based targets (SBT) aligned with a 1.5°C trajectory across their value chains.
- Advances in scientific understanding of the role of blue carbon ecosystems have helped articulate the business case for mitigation measures beyond value chain reduction targets
- The financial and insurance sectors are increasingly aware of the risks associated with undermining the functioning of ocean ecosystems that act as natural buffers to climate change and are getting actively involved in the ocean's industry

A. Port Infrastructure Development and Green Shipping

i. Leveraging the scope designed by the various policies, guidelines and programs initiated by the Government of India

The various policies and programs initiated by the government of India like the - Sagarmala program, Harit Sagar Green Ports Guidelines 2020, the Maritime India Vision 2030 etc, can be used by the private sector as a guiding tool for decision making to not only develop a robust port infrastructure for green shipping, focusing on decarbonisation and sustainable expansion, but also establish frameworks towards minimising disturbance to the ecosystem dynamics of the surrounding aquatic and atmospheric environment.

The Maritime India Vision 2030 (MIV 2030) identifies several measures to enhance private sector participation in the sector. These include strengthening model concession agreements, granting infrastructure status to ships, and expanding the implementation of PPP to additional port operations.

While designing Green Ports, businesses need to ensure a human centred design, prioritizing safety of the labourers and other people working on ports.

ii. Construction of transport infrastructure to enhance Port Connectivity

Businesses can focus on supporting India's oceans economy by developing multimodal logistics centres around the Ports to achieve efficiency in logistics, time and cost. This will improve the supply chain sustainability and increase the capacities of Indian ports to handle large cargos.

iii. Accelerated Technology Development

As India is increasingly focused on decarbonising its ports and energy transition to clean energy at ports, the need for technology and innovation is fast increasing. Access to technology has become imperative for port authorities. Training manpower in adequate technical skill sets should also be taken into consideration by businesses while providing technology solutions to the Ports.

[15] The Ocean-Climate Nexus: A blueprint for climate smart ocean to meet 1.5 degree C, UNGC

iv. Prevent Environmental Pollution

- Cold Ironing: It is now imperative to explore provision of providing green/clean fuels from shore to ships which are anchored at ports
- Water pollution by berthed ships at ports: The ports should provide shore reception facility for safe disposal of waste, by the ships anchored at the Ports, as per government of India guidelines. Installation of water treatment, desalination and water harvesting plants can be explored by businesses at the Ports.
- The Ports are shifting to renewable/clean sources of energy for running all the Port related operations

B. Marine Fisheries, Aquaculture and Fish Processing Sector

The significance of this sector, for Indian businesses, is two dimensional: employment potential and export potential. Apart from the direct employment to fishermen, this sector is responsible for generation of employment for several millions in seafood and ancillary industries.

i. *Enhancing Mariculture Production*

Mariculture is a subset of aquaculture and is the farming of marine organisms in salt water for food and other products such as pharmaceuticals and jewellery items like pearls. This is an important emerging industry of the Blue Economy.

Businesses can explore diversification of fish production in other areas like integrated fish farming, cold water fisheries, riverine fisheries, capture fisheries, brackish water fisheries, etc. leading to better income generation opportunities. Within fish and fish products, India is highly competitive in shrimps and prawns and it should try to enhance this capacity in a sustainable manner. It is important to ensure that fish production and farming is environmentally-compatible, financially-viable and socially-acceptable.

ii. Technology and Innovation

Technology like block chain is required for sustainable fish production and enhances end-to-end traceability of fish consignments.

India is the second largest producer of fish globally, for it to increase its share in the GDP, use of modern technology and innovation for breeding, will be imperative. The private sector is well equipped to provide advanced technology solutions to the fisheries sector and strengthen the source of livelihood for many coastal communities. In turn, businesses will also benefit from focusing on traceability and transparency in the supply chain.

iii. Infrastructure Development

- Adequate infrastructure needs to be built as per international standards to strengthen the value chain/cold chain/supply chain and minimize post-harvest loss of fisheries, especially modern landing facilities, fishing harbors, ice crushing units, refrigeration, modernized packaging techniques for chilled products etc.
- Post harvest loss can be minimized by setting up centralized vending centers.
- Provision of modern fishing vessels to handle storage and preserve quality of fish, as well as use of motorized fishing boats further helps to prevent loss.

iv. Financial Inclusion for Marine Fishery

Indian financial institutes can play an integral role in advancing the Marine fisheries industry and thereby promote Blue Economy in India, few recommendations are:

- Make financing schemes like subsidies, insurance, etc accessible to fish processing industries to encourage sustainable fishing, marketing practices and also cover risks

- Introduce financial incentives to attract technology and investment in deep sea fishing and value chain development
- Increased access to institutional credit at affordable cost for meeting capital and operational costs

C. Harness Blue Finance

Investments in marine technologies are imperative but they are capital intensive and have a high gestation period. In order to shorten the adoption path, it is important that companies are able to access institutional credit at affordable cost for financing investment in fixed and working capital in various oceans related sectors. As per a report by FICCI (2017), substantial scope exists to strengthen MSMEs through improved access to finance, fostering entrepreneurship, market access and an enabling business environment regionally.

SEBI has introduced blue bonds that would support the sustainable use of ocean resources and improve livelihood and development while preserving the ocean ecosystem.

Sectors like fisheries and aquaculture, need high investment, though there are many government initiatives which are currently supporting the industry, but for the businesses to grow and sustain itself they will need investment from the private sector. Micro-finance institutions can support the SME's/SHGs in the fisheries sector, who can unlock the growth potential of the blue economy.

Similarly, shipping in India is the industry in the blue economy with the most scope to grow, but is mainly dominated by foreign players, with whom domestic players cannot compete. Investment by the private sector or public-private partnership models is crucial for: access to credit, meeting high operating costs, improving infrastructure and meeting bureaucratic hurdles which is crucial to help the industry grow and increase their share in India's GDP[16].

The Government's draft Blue Economic Policy 2020 suggests the formation of a Maritime Development Fund with fund mobilization from stakeholders in a Public Private Partnership ventures, which would comprise sub-funds catering to requirements of sectors like: shipbuilding, ship repair and ship recycling, maritime infrastructure, harnessing renewable energy, cleaning of marine litter, Port equipment and services, cruise terminals and marinas and technology development to cater for industry in the maritime sector.

D. Investment in technology and Innovation

- Coastal Marine Spatial Planning (CMSP): India has already started this in Puducherry, such tools can be adopted by all coastal states in India
- Marine Biotechnology: One of the fastest emerging high-technology sectors in the Blue Economy is marine biotechnology. It has wide-ranging applications in industrial sectors including pharmaceuticals, cosmetics, nutritional supplements, molecular probes, enzymes, fine chemicals and agrichemicals[17].
- Technologies like imaging and physical sensors, satellite technologies, advanced information and communication technology (ICT), big data analytics, biotechnology, nanotechnology and subsea engineering etc will be required to deploy sustainable, cost effective and efficient systems in ports, supply chains, fisheries, combating marine litter, pollution by ships anchored at ports etc

[16] **https://timesofindia.indiatimes.com/blogs/voices/diving-into-indias-blue-economy-a-sea-of-opportunities/**

[17] **https://ficci.in/spdocument/20896/blue-economy-vision-2025.pdf**

- Offshore energy source: The Indian government is committed to harnessing marine renewable energy. The Ministry of New and Renewable Energy has declared Ocean Energy as renewable energy and has clarified, that energy produced using various forms of ocean energy such as tidal, wave, ocean thermal energy conversion, among others, shall be considered as renewable energy and be eligible for meeting the non-solar Renewable Purchase Obligations of the country.
- Waste Management in oceans and at ports: there is a need to adopt a robust waste management strategy which creates infrastructures and processes which reduce and prevents the rising ocean pollution and degradation of ocean health due to anthropogenic activities.
- Cyber security: Maritime cybersecurity in India is becoming an increasingly pressing concern for India's strategic and commercial interests. As they have grown in complexity, maritime operations have become increasingly dependent on a variety of sophisticated technologies.
- Safety: A deep knowledge system of the ocean ecosystem is essential to protect life, property and the environment. Science, Technology & Innovation should be used to predict frequency and impact of hazards.
- Technological instruments like acoustics, optics and radars are also extensively used in extracting data and potential of various resources from oceans. Remotely Operated Underwater Vehicles, Satellite Oceanography, GIS, SONAR and Animal Telemetry, among others, also help in mapping varied ocean resource bases[18].

Sustainable ocean economy has to be based on clean technologies that will ensure the economic and social needs of the people without damaging the planet.

The Indian Blue economy may benefit from the following industry actions and initiatives:

- Private participation and creation of an attractive investment market. Budgetary enhancements and promotion of investments for technological innovations and resources would support the creation of a harmonized blue economy framework
- Developing a regional consortium to add value to India's focus on building a scientific interface
- Investment in research and development, including private and public institutions, to accelerate the ideation and innovation process
- Mapping current technologies in ocean-related sectors and leveraging on existing technological solutions and information is essential to pave the road map for the future of ocean-based research
- Skill-development, capacity building and training to enhance the workforce associated with the deep ocean

E. Increasing the role of Private Sector in the Ocean Economy

According to the government, The MSME sector can play a catalytic role in unlocking the potential for growth in blue manufacturing by augmenting product value addition, wage employment and income generation.

The Maritime India Vision 2030 (MIV 2030) identifies several measures to enhance private sector participation in the sector. These include strengthening model concession agreements,

[18] **https://www.teriin.org/sites/default/files/2021-05/wp2-STI-Blue-economy-India.pdf**

granting infrastructure status to ships, and expanding the implementation of PPP to additional port operations.

F. Just Transition and Decent Work for All

As the ocean's industry is growing there is a need for developing new skills and upgrading old ones. Each ocean-based sector needs to prioritize human resources for a better future. Skill development, capacity building, and training need to be accelerated and enhanced to ensure a strong and skilled. The businesses play a key role in developing sector specific skill-sets for the human resources employed in the marine ecosystem.

The new emerging sector requires a highly skilled workforce and the transitions in traditional sectors require a specific type of skilling as well. Creating a synergy between the two sectors to ensure that livelihood opportunities for both the skilled and unskilled labour are enhanced is imperative. Decent work in the blue economy entails addressing climate change alongside safer working environments for all.

Businesses which are part of the blue economy must be grounded in occupational safety and health, actively protect vulnerable groups, facilitate knowledge sharing between countries, and ensure diversity and inclusion across sectors.

G. Partnership for the Development of Blue Economy

- International cooperation: India has significant potential to engage in international cooperation to advance our interests in the blue economy. Sharing technology and innovation across countries at different levels of development is necessary to ensure genuine benefits to safe and sustainable ocean resource management.
- Initiatives like UNGC's Oceans Stewardship support the private sector to adopt sustainability frameworks and goals into core business operations. It has taken out a standard for healthy and productive oceans which has nine principles that provide a framework for responsible business practices across sectors and geographies. The principles are broadly categorised under: Ocean Health and Productivity, Governance and Engagement and Data and Transparency.
- National Agencies Collaborating: The Indian industries and knowledge institutions must collaborate to build a multi-stakeholder approach to addressing the blue economy and moving towards sustainable management and stewardship of the deep oceans.
- Public Private Partnership is encouraged for large scale and capital intensive projects that accelerate growth, while ensuring sustainable development

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