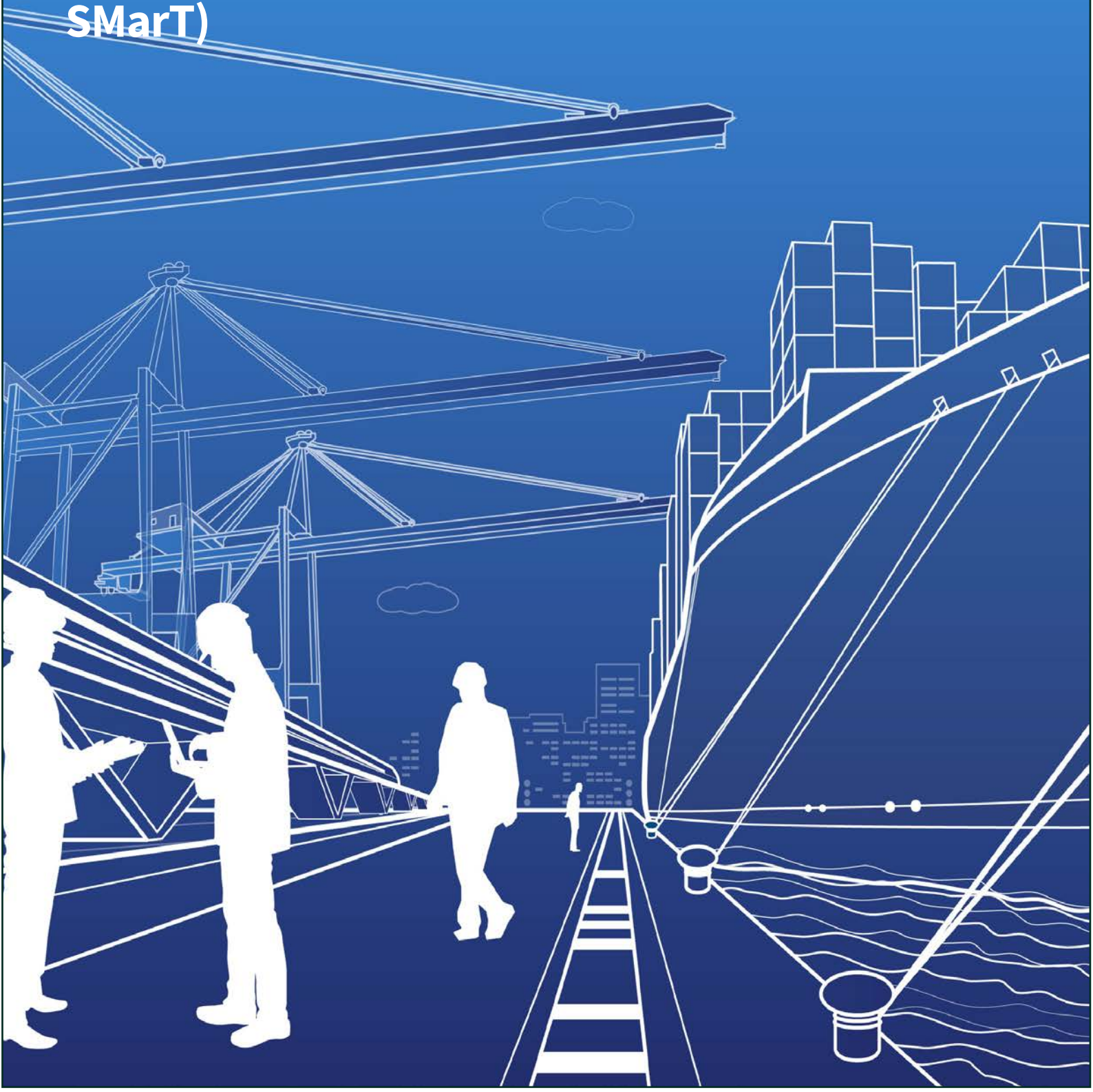
Consultative Document for the Proposed Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT)



सर्बानंद सोणोवाल
SARBANANDA SONOWAL

सत्यमेव जयते

पत्तन, पोत परिवहन और जलमार्ग मंत्री
भारत सरकार
Minister of Ports, Shipping and Waterways
Government of India

FOREWORD

I am honoured to present the Consultative document of the Detailed Project Report (DPR) for the Indian Ocean Centre for Sustainable Maritime Transport (IOCE-SMarT), proposed to be established in Mumbai. This visionary initiative stands as a testament to the Government of India's steadfast commitment to enhancing capacity building and promoting sustainable maritime practices.

The establishment of IOCE-SMarT will mark a significant milestone in India's maritime journey. As a premier centre dedicated to fostering advanced research, technological innovation, and collaborative partnerships, IOCE-SMarT will play a pivotal role in addressing the challenges of sustainable maritime transport. By serving as a hub for knowledge exchange and skill development, the Centre will significantly contribute to enhancing India's maritime capabilities and influence within the Indian Ocean region and beyond.

A key component of this initiative is the proposed BIMSTEC Maritime Training Centre (BMarTC), to be developed under IOCE-SMarT in collaboration with the Ministry of External Affairs (MEA). This Centre will serve as a critical platform for regional cooperation, providing specialized training and fostering deeper maritime partnerships among BIMSTEC nations.

The Government of India recognizes the vital role of sustainable maritime transport in driving economic growth while safeguarding our marine environment. Through initiatives like IOCE-SMarT, we aim to align our maritime objectives with global standards, fostering innovation and resilience in the face of emerging environmental challenges. This initiative underscores India's dedication to not only advancing its own maritime interests but also contributing to regional cooperation and the broader global agenda on sustainability.

I extend my heartfelt appreciation to the Directorate General of Shipping and Lloyd's Register for their diligent efforts in preparing this comprehensive document. Their insights and expertise have laid a strong foundation for the successful realization of IOCE-SMarT.

I invite all stakeholders—industry leaders, academic institutions, policymakers, and environmental organizations—to actively participate in the consultation process. Your valuable feedback will ensure that IOCE-SMarT becomes a centre of excellence, driving sustainable maritime practices and fostering innovation across the sector.

Together, let us steer India's maritime sector towards a future defined by sustainability, technological advancement, and regional leadership.

(Sarbananda Sonowal)

Place: New Delhi
Date: 14th February, 2025

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SHANTANU THAKUR

सत्यमेव जयते

राज्य मंत्री
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
भारत सरकार
Minister of State
For Ports, Shipping and Waterways
Government of India

Foreword

It is a privilege to present this Consultative Document for the Indian Ocean Centre for Sustainable Maritime Transport (IOCE-SMarT), a pioneering effort set to transform India's maritime landscape through sustainable development and regional collaboration. This project represents a forward-thinking approach to strengthening India's maritime sector, with a focus on sustainability, capacity building, and international cooperation.

The IOCE-SMarT, to be established in Mumbai, is more than just an infrastructure project—it is a platform that will drive innovation, promote advanced research, and create opportunities for knowledge exchange across the maritime industry. It will play a crucial role in equipping our maritime workforce with the skills needed to navigate the evolving landscape of sustainable transport.

A notable feature of this initiative is the BIMSTEC Maritime Training Centre (BMarTC), which will be developed under IOCE-SMarT in collaboration with the Ministry of External Affairs (MEA). This Centre will serve as a bridge, fostering closer maritime ties and shared learning experiences among BIMSTEC nations.

The Government of India remains committed to fostering sustainable maritime practices, and IOCE-SMarT is a clear demonstration of this commitment. By aligning with global sustainability goals and regional cooperation efforts, we aim to create a maritime sector that is both resilient and forward-looking.

I commend the Directorate General of Shipping and Lloyd's Register for their hard work and expertise in preparing this comprehensive document. Their efforts have provided a solid foundation for this important initiative.

I encourage all stakeholders—whether from the maritime industry, academia, policymaking bodies, or environmental organizations—to engage actively in the consultation process. Your perspectives and insights will be invaluable in shaping IOCE-SMarT into a centre of excellence that meets the needs of the present while preparing for the challenges of the future.

Let us join hands in shaping a maritime future that champions innovation, embraces sustainability, and fosters inclusivity at every level.

(Shantanu Thakur)

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नौवहन महानिदेशक
एवं अपर सचिव, भारत सरकार

Shyam Jagannathan, I.A.S.
Director General of Shipping &
Additional Secretary to the Govt. of India

सत्यमेव जयते

भारत सरकार
Government of India
पत्तन, पोत परिवहन और जलमार्ग मंत्रालय
MINISTRY OF PORTS, SHIPPING AND WATERWAYS
नौवहन महानिदेशालय
Directorate General of Shipping

Date: 14.02.2025

Message from the Director General of Shipping

It is with a sense of professional achievement that I introduce this Consultative Document for the Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT). This comprehensive proposal, prepared through the collaborative efforts of Lloyd's Register (LR) and the Directorate General of Shipping (DGS), represents a critical step in advancing India's strategic objectives for sustainable maritime development.

The IOCE-SMarT is envisioned as a premier institution dedicated to fostering advanced research, capacity building, and technological innovation in maritime sustainability. By establishing robust linkages with international bodies and regional partners, including BIMSTEC countries, this initiative is set to catalyse transformative growth within the Indian Ocean maritime ecosystem.

The governance structure and operational framework proposed for IOCE-SMarT are designed to facilitate seamless integration between research outcomes and practical maritime applications. This approach is anticipated to significantly enhance India's capabilities in sustainable maritime practices while strengthening regional maritime cooperation and positioning the Indian Ocean as a leader in this domain.

I would like to formally acknowledge and commend Lloyd's Register for their expertise and dedication in the development of this document. Their technical proficiency and strategic insights have been instrumental in shaping a viable and forward-looking roadmap for IOCE-SMarT.

The document will now undergo a thorough consultation process with key stakeholders. I encourage active participation from maritime industry leaders, academic institutions, regulatory authorities, and environmental organizations. Your feedback and insights are essential to refining this initiative and ensuring it effectively addresses the challenges of sustainable maritime transport.

Once the Ministry of Ports, Shipping, and Waterways (MoPSW) grants its approval, the establishment of IOCE-SMarT will signify a major advancement in India's maritime landscape, supporting both national priorities and regional collaboration.

I extend my sincere appreciation to Lloyd's Register and all stakeholders involved in this important initiative. Your dedication and cooperation will play a vital role in shaping a maritime sector that is sustainable, innovative, and globally competitive. Let the institutions conceptualized herein grow into a vibrant repository of leading research and excellence in the transition to a sustainable future.

14/2/25

(Shyam Jagannathan)
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In partnership with the India Directorate General of Shipping, Lloyd's Register (LR) is proud to present this pioneering initiative to establish a world-class hub for training, research, and innovation in sustainable maritime practices. Driven by the Ministry of Ports, Shipping and Waterways, Government of India, the Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT) aims to generate sustainable development and foster regional collaboration across India and the broader Indian Ocean region.

The centre will cultivate connections and partnerships both regionally and internationally and support the development of an appropriately skilled workforce for a green and smart future.

The IOCE-SMarT is a crucial component of India’s vision to promote sustainable maritime practices and LR applauds the Government of India’s commitment to this project, which will not only bolster the country’s growth as a world-leading maritime centre but also benefit the global shipping industry.

Andy Mckeran
Chief Commercial Officer
Lloyd’s Register

Document control

Revision history

Revision No.	Date	Revision
0-1	03 Jan 2025	Draft for LR comment
2	28 Jan 2025	Revised
3	14 Feb 2025	Revised to include DG comments

List of abbreviations

Abbreviation	Description
AI	Artificial Intelligence
ASEAN	Association of Southeast Asian Nations
BAU	Business as Usual
BIMSTEC	Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation
bio-LNG	Bio Liquefied Natural Gas
BMS	Battery Management Systems
BRICS	Brazil, Russia, India, China, South Africa
BRSR	Business Responsibility and Sustainability Reporting
BWTS	Ballast Water Treatment Systems
CAPEX	Capital Expenditure
CCS	Carbon Capture & Sequestration
CCUS	Carbon Capture, Utilization, and Storage
CIF	Climate Investment Fund
CII	Carbon Intensity Indicator
ClassNK	Nippon Kaiji Kyokai (Japanese Classification Society)
CO2	Carbon Dioxide
COP26	26th United Nations Climate Change Conference
DAC	Direct Air Capture
DGS	Directorate General of Shipping
DSME	Daewoo Shipbuilding & Marine Engineering
ECGC	Export Credit Guarantee Corporation of India Limited
EEXI	Energy Efficiency Existing Ship Index
EEZ	Exclusive Economic Zone
EIB	European Investment Bank
EPR	Extended Producer Responsibility
ESG	Environmental, Social, and Governance
ETS	Emission Trading Scheme
EU	European Union
EU ETS	European Union's Emissions Trading System
EUSRR	EU Ship Recycling Regulations
EV	Electric Vehicle

EXIM	Export-Import
FAME India	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India
FDI	Foreign Direct Investment
GCF	Green Climate Fund
GE	General Electric
GEF	Global Environment Facility
GFDZs	Green Fuel Development Zones
GHG	Greenhouse Gases
GMC	German Maritime Centre
GMDC	Global Maritime Decarbonization Centre
GoI	Government of India
GRI	Global Reporting Initiative
GRIHA	Green Rating for Integrated Habitat Assessment
GST	Goods and Services Tax
GTTP	Green Tug Transition Program
GW	Gigawatts
HFO	Heavy Fuel Oil
HHI	Hyundai Heavy Industries
HKC	Hong Kong Convention
ICT	Information and Communication Technology
IFC	International Finance Corporation
IGBC	Indian Green Building Council
IIT	Indian Institute of Technology
IMDA	Indian Maritime Data Analytics
IMDF	India's Maritime Development Fund
IMO	International Maritime Organization
IMO DCS	International Maritime Organization Data Collection System
IOCE-SMaRT	Indian Ocean Centre for Excellence for Sustainable Maritime Transport
IOR	Indian Ocean Region
IoT	Internet of Things
IP	Intellectual Property
IMU	**Indian Maritime University**
IRENA	International Renewable Energy Agency
ISO	International Organization for Standardization

ITM	Industry Transformation Map
IWAI	Inland Waterways Authority of India
IWT	Inland Water Transport
JICA	Japan International Cooperation Agency
JIT	Just-In-Time
JNPA	Jawaharlal Nehru Port Authority
KRW	South Korean Won
LCA	Life Cycle Assessment
LDCs	Least Developed Countries
LED	Light-Emitting Diode
LEED	Leadership in Energy and Environmental Design
LNG	Liquified Natural Gas
LT-LEDS	Long-Term Low-Emission Development Strategy
MARPOL	International Convention for the Prevention of Pollution from Ships
MDB	Multilateral Development Bank
MDO	Marine Diesel Oil
MEPC	Marine Environment Protection Committee
MGO	Marine Gas Oil
MIV 2030	Maritime India Vision 2030
MKAV	Maritime Amrit Kaal Vision
MMMCZCS	Mærsk Mc-Kinney Møller Centre for Zero Carbon Shipping
MOF	Korea's Ministry of Oceans and Fisheries
MOL	Mitsui O.S.K. Lines
MoPSW	Ministry of Ports, Shipping and Waterways (Government of India)
MPA	Maritime and Port Authority of Singapore
MRV	Monitoring, Reporting, and Verification
MSC	Mediterranean Shipping Company
MSGI	Maritime Singapore Green Initiative
MSME	Micro, Small, and Medium Enterprises
MTI	Maritime Training Institute
NAPCC	National Action Plan on Climate Change
NDB	New Development Bank
NEDO	New Energy and Industrial Technology Development Organization
NEMMP	National Electric Mobility Mission Plan

NGSP	National Green Shipping Policy
NIS	Norwegian International Ship Register
NOx	Nitrogen Oxides
NYK	Nippon Yusen Kabushiki Kaisha (Japanese Shipping Company)
OPS	Onshore Power Supply
PANI	Portal for Assets and Navigational Information
PE/VC	Private Equity/Venture Capital
PLI	Production-Linked Incentive
PM	Particulate Matter
PPP	Public-Private Partnership
R&D	Research and development
RED	Renewable Energy Directive
RIS	River Information System
RMI	Rocky Mountain Institute
SAARC	South Asian Association for Regional Cooperation
SAFc	Sustainable Aviation Fuel Certificates
SASB	Sustainability Accounting Standards Board
SATAT	Sustainable Alternative Towards Affordable Transportation
SBFAP	Shipbuilding Financial Assistance Policy
SDGs	Sustainable Development Goals
SEBI	Securities and Exchange Board of India
SEEMP	Ship Energy Efficiency Management Plan
SENSREC	Safe and Environmentally Sound Recycling
SIDS	Small Island Developing States
SMEs	Small and Medium Enterprises
SMI	Singapore Maritime Institute
SOx	Sulfur Oxides
SRS	Singapore Registry of Ships
STS	Shore-to-Ship Power
TCFD	Task Force on Climate-Related Financial Disclosures
TRL	Technology Readiness Level
UAE	United Arab Emirates
UNCTAD	United Nations Conference on Trade and Development

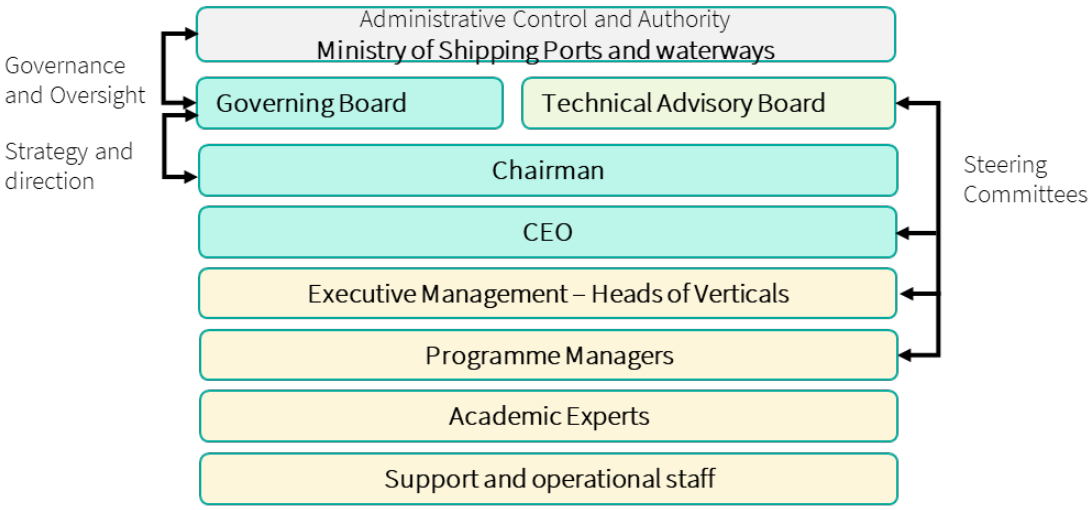
Executive summary

Indian Ocean Centre for Excellence for Sustainable Maritime Transport (IOCE-SMarT) is a visionary initiative driven by the Ministry of Ports, Shipping and Waterways, Government of India, that seeks to establish a world class hub for training, research, and innovation in sustainable maritime practices in India. It is a transformative step towards fostering a sustainable, safe, and efficient maritime industry in the Indian Ocean region. Envisaging partnership with the IMO's global MTCC network, IOCE-SMarT seeks to advance the maritime sector in the Indian Ocean region through technological innovation, sustainable practices, digital proficiency, and technical cooperation.

IOCE-SMarT proposes the establishment of specialized verticals, each focusing on a critical area of maritime development. The IOCE-SMarT's verticals are designed to bridge the gap between theoretical research and practical applications, with a strong emphasis on industry partnerships.

Vertical	Objective
BMSMarTC	Foster maritime collaboration among BIMSTEC nations
DigiSMarT	Integrate digital technologies in maritime sector
LawSMarT	Advance maritime legal expertise and policy
FinSMarT	Develop sustainable financing for green maritime
InnovSMarT	Drive innovation and technological advancement
CollSMarT	Foster international partnerships and cooperation
EduSMarT	Enhance maritime education and skills
EcoSMarT	Promote environmental sustainability
TechSMarT	Advance maritime technology
GreenSMarT	Foster green technologies and practices

The proposed Governance and Management framework of the IOCE-SMarT adopts a blended governance model - integrating elements from Advisory, Cooperative, Patron, Policy Board, and Management Team models - and establishes a clear structure for decision-making, resource allocation, and accountability to drive its mission of advancing maritime excellence and sustainability.



The Ministry of Ports, Shipping, and Waterways (MoPSW) exercises policy and administrative control over IOCE-SMarT, ensuring its alignment with national maritime goals and broader regional objectives. The Ministry provides policy direction, facilitates intergovernmental collaboration, mobilizes resources, and oversees funding and financial accountability. A Chairman or Director General, preferably a seasoned maritime professional seconded from the Ministry or DG Shipping, leads the organization, offering strategic leadership and representing IOCE-SMarT at international forums. This role ensures operational efficiency, alignment with global maritime sustainability goals, and oversight of verticals like BMSMarTC.

The Governing Board, with a maximum of 11 members, serves as the primary decision-making body, representing ministries, government bodies, and maritime associations. It approves policies, budgets, and performance reports while fostering collaboration among verticals and external partners. A Technical Advisory Board of similar size provides technical guidance, informs best practices from industry and academia, and ensures alignment with the latest sustainability trends. Both boards have members serving fixed two-year terms, promoting balanced representation and governance efficiency.

Operational management is led by a CEO, also a seasoned maritime professional, who implements the Governing Board's strategies, coordinates with vertical heads and stakeholders, and ensures compliance with IOCE-SMarT's mission. Each vertical is headed by experts who focus on the relevant area with program and project managers execute specific initiatives, manage resources, and monitor outcomes. Academic and domain experts contribute to innovation, policy formulation, and capacity-building programs to maintain IOCE-SMarT's leadership in maritime innovation.

Steering committees, comprising senior representatives and technical experts, focus on advancing sustainable maritime technology and aligning projects with global sustainability goals. Support staff, supervised by a Registrar, handle administrative, financial, and logistical functions to ensure seamless operations across the organization. Collectively, this structure positions IOCE-SMarT as a pivotal institution driving sustainable development in the maritime sector.

The Maritime Training Institute (MTI) – Powai, Mumbai premises has been proposed to develop the IOCE-SMarT. Establishing the Indian Ocean Centre for Excellence for Sustainable Maritime Transport at the Maritime Training Institute (MTI) in Powai involves both initial capital expenditures (CAPEX) and ongoing operating expenditures (OPEX). To ensure sustainability, a financial strategy and implementation roadmap have also been highlighted in the report

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1. Introduction

The Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT) is envisioned as an international centre of excellence in India, designed with a regional scope to serve as a pivotal hub for fostering knowledge, innovation, and collaboration within the maritime sector across the Indian Ocean region. It aims to facilitate connections and partnerships within the Indian Ocean region while also serving as a vital link to International Maritime Organization's (IMO) Global Maritime Technology Cooperation Centre (MTTC) Network. Implementing cutting-edge technologies and adopting best practices to mitigate greenhouse gas emissions would be one of the core focus areas for the initiative. The centre will prioritize promoting technical collaboration, enhancing capacity, and facilitating the digital transformation and decarbonisation of the maritime sector, addressing the needs of India and the broader Indian Ocean region

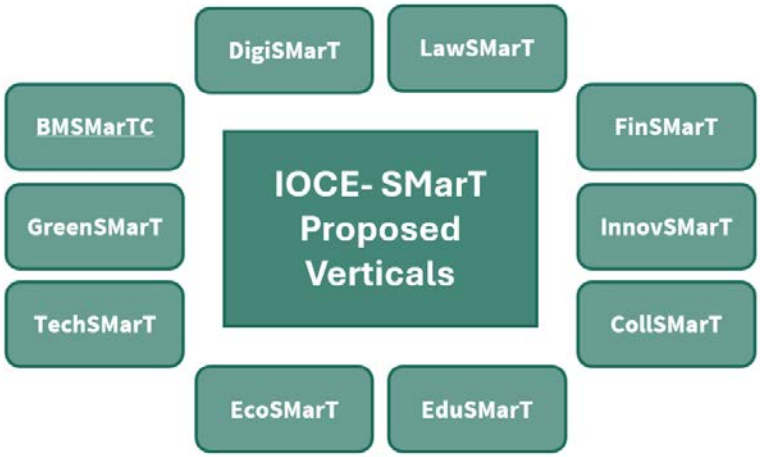
The centre is proposed to be established to address the critical challenges and opportunities emerging from the region's rapid maritime growth. The region's strategic location, coupled with its expanding trade and shipping activities, positions it as a vital player in the global maritime economy. However, this growth is accompanied by significant challenges, including environmental sustainability, technological adaptation, and workforce development.

The primary objective of IOCE-SMarT is to transform the maritime sector in India and the Indian Ocean region into a technologically advanced, environmentally sustainable, and digitally proficient industry. By promoting the latest advancements in greenhouse gas (GHG) reduction, autonomous shipping, and digitalization, IOCE-SMarT will address regional and global challenges while aligning with the International Maritime Organization's (IMO) decarbonization and digitalization strategies.

Furthermore, the centre will strengthen existing seafarer training institutions, ensuring that the workforce is equipped to meet the demands of a greener and smarter maritime industry. By integrating a regional dimension into its operations, IOCE-SMarT will enhance the region's capacity to address climate change and foster inclusive growth in the maritime domain.

The establishment and further functioning of IOCE SMarT is expected to operate within the legislations of Indian maritime domain and the regional Indian Ocean collaborative efforts such as BIMSTEC. It is expected to hold potential to significantly contribute to India's vision of becoming a global leader both politically and economically, aligning with the country's aspirations for regional leadership and strategic influence on the global maritime sector.

Figure 1: Summary proposed verticals

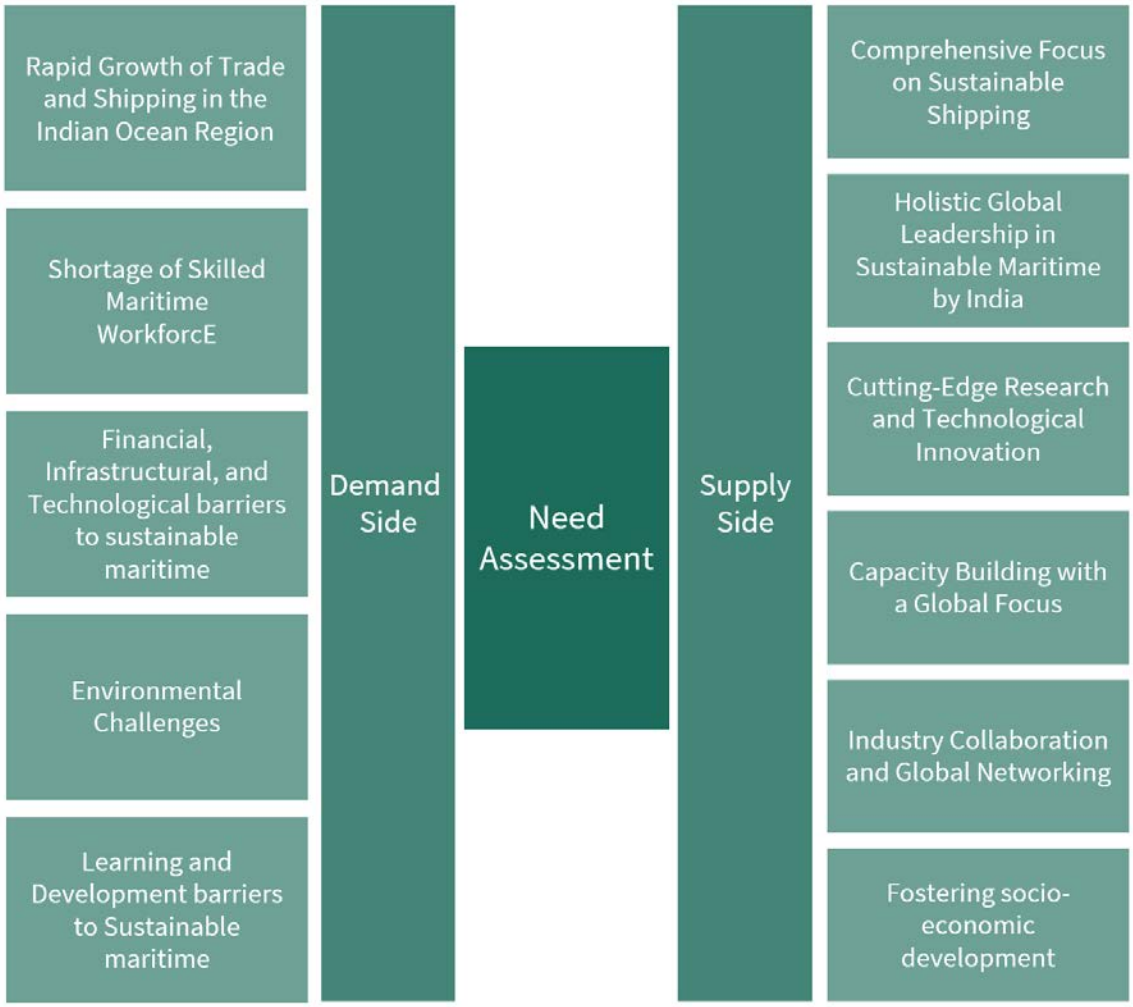


2. IOCE-SMarT – Need Assessment

2.1. Introduction

With a comprehensive approach to sustainable shipping, the centre is intended to support the transition towards green shipping practices in a holistic way, addressing the specific needs of Indian Ocean region to achieve a leading position in the global maritime landscape. The following sections outline the key demand- and supply-side needs that underscore the importance of IOCE-SMarT.

Figure 2: Summary of the demand-side and supply-side needs that IOCE-SMarT can address



2.2. Needs Assessment - Demand Side

The demand-side needs assessment examines the factors driving the establishment of IOCE-SMarT. India Ocean Region's burgeoning trade activities, growing demand for skilled maritime professionals, and pressing environmental challenges create a compelling case for targeted interventions. Addressing these demands requires strategic investments in infrastructure, technology, and human capital to ensure sustainable growth and resilience in the maritime sector.

2.2.1. Rapid Growth of Trade and Shipping in the Indian Ocean Region

The Indian Ocean has a coastline totalling 70,000 km. It is home to approximately 36 countries, representing 35% of the world's population and 40% of the global coastline.

The Indian Ocean Region lays a pivotal role in global commerce, with nearly 100,000 ships transiting the ocean annually. The region currently handles 30% of global containerized cargo and 42% of the world's crude oil, petroleum products, and distillates.[1]

The northern Indian Ocean hosts the world's busiest sea lane along the global east-west trade route, making it a critical maritime geostrategic hub. Major shipping routes converge in the region, with most container ships passing through the Cape of Good Hope, the Suez Canal and Red Sea, and the Strait of Malacca to enter or exit the Indian Ocean.

[2]Countries like Sri Lanka and Bangladesh are investing heavily in port expansions and new facilities, such as Colombo Port City and the Matarbari Deep-Sea Port, to handle larger vessels and enhance connectivity. In FY24, India's key ports managed a total cargo traffic of 817.97 million tonnes (MT), marking a 4.45% increase compared to 784.305 million tonnes in FY23. During FY23, the country's merchandise exports reached US$ 451 billion, rising from US$ 417 billion in the previous fiscal year.[3] However, challenges such as port congestion, aging infrastructure, and environmental sustainability remain, necessitating greater investments in technology and green shipping solution.

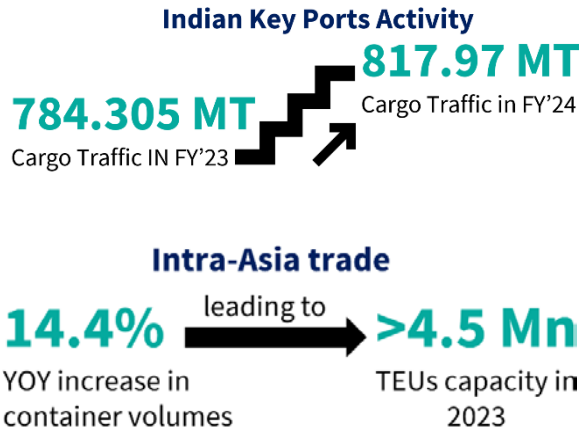
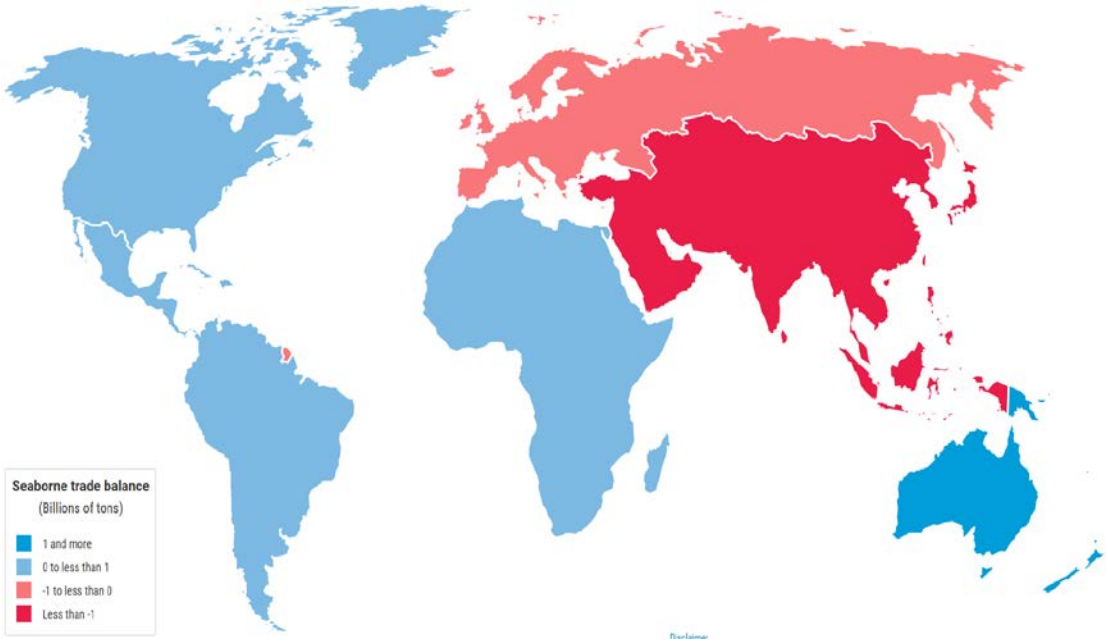


Figure 3: Global sea-borne trade balance



In 2021, Asia continued to dominate global maritime freight activities. Ports across Asia, encompassing both developed and developing regions, handled approximately 4.6 billion tons of goods, accounting for around 42% of the total goods loaded globally. Additionally, Asian ports received about 7.1 billion tons of goods, representing 64% of the total goods discharged worldwide. Europe ranked second, managing approximately 1.6 billion tons of loaded goods and 1.7 billion tons of discharged goods during the same year.

[1] https://frontline.thehindu.com/world-affairs/indian-ocean-region-by-the-numbers-vital-hub-for-global-commerce-strategic-chokepoints-vast-oil-reserves/article67891133.ece
[2] https://theloadstar.com/booming-intra-asia-trade-pushes-container-traffic-to-new-monthly-record/
[3] https://www.ibef.org/industry/ports-india-shipping

2.2.2. Shortage of Skilled Seafarer Workforce

Global shortage of STCW-certified officers

26,240

Number of STCW-certified seafarers' shortage

The maritime industry is confronting a significant shortage of skilled seafarers, with projections indicating a potential gap of almost 90,000 officers by 2026. The Indian Ocean region's maritime growth is outpacing the availability of trained professionals. Despite a 10.8% increase in the supply of seafarers since 2015[4], the demand continues to outpace growth due to the rising complexity of vessel operations and the need for specialized training. Challenges such as an aging workforce, limited training infrastructure, and declining interest in maritime careers exacerbate the issue across the region.

India, contributing 10-12% of the global seafarer workforce[5], has untapped potential in the global market. To remain competitive, it is crucial to establish modern training institutions and up-to-date programs to upskill Indian seafarers. The Indian Maritime University (IMU) emphasizes the growing demand for certified personnel as fleets and trade volumes increase. However, this challenge extends to the wider Indian Ocean region, where skill shortages hinder any efforts to meet international standards in safety, efficiency, and sustainability.

A report commissioned by the Maritime Just Transition Task Force (MJTTF) Secretariat found that 450,000 seafarers would need additional training by 2030, rising to 800,000 by the mid-2030s, assuming a rapid adoption of alternative fuels during that period[6]. These findings underscore the importance of developing new competencies for seafarers to support the transition to greener and smarter maritime operations.

Governments and shipping companies in the Indian Ocean Region are investing in initiatives to enhance maritime education and make seafaring an attractive career choice. However, addressing the challenges will require sustained efforts in modernizing training facilities, improving working conditions, and promoting gender diversity within the workforce.

2.2.3. Financial, Infrastructure, and Technological Barriers to Sustainable Maritime

Cost of full global decarbonization

$28 bn - $90 bn

Annual investment requirement expected to develop infrastructure for carbon neutral fuels globally

[7]Decarbonisation initiatives and transitioning to low or zero-carbon fuels and technologies requires substantial upfront capital expenditure and financial incentives. In India, retrofitting all inland waterway cargo vessels with LNG systems by 2030 could reduce emissions by 27%[8], but the upfront costs make this transition challenging for operators. Additionally, the shift to cleaner maritime fuels like ammonia, hydrogen, and biofuels remains economically unfeasible for many shipping companies in the Indian Ocean Region without substantial subsidies or incentives. Meeting IMO emission reduction targets demands policy coherence and robust financial mechanisms, which are currently insufficient in the region. Small-scale shipping operators also face difficulties in accessing green financing or benefiting from carbon offset programs due to their complex and restrictive structures

The adoption of cleaner fuels and advanced technologies is further hindered by the high cost of infrastructure upgrades and retrofitting existing fleets. The region faces logistical hurdles, such as inadequate port infrastructure to support alternative fuel bunkering.

Digital solutions, such as predictive maintenance systems and voyage optimization platforms, offer potential for reducing emissions. These technologies could cut fuel consumption by up to 10% through real-time monitoring and optimized route planning. However, many shipping operators in the Indian Ocean Region lack the financial resources or expertise to implement such advanced systems effectively. Additionally, transitioning older fleets to

[4] https://www.ics-shipping.org/press-release/new-bimco-ics-seafarer-workforce-report-warns-of-serious-potential-officer-shortage/
[5] https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Air%20pollution/Maritime%20India%20vision%202030.pdf
[6] https://www.ics-shipping.org/wp-content/uploads/2024/11/MJTTF-Report_Training-Aspects-for-Seafarers_Single-Spread_20241122.pdf
[7] https://unctad.org/news/bold-global-action-needed-decarbonize-shipping-and-ensure-just-transition-unctad-report
[8] https://www.ceew.in/sites/default/files/decarbonising-shipping-vessels-in-indian-waterways-with-clean-fuel.pdf

meet decarbonization standards often requires extensive retrofitting, which causes operational disruptions and poses technical challenges, particularly for aging vessels common in the region

Achieving an equitable and sustainable shipping sector requires significant investments in green port infrastructure and digital technologies. Without such measures, the cost gap between alternative fuels and conventional heavy fuels will remain a major obstacle, slowing the energy transition.

2.2.4. Environmental challenges

Greenhouse gas (GHG) emissions from international shipping account for nearly 3% of the world's total human-caused emissions. If considered as a single entity, international shipping would rank as the fifth-largest emitter globally.

Indian Ocean Region, with India being a major contributor, is highly dependent on non-renewable energy sources, making it a key player in global CO2 emissions. India is the world's third-largest CO2 emitter[9], with its maritime sector playing a notable role through port activities, ship traffic, and supporting industries. In 2022, India's maritime sector was responsible for 5.3 million metric tons of Greenhouse gas (GHG) emissions.[10]

Global Greenhouse gas emissions

20%

% increase over the past decade

3%

% contribution from the shipping sector

Ports in the region also face issue of pollution caused by untreated ship ballast water and oil discharges, leading to degradation of coastal and marine ecosystems. Moreover, with most of the global trade volume passing through it, the Indian Ocean Region ports experience high volumes of traffic, increasing the strain on their infrastructure.

Efforts to decarbonize the maritime industry, such as transitioning to green shipping corridors and cleaner fuels, are still in the early stages. Furthermore, the region's ship recycling industry, a global leader in dismantling end-of-life vessels, operates with inadequate environmental safeguards, limiting its potential to evolve into a green maritime hub.

2.2.5. Learning and Development Barriers to Sustainable maritime

4,50,000

Seafarers would require some addition training by 2030

The Indian Ocean Region faces inadequate integration of sustainability modules into traditional maritime curricula, limiting the awareness and technical expertise of seafarers and port operators in adopting green practices. Another challenge lies in technological literacy among the maritime workforces. The Maritime Technology Cooperation Centres (MTCCs) in Asia reported that many stakeholders in the region lack the knowledge to implement energy-efficient technologies, such as advanced hull designs or emission reduction mechanisms.

Limited government funding and private sector participation further exacerbate the problem, preventing the establishment of modern training facilities that align with international green shipping protocols.

[9] https://www.wri.org/insights/interactive-chart-shows-changes-worlds-top-10-emitters
[10] https://unctad.org/system/files/official-document/rmt2023_en.pdf

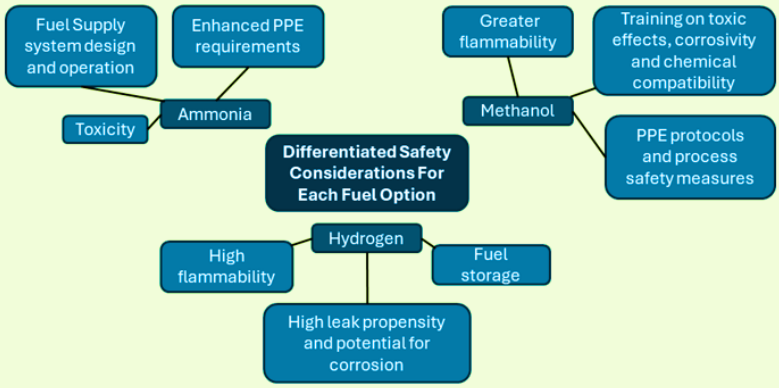
Case in Point[11]

CASE IN POINT

Considerations of training aspects for seafarers on ships powered by ammonia, methanol and hydrogen

As the maritime industry accelerates its efforts to reduce greenhouse gas (GHG) emissions, the need to adopt alternative fuels has become increasingly urgent. However, the shift to zero and near-zero GHG emission fuels such as ammonia, methanol, and hydrogen presents significant challenges, particularly in seafarer training and competency. Recognizing these gaps, the Maritime Just Transition Task Force (MJTTF), in partnership with the IMO Secretariat and with support from Lloyd's Register Foundation, has launched the "**Baseline Training Framework for Seafarers in Decarbonization**." This initiative aims to develop comprehensive training materials and competency standards to address the specific demands of these alternative fuels

The report highlights the inadequacy of existing training frameworks under the Seafarers' Training, Certification, and Watchkeeping (STCW) Code for handling alternative fuels. It emphasizes the unique challenges posed by these fuels, such as ammonia's toxicity, methanol's flammability, and hydrogen's high propensity for leaks. Through a series of 12 workshops involving 116 participants, safety-critical tasks, knowledge gaps, and training needs were identified, focusing on physical properties, hazard prevention, emergency response, and the operation of new equipment.



A proposed competency framework was drafted, detailing knowledge, understanding, and proficiencies (KUPs) for each fuel. This framework prioritizes safety, environmental precautions, and compliance with global legislative requirements. The report stresses the importance of industry-wide collaboration, particularly with the IMO and other stakeholders, to establish standardized global training materials and certifications tailored to the distinct properties of each fuel.

Looking ahead, the project outlines several next steps, including the development of detailed training frameworks, instructor handbooks, and train-the-trainer programs to ensure uniformity in education. Continuous collaboration with stakeholders is essential to refine these programs and adapt to evolving industry needs. The report underscores the collective responsibility of the maritime industry to upskill and reskill its workforce, ensuring safety and operational efficiency in the transition to a greener future.

[11] https://www.lr.org/en/knowledge/research-reports/2024/considerations-of-training-aspects-for-seafarers/

2.3. Needs Assessment - Supply Side

The supply-side needs assessment highlights the gaps in existing maritime infrastructure, institutions, and innovation capabilities. Indian Ocean region's ability to meet growing demands and adopt sustainable practices hinges on addressing these supply-side challenges. IOCE-SMarT aims to bridge these gaps, fostering a robust ecosystem that supports sustainable maritime development and global leadership

2.3.1. Comprehensive Focus on Sustainable Shipping

While the national strategies promote eco-friendly practices, the region lacks a dedicated hub for comprehensive sustainable shipping solutions. Current efforts primarily focus on general maritime innovation, with limited attention to developing green shipbuilding capabilities, alternative fuels, and technologies across the entire maritime value chain. For instance, India's maritime initiatives emphasize port efficiency and capacity expansion but have only recently begun integrating decarbonization strategies on a broader scale, such as clean energy fuel hubs and solar adoption at ports.

2.3.2. Holistic Global Leadership in Sustainable Maritime by India

India's maritime leadership has seen remarkable advancements through initiatives like the Sagarmala program and Global Maritime India Summits, which emphasize infrastructure development, green shipping, and regional economic integration. However, gaps remain in India's global maritime influence. While the Maritime Amrit Kaal Vision 2047 outlines ambitious goals, including achieving carbon-neutral ports and boosting the blue economy, these efforts are largely inward-focused.

For example, despite India's leading role in seafarer supply and ship recycling, there is limited emphasis on positioning itself as a global hub for sustainable maritime practices akin to nations like Norway or Singapore. India's participation in regional platforms such as BIMSTEC and the India-Middle East-Europe Economic Corridor reflects its growing role in regional trade but there is insufficient integration of these efforts into broader international frameworks like the IMO to shape global policies on decarbonization or blue economy practices.

2.3.3. Cutting-Edge Research and Technological Innovation

Despite the Indian Ocean Region's growing prominence in global trade, much of the research and development (R&D) infrastructure remains focused on conventional maritime operations rather than future-oriented technologies. Advanced technologies like Big Data Analytics and AI, essential for optimizing operations such as ship routing and fuel efficiency, are underutilized in the region. The use of IoT-enabled solutions, like the "Internet of Ships," which connects shipboard systems for operational efficiency, is also in its nascent stage in the Indian Ocean region.

New research estimates that the maritime artificial intelligence (AI) market is now valued at USD $4.13 billion, with a projected five-year compound annual growth rate of 23%. This marks a substantial increase from last year's valuation of USD $1.47 billion, underscoring the rapid adoption of AI technologies across the sector [12]

Moreover, while nations like Singapore have established innovation ecosystems such as the PortXL accelerator, the Indian Ocean Region lacks similar dedicated platforms to foster collaboration between maritime stakeholders and tech startups for developing energy-efficient technologies and sustainable practices, which are critical for decarbonizing the maritime industry.

[12] https://www.lr.org/en/knowledge/press-room/press-listing/press-release/2024/lloyds-register-commissioned-research-reveals-the-rapid-rise-of-ai-in-maritime/

Case in Point[13]

CASE IN POINT

Data-driven maintenance offers clear path for improving fleet reliability and efficiency

Joint research from **Lloyd's Register (LR)**, Nippon Yusen Kabushiki Kaisha (NYK Line) and MTI Co., Ltd. (MTI) has identified that the adoption of **data-driven Condition-Based Maintenance (DCBM)** can have a significant impact on vessel efficiency and reliability.

The white paper shows how DCBM processes that utilise the latest analytical models can deliver considerable benefits to the maritime industry, whilst outlining the potential pathways to its successful implementation and the obstacles that must be navigated.

The report also points to four challenges that shipowners must address to maximise the benefits of condition-based maintenance. These are a lack of precision in maintenance and inspection checklists, deviations from scheduled maintenance and inspections, vague or undefined criteria when identifying hazardous operating conditions and ensuring an effective strategic response when faced with system failures.

By overcoming these challenges, owners and operators can benefit from increased equipment availability, reduced downtime and lower total maintenance costs. This could collectively contribute to a higher return on investment from their assets and significantly lower operational expenditure (OPEX) whilst reducing crew workload and improving safety standards.

The report encourages industry stakeholders, including Original Equipment Manufacturers (OEMs), to explore the possibilities of DCBM technologies for a range of improvements beyond just enhancing safety. The research indicates that by embracing a data-driven future and prioritising analytic-driven maintenance, owners and operators can secure a competitive advantage, reduce overheads, and deliver excellence in maritime operations.

[13] https://www.lr.org/en/knowledge/press-room/press-listing/press-release/2024/data-driven-maintenance-offers-clear-path-for-improving-fleet-reliability-and-efficiency/

2.3.4. Capacity Building with a Global Focus

Capacity-building programs often lack integration with international frameworks or advanced training in areas such as digital transformation, cybersecurity, and innovative propulsion technologies. India's "Amrit Kaal Vision 2047" outlines ambitions to position the country as a maritime hub with sustainable practices. However, it is important to realize that this vision requires a transformative approach to education and training, focusing on global collaboration and cutting-edge research. By investing in initiatives like specialized courses and competencies on alternative fuels, AI-driven logistics, and resilient maritime systems, the Indian Ocean region could bridge the capacity-building gaps and emerge as a leader in sustainable shipping practices

2.3.5. Industry Collaboration and Global Networking

The Maritime India Vision 2030, launched by India, emphasizes national growth and innovation, however, does not extensively focus on integration with global maritime standards or international collaboration across diverse sectors of shipping, logistics, and green technologies. Government of India and key maritime organizations like the Indian Maritime University have worked to build frameworks for innovation, but global networking and comprehensive collaboration on a larger scale remain a challenge.

To realize the full potential of green shipping and sustainable maritime practices, a more robust, global framework for collaboration and shared innovation is essential, one that can address not only local industry needs but also international standards and emerging technologies across the entire maritime value chain.

Collaboration among stakeholders across the entire shipping value chain is essential for ensuring a smooth and sustainable energy transition within the industry.

Case in Point

CASE IN POINT

Collaboration and partnerships

Collaboration between stakeholders from across the shipping value chain is crucial to ensuring the industry can navigate the energy transition safely and sustainably. **Lloyd's Register** and **Lloyd's Register Foundation** are partnering in collaborative initiatives and partnerships, strengthened by the Maritime Decarbonisation Hub.

The Silk Alliance

The Silk Alliance is a coalition of 13 leading cross-supply chain stakeholders brought together by the **LR Maritime Decarbonisation Hub** to develop a fleet fuel transition strategy that can enable the establishment of a highly scalable Green Corridor Cluster, starting with the intra-Asia container trade in Singapore and the wider Asia region.

Sustainable Shipping Initiative

The decarbonisation of the shipping industry has been an area of strategic focus for Lloyd's Register for over a decade. In 2011, we were a founding member and the first classification society to join the Sustainable Shipping Initiative. It brings together leading organisations to improve the sustainability of the shipping industry in terms of social, environmental and economic impacts.

SSI Sustainable Shipping Initiative

Other Initiatives includes:

2.3.6. Fostering Socio-economic Development

There is a growing recognition of the importance of the maritime sector to economic growth and job creation. India has prioritized developing its maritime infrastructure, with much of the focus being on boosting trade and port capabilities rather than on community development or creating inclusive growth.

Developing a robust indigenous maritime sector should extend beyond achieving macroeconomic goals and emphasize delivering social benefits. The systematic development of Inland Waterways offers a unique opportunity for inclusive growth and job creation.

The National Maritime Foundation (NMF) has highlighted the need for more inclusive approaches to coastal adaptation and community-based planning for creation of jobs and human capital development, but such efforts are still in their early stages and lack robust, national-scale implementation.

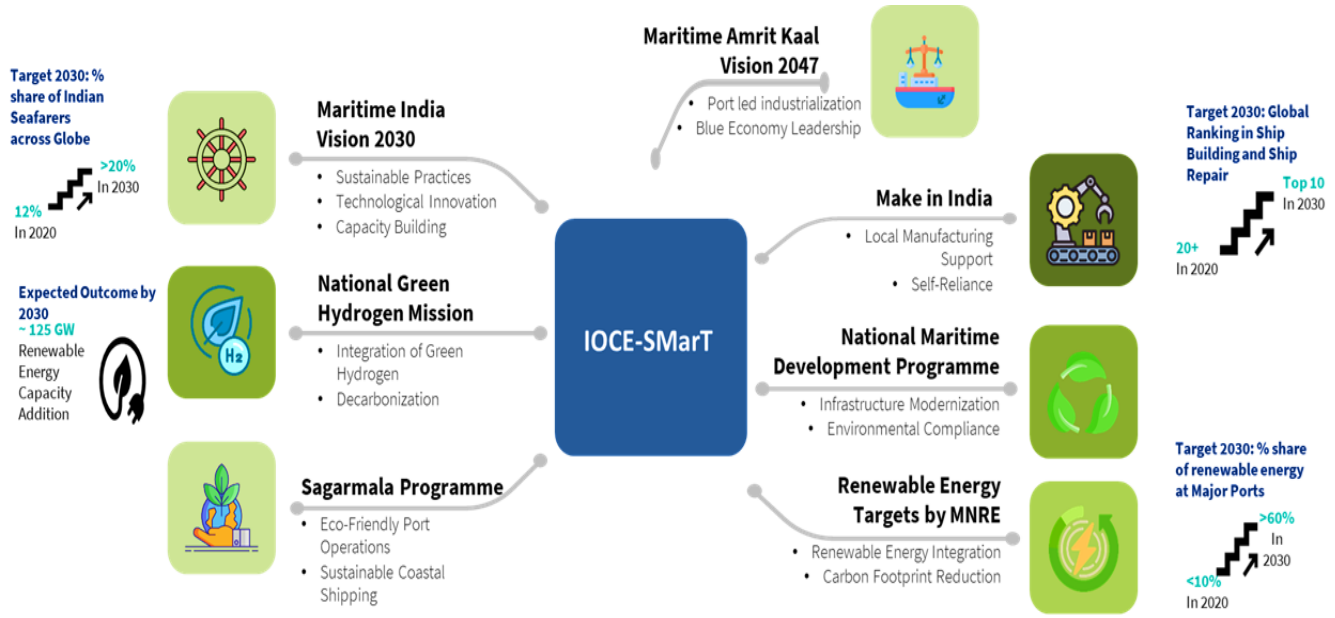
3. Strategic Alignment

The Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT) represents a significant step towards enhancing India's maritime capabilities by aligning with several key national initiatives. This initiative aims to position India as a global leader in sustainable maritime practices through strategic partnerships and innovative technologies. By integrating with the Maritime India Vision 2030 (MIV 2030), the National Green Hydrogen Mission, the Sagarmala Programme, Make-in-India, the National Maritime Development Programme (NMDP), and the renewable energy targets established by the Ministry of New and Renewable Energy (MNRE), IOCE-SMarT fosters a comprehensive approach to maritime sustainability. This ensures that the IOCE-SMarT program works towards deriving value from the synergy between all the policies which works towards the achievement of sustainable goals rather than working in a silo.

3.1. Alignment with the objectives and vision of Key National Strategies

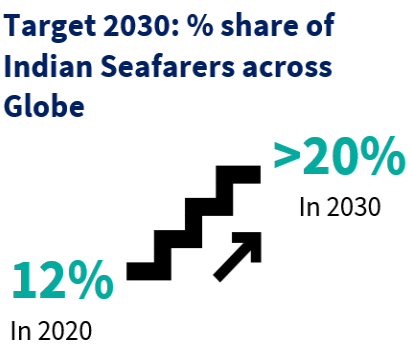
The IOCE-SMarT initiative, focusing on integrating smart technologies and green solutions in India's maritime industry, aligns closely with several national initiatives aimed at improving India's maritime infrastructure, sustainability, and energy transition.

Figure 4: Collaboration with other maritime policies



3.1.1. Maritime India Vision 2030 (MIV 2030)

Maritime India Vision 2030 (MIV 2030) aims to establish India as a global maritime leader through over 150+[14] initiatives focused on enhancing infrastructure, connectivity, and sustainability. Key objectives include reducing logistics costs, improving operational efficiency, and driving technological innovation. The IOCE-SMarT initiative supports these goals by promoting sustainable maritime practices, fostering capacity building, and advancing research to modernise India's maritime ecosystem. The vision also emphasises the adoption of renewable energy, upgrading port infrastructure, and reducing pollution. Additionally, MIV 2030 seeks to strengthen India's



[14] https://shipmin.gov.in/sites/default/files/MIV%202030%20Presentation_compressed_0.pdf

shipbuilding industry, improve maritime education, and develop a skilled workforce, with the goal of creating over 2 million jobs and reinforcing India's position as a global maritime leader.

3.1.2. National Green Hydrogen Mission

Expected Outcome by 2030

~ 125 GW

Renewable Energy Capacity Addition

The National Green Hydrogen Mission aims to position India as a global leader in green hydrogen production, focusing on decarbonising sectors like maritime shipping through clean energy solutions. IOCE-SMarT supports this mission by integrating green hydrogen technologies into India's maritime fleet, promoting the use of hydrogen-powered vessels as an alternative to traditional fossil fuels. This aligns with the mission's goal to reduce carbon emissions and establish a sustainable hydrogen economy. By facilitating the adoption of clean energy solutions, IOCE-SMarT accelerates India's transition to a cleaner, greener maritime future.

3.1.3. Sagarmala Programme

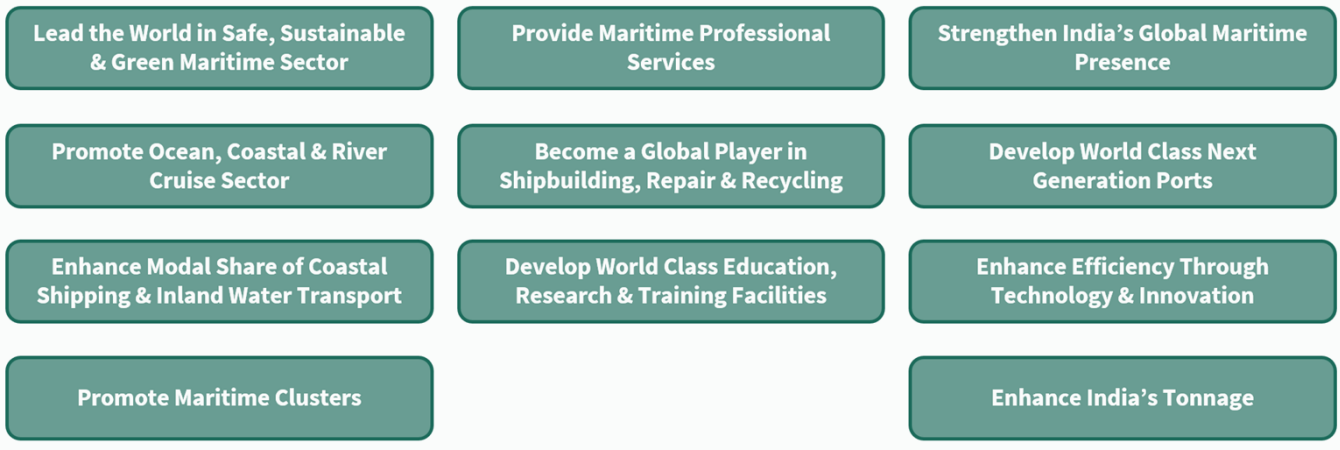
The Sagarmala Programme aims to transform India's ports and coastal infrastructure by modernising port facilities, enhancing connectivity, and promoting sustainable coastal shipping. It focuses on improving logistics efficiency and fostering economic growth along India's 7,500[15] km coastline. IOCE-SMarT aligns with these objectives by integrating smart port technologies like automated cargo handling, optimising operations and reducing congestion. Additionally, IOCE-SMarT supports sustainability goals by incorporating renewable energy solutions such as solar and wind power and promoting eco-friendly coastal shipping practices, driving the development of a greener and more efficient maritime sector in line with Sagarmala's vision.

3.1.4. Maritime Amrit Kaal Vision 2047

The Amrit Kaal Vision 2047, developed by the Ministry of Ports, Shipping & Waterways, builds upon the Maritime India Vision 2030 to establish world-class ports, enhance inland water transport and coastal shipping, and promote a sustainable maritime sector. Anchored in India's Blue Economy, the vision was shaped through 150+ stakeholder consultations and the analysis of 50 international benchmarks, identifying 300+ actionable initiatives for ports, shipping, and waterways.

Unveiled during the Global Maritime India Summit, this ambitious roadmap is backed by an investment of Rs. 80,000 lakh crores, driving a transformative shift in India's maritime sector.

Figure 5: Key Themes of Amrit Kaal Vision 2047

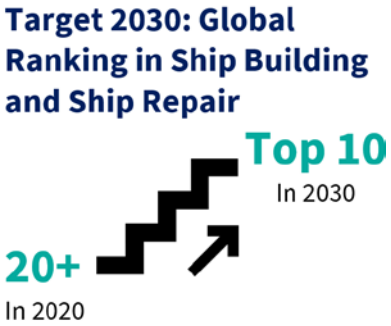


This vision sets a clear path for modernization, sustainability, and global competitiveness, establishing India as a maritime powerhouse by 2047.

[15] https://shipmin.gov.in/sites/default/files/sagarmala-eng.pdf

3.1.5. Make in India

The Make in India initiative aims to strengthen India's maritime sector by boosting domestic manufacturing, promoting innovation, and making India a global leader in shipbuilding and maritime technology. IOCE-SMarT aligns with this vision by supporting the development of smart, sustainable ships and green maritime technologies. By focusing on energy-efficient, eco-friendly vessels, IOCE-SMarT fosters innovation and enhances self-reliance in maritime manufacturing. Additionally, it generates employment and builds capacity in the shipbuilding and maritime tech industries, contributing to India's economic growth and technological leadership.

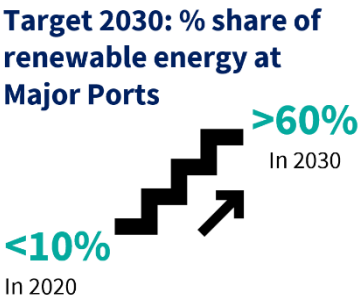


3.1.6. National Maritime Development Programme (NMDP)

The National Maritime Development Programme (NMDP) focuses on modernising major and non-major ports, addressing inefficiencies, and integrating modern technology to enhance India's global maritime competitiveness. This includes developing six mega ports, upgrading equipment, and improving inland waterway transportation to provide cost-effective, environmentally friendly alternatives to road and rail. IOCE-SMarT aligns with NMDP by integrating smart technologies and green energy solutions like solar, wind, and green hydrogen, optimising port operations and reducing environmental impact. This collaboration supports NMDP's goal of creating sustainable, efficient, and globally competitive maritime infrastructure, while advancing eco-friendly practices and promoting economic growth.

3.1.7. Renewable Energy Targets by the Ministry of New and Renewable Energy

The Ministry of New and Renewable Energy (MNRE) has set ambitious targets to boost renewable energy usage across sectors, aiming for 500 GW of installed non-fossil fuel capacity by 2030[16]. IOCE-SMarT supports this vision by integrating renewable energy solutions such as solar panels, wind-assisted propulsion, and green hydrogen into maritime operations, reducing the sector's carbon footprint. This aligns with MNRE's efforts to transition to cleaner energy sources and supports the National Maritime Development Programme (NMDP) by promoting sustainable port operations and reducing emissions. By incorporating renewable energy in port infrastructure and shipping, IOCE-SMarT helps advance India's clean energy transition, ensuring a sustainable maritime future.

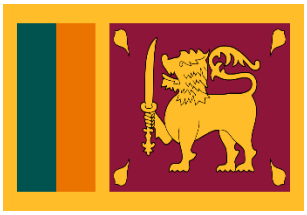


3.2. Supporting Regional Goals and Challenges

The IOCE-SMarT initiative is designed to support the maritime goals of countries in the region, aligning with their national and regional priorities. In collaboration with BIMSTEC and key nations such as Sri Lanka, Thailand, Bangladesh, and Myanmar, IOCE-SMarT addresses a wide range of challenges faced by these countries in the maritime domain, including marine pollution, climate resilience, and the sustainable exploitation of marine resources. Through the sharing of best practices, technical expertise, and capacity-building efforts, IOCE-SMarT contributes to strengthening maritime governance, improving regional trade connectivity, and advancing the blue economy. By fostering innovation in maritime technologies, promoting eco-friendly solutions, and facilitating knowledge exchange, IOCE-SMarT plays a pivotal role in enhancing maritime security, ensuring sustainable maritime practices, and addressing the evolving challenges of the region. This initiative provides a platform for strengthened regional cooperation, supporting the development of integrated maritime policies and solutions that are both economically viable and environmentally responsible.

[16] https://powermin.gov.in/en/content/500gw-nonfossil-fuel-target

3.2.1. Sri Lanka



BIMSTEC - Sector of Cooperation

Sector: Science, Technology and Innovation

Sub-sectors: Technology, Health, Human Resource Development

Overview

Strategically positioned in the Indian Ocean, Sri Lanka leverages its maritime sector as a driver of economic growth and regional connectivity. Key ports like Colombo, Hambantota, and Trincomalee are being developed to enhance transshipment, logistics, and industrial capacities, cementing Sri Lanka's role as a hub on global trade routes. The nation prioritizes maritime security, sustainable fisheries, shipbuilding, marine tourism, and renewable energy initiatives, aligning with international standards to ensure sustainable development and regional cooperation.

Challenges

1. Marine Pollution: Plastic waste and pollution threaten biodiversity and fisheries, necessitating improved waste management, recycling, and cohesive policies.
2. Maritime Domain Awareness (MDA): Limited information sharing on illegal fishing, piracy, and other threats hampers effective governance.
3. Fragmented Maritime Policies: An integrated maritime policy aligning security, trade, and environmental goals is essential.
4. Untapped Blue Economy Potential: Sectors like fisheries, renewable energy, and marine tourism lack structured policies and investment.
5. Climate Vulnerability: Rising sea levels, tsunamis, and coastal erosion highlight the need for adaptive measures and disaster resilience planning

BIMSTEC Support

1. BIMSTEC facilitates regional collaboration through agreements such as the BIMSTEC Agreement on Maritime Transport Cooperation, which promotes sustainable practices and waste management solutions. For Sri Lanka, this offers access to technical expertise and financial assistance to develop robust policies targeting marine pollution. Through initiatives like the Marine Environment and Coastal Zone Management Framework, Sri Lanka can adopt innovative strategies to reduce plastic waste, improve recycling systems, and align with global environmental standards.
2. BIMSTEC's MDA Cooperation Framework strengthens regional security by fostering joint surveillance exercises, data-sharing platforms, and capacity-building programs. Sri Lanka benefits from access to cutting-edge technologies like satellite monitoring and vessel tracking systems, enhancing its ability to combat illegal fishing, piracy, and smuggling. Collaborative training programs further improve technical expertise and readiness in addressing maritime security challenges.
3. Through the BIMSTEC Master Plan on Transport Connectivity and the Maritime Security Cooperation Framework, BIMSTEC promotes cohesive maritime governance by integrating national security, trade, and environmental priorities. For Sri Lanka, adopting these frameworks ensures better coordination of its maritime policies, enabling synergies between regional and national objectives. The BIMSTEC SDG Maritime Policy provides a blueprint to streamline governance, fostering sustainability and resilience in maritime operations.
4. BIMSTEC's Blue Economy Initiatives support Sri Lanka in leveraging opportunities in fisheries, offshore renewable energy, and maritime tourism. Collaborative projects, such as the BIMSTEC Offshore Wind

Energy Program, offer technical expertise, funding, and policy guidance to unlock economic potential while ensuring environmental sustainability. These efforts enable Sri Lanka to enhance fisheries management, promote eco-tourism, and integrate marine conservation into its economic growth strategies.

5. The BIMSTEC Disaster Management Cooperation Framework strengthens Sri Lanka's ability to mitigate and recover from maritime disasters like tsunamis and coastal erosion. By participating in joint research, preparedness exercises, and knowledge-sharing initiatives, Sri Lanka can develop climate-resilient infrastructure, improve early warning systems, and integrate adaptive measures into its development plans. This regional cooperation ensures a comprehensive approach to disaster risk reduction.

IOCE-SMarT Contributions

1. Marine Pollution Management:
   IOCE-SMarT enhances Sri Lanka's capacity to tackle marine pollution through training programs and knowledge-sharing initiatives. These efforts focus on reducing plastic waste, promoting recycling, and exploring innovative technologies like biodegradable materials. By facilitating collaborative research, IOCE-SMarT helps Sri Lanka adopt evidence-based policies aligned with global environmental standards, including the UN Sustainable Development Goals (SDGs).

2. Strengthening Maritime Domain Awareness (MDA):
   IOCE-SMarT provides access to advanced technologies such as satellite-based monitoring systems, automatic identification systems (AIS), and regional data-sharing platforms. These tools enable Sri Lanka to monitor maritime activities, address security threats, and enhance decision-making. Training programs for law enforcement and maritime professionals further improve skills in operating MDA systems and responding to challenges like illegal fishing and piracy.

3. Integrated Maritime Policy Support:
   IOCE-SMarT aids in developing unified maritime policies that align security, trade, and environmental objectives. By fostering inter-agency coordination and providing policy templates based on global best practices, IOCE-SMarT helps Sri Lanka adopt a holistic approach to maritime governance. Additionally, regional cooperation initiatives ensure harmonised policies for efficient management of trade routes, environmental protection, and security concerns.

4. Unlocking Blue Economy Potential:
   IOCE-SMarT supports structured policy development in sustainable fisheries, marine energy, and eco-tourism. By connecting Sri Lanka with funding organisations and facilitating public-private partnerships, it ensures access to investments critical for growth. Collaborative research initiatives and capacity-building programs equip local industries and policymakers with the tools to engage effectively in the blue economy, unlocking long-term economic and environmental benefits.

5. Enhancing Climate Resilience:
   IOCE-SMarT integrates disaster risk reduction measures into Sri Lanka's maritime development plans. Training programs for emergency responders, regional cooperation on disaster management, and the development of resilient coastal infrastructure enable Sri Lanka to mitigate the impacts of tsunamis, cyclones, and rising sea levels. By partnering with international agencies, IOCE-SMarT ensures Sri Lanka's disaster preparedness is both robust and regionally aligned.

3.2.2. Thailand

BIMSTEC - Sector of Cooperation

Sector: Connectivity

Overview

Thailand, strategically located along the Gulf of Thailand and the Andaman Sea, is leveraging its maritime sector to boost economic growth and regional connectivity. Key initiatives include modernizing major ports like Laem Chabang and Map Ta Phut, enhancing trade efficiency, and positioning the country as a logistics hub. The government focuses on maritime security, sustainable fisheries, marine tourism, and renewable energy, aligning with global standards to balance growth with environmental sustainability.

Challenges

1. Limited Focus on Advanced Marine Technologies: Insufficient emphasis on adopting cutting-edge technologies, such as ocean-based renewable energy systems, smart ports, and digital monitoring solutions, restricts the maritime sector's potential for innovation and modernization.
2. Slow Digital Technology Adoption: A lack of awareness and investment in digital infrastructure hinders operational efficiency and innovation, making Thailand less competitive in a global market increasingly driven by digital solutions.
3. Fragmented Regional Coordination: The absence of a unified framework for coordinating regional initiatives under ASEAN and BIMSTEC results in overlapping projects, inefficiencies, and wasted resources.
4. Insufficient Capacity Building: A gap in skill development programs limits the workforce's ability to leverage modern technologies, hindering the sector's ability to adapt to evolving industry demands.
5. Regulatory Challenges: Complex regulations, particularly concerning compliance with international maritime laws and environmental standards, deter innovation and investments in modern solutions.
6. Environmental Sustainability Concerns: The lack of effective policies for pollution control and marine resource management risks long-term ecological damage, undermining Thailand's sustainability goals.
7. Lack of Integrated Maritime Governance: Fragmented governance frameworks create inefficiencies in resource management and decision-making, complicating efforts to address modern maritime challenges.

BIMSTEC support

1. Collaborative Research on Advanced Technologies: BIMSTEC facilitates joint R&D in marine technologies, focusing on ocean-based renewable energy, smart ports, and digital monitoring systems. This enhances Thailand's maritime innovation and sustainability.
2. Streamlined Regional Connectivity: The BIMSTEC Master Plan for Transport Connectivity provides a strategic roadmap for coordinating maritime initiatives, reducing project overlaps, and boosting logistics efficiency to position Thailand as a regional trade hub.
3. Capacity-Building Programs: BIMSTEC offers targeted training initiatives to develop a skilled workforce in modern maritime practices, including marine engineering, digital logistics, and environmental management, ensuring Thailand's industry stays competitive.
4. Integrated Maritime Governance: Technical assistance is provided to formulate cohesive maritime policies that harmonize trade, security, and environmental goals. Workshops and best-practice sharing help Thailand strengthen governance frameworks.
5. Maritime Security Cooperation: BIMSTEC strengthens Thailand's maritime security through joint efforts to combat piracy, illegal fishing, and disaster management. This includes shared intelligence, coordinated responses, and joint training exercises.

6. Environmental Sustainability Frameworks: Support is offered for pollution control, marine biodiversity conservation, and sustainable resource management. BIMSTEC aligns these initiatives with global standards, aiding Thailand in addressing ecological challenges.
7. Port Infrastructure Modernization: BIMSTEC investments in port upgrades, including improved capacity and efficiency, enhance Thailand's logistics capabilities, fostering regional trade and economic growth

IOCE-SMarT contributions

1. Promoting Advanced Marine Technologies: Facilitate R&D partnerships to drive innovations like ocean-based renewable energy, smart ports, and digital monitoring tools.
2. Accelerating Digital Adoption: Implement targeted training to enhance digital tool usage, improving operational efficiency and data management in Thailand's maritime sector.
3. Streamlining Regional Coordination: Develop unified frameworks to align ASEAN and BIMSTEC maritime initiatives, minimize overlaps, and ensure efficient resource use.
4. Building a Skilled Workforce: Offer workshops, internships, and tailored curricula in collaboration with institutions to bridge the maritime skills gap and meet industry demands.
5. Regulatory Assistance: Provide technical expertise in international maritime laws, helping Thailand align with global standards and adopt innovative practices.
6. Advancing Environmental Sustainability: Promote pollution control, emissions reduction, and marine conservation frameworks, fostering regional cooperation on ecological challenges.
7. Strengthening Maritime Governance: Support the creation of integrated frameworks to enhance inter-agency coordination, streamline decision-making, and manage resources efficiently

3.2.3. Bangladesh

BIMSTEC - Sector of Cooperation

Sector: Trade, Investment and Development

Sub-sectors: Blue economy

Overview

Bangladesh, strategically located along the Bay of Bengal, is transforming its maritime sector to drive sustainable growth and regional influence. Key initiatives include modernizing Chittagong Port and developing the Matarbari Deep Sea Port to boost trade connectivity, leveraging marine resources for offshore gas, renewable energy, and sustainable fisheries. The country aims to position its shipbuilding industry as a global green shipbuilding hub while enhancing maritime security to protect its EEZ and address climate change impacts. With targeted policies, innovation, and regional collaboration, Bangladesh is set to become a resilient and influential player in the Indian Ocean region.

Challenges

1. Maritime Pollution: Inadequate waste management leads to rising plastic waste, untreated industrial discharge, and sewage in the Bay of Bengal, damaging biodiversity, fisheries, coastal tourism, and public health.
2. Port Congestion: Outdated infrastructure and inefficient cargo handling at Chittagong Port cause delays, higher logistics costs, and reduced global competitiveness, highlighting the need for modernization.
3. Underdeveloped Coastal Infrastructure: Poorly connected coastal regions hinder goods movement, limiting seafood processing, tourism, and economic growth opportunities.
4. Disaster Management Gaps: Coastal areas lack a coordinated maritime disaster management system, leaving communities vulnerable to cyclones, flooding, and oil spills.

5. Limited R&D Investment: Minimal research in sustainable fishing, shipbuilding, and climate impact mitigation restricts innovation and sectoral advancement.
6. Skilled Workforce Shortage: Insufficient training and education programs result in a lack of skilled professionals in marine engineering, port management, and maritime law.
7. Lack of Maritime Spatial Planning: Absence of an integrated framework leads to uncoordinated marine resource use, causing sector conflicts and environmental degradation.

BIMSTEC support

1. Tackling Maritime Pollution: BIMSTEC can promote regional cooperation to implement effective waste management systems, leveraging best practices and technologies to manage plastic waste, industrial discharge, and sewage. Frameworks like the BIMSTEC Marine Environment Management Plan can guide conservation efforts to protect marine ecosystems.
2. Port Congestion Relief: By supporting port modernization and capacity expansion, BIMSTEC can help alleviate congestion at Chattogram Port. The BIMSTEC Master Plan for Transport Connectivity offers a roadmap for infrastructure upgrades to enhance Bangladesh's competitiveness in maritime trade.
3. Improving Coastal Infrastructure: Investments in transportation networks connecting remote coastal regions to major ports can enhance trade opportunities for industries like seafood processing and tourism, fostering economic growth in underdeveloped areas.
4. Strengthening Disaster Preparedness: BIMSTEC can aid in establishing a maritime disaster management system with early warning systems, joint response exercises, and infrastructure for handling emergencies, bolstering resilience against cyclones and oil spills.
5. Boosting Maritime R&D: Collaborative research initiatives in sustainable fishing, shipbuilding, and environmental management, supported by BIMSTEC funding, can drive innovation and enhance the maritime sector's competitiveness.
6. Developing a Skilled Workforce: BIMSTEC can support targeted training programs in maritime disciplines and facilitate exchange programs, addressing skill gaps and fostering industry-ready professionals.
7. Implementing Maritime Spatial Planning: With technical expertise from member states, BIMSTEC can help develop an integrated MSP framework to balance marine resource use, reduce sectoral conflicts, and ensure environmental sustainability.

IOCE-SMarT contributions

1. Waste Management: Implementing strategies to manage plastic waste, industrial discharge, and sewage, protecting marine ecosystems and supporting local communities reliant on fishing and tourism.
2. Port Infrastructure: Addressing port congestion by modernizing facilities, enhancing cargo handling, and leveraging regional funding to expand capacity and improve competitiveness.
3. Maritime R&D: Fostering collaborative research in sustainable fishing, shipbuilding, and marine environmental management, promoting innovation through partnerships with academic institutions and private sector funding.
4. Skilled Workforce Development: Offering training programs in maritime disciplines and creating vocational courses to bridge the skills gap, with exchange programs for practical experience.
5. Maritime Spatial Planning (MSP): Assisting in the development of an MSP framework to balance maritime activities and protect the environment, using best practices from other member states.

3.2.4. Myanmar

BIMSTEC - Sector of Cooperation

Sector: Agriculture and Food Security

Sub-sectors: Agriculture, Fisheries & Livestock

Overview

Myanmar is focusing on developing its maritime sector to drive economic growth and regional integration. Key priorities include upgrading major ports like Yangon and Thilawa and developing Kyaukphyu Deep Sea Port as part of the China-Myanmar Economic Corridor (CMEC). The country is utilizing its blue economy by sustainably managing marine resources, exploring renewable energy options like offshore wind power, and addressing maritime security concerns such as illegal fishing and piracy. Myanmar is also developing its shipbuilding sector, emphasizing green shipbuilding, and fostering marine tourism in the Mergui Archipelago. These efforts aim to position Myanmar as a vital maritime hub in Southeast Asia

Challenges

1. Overexploitation of Marine Resources: Extensive fishing, habitat destruction, and pollution have degraded critical ecosystems like mangroves and coral reefs, reducing biodiversity and resilience to climate change.
2. Weak Regulatory Frameworks: Centralized management by the Department of Fisheries limits local involvement and effective enforcement of conservation regulations.
3. Climate Change Impacts: Rising sea levels, stronger storms, and altered rainfall patterns threaten coastal ecosystems and communities.
4. Inadequate Infrastructure: Underdeveloped ports and poor inland connectivity lead to shipping delays and increased costs, hindering trade competitiveness.
5. Limited Investment in Conservation: Insufficient funding for marine conservation undermines efforts to protect species and restore habitats.
6. Lack of Public Awareness: Limited awareness about marine conservation hinders sustainable resource use and community support for conservation efforts

BIMSTEC support

1. Climate Resilience and Marine Biodiversity: By promoting regional cooperation, BIMSTEC can help Myanmar develop frameworks for climate resilience and marine biodiversity conservation, including research collaboration and best practice sharing.
2. Policy Strengthening: BIMSTEC can assist Myanmar in strengthening policies to mitigate coastal development impacts and marine pollution, through capacity-building programs for local authorities.
3. Institutional Capacity Building: BIMSTEC can support Myanmar in enhancing enforcement of maritime regulations through training and technical assistance, improving governance in the maritime sector.
4. Sustainable Practices Training: BIMSTEC can collaborate with educational institutions to offer training in marine conservation, sustainable fishing, and maritime law, helping build a skilled workforce.
5. Infrastructure Development: Through the Master Plan for Transport Connectivity, BIMSTEC can help improve Myanmar's port facilities and transportation networks to reduce congestion and enhance trade competitiveness.
6. Climate Change Mitigation: BIMSTEC can provide technical expertise and funding for climate resilience projects, including early warning systems and community-based adaptation programs.
7. Sustainable Resource utilization: BIMSTEC can foster responsible resource use and marine pollution reduction through regional cooperation on sustainable maritime practices

IOCE-SMarT contributions

1. Climate Resilience and Marine Conservation: Facilitating the creation of frameworks to enhance climate resilience and biodiversity conservation, through collaborative research and sharing best practices.
2. Policy Strengthening: Providing technical assistance in developing and implementing policies to address coastal development and marine pollution, including capacity-building workshops for stakeholders.
3. Regulatory Enforcement: Strengthening enforcement through training programs, improved monitoring systems, and regional cooperation to combat illegal fishing and ensure environmental compliance.
4. Sustainable Practices Training: Expanding capacity-building initiatives focused on sustainable fisheries, marine conservation, and disaster preparedness through collaboration with local universities.
5. Infrastructure Development: Supporting port modernization and connectivity improvements to alleviate congestion and enhance trade efficiency.
6. Climate Change Mitigation: Offering expertise and funding for climate resilience projects, such as early warning systems and community-based adaptation programs.
7. Sustainable Maritime Practices: Promoting responsible resource use and marine pollution reduction through regional cooperation on sustainable practices

3.2.5. Bhutan

BIMSTEC - Sector of Cooperation

Sector: Environment & Climate Change

Sub-sectors: Mountain Economy

Overview

Bhutan, despite being landlocked, focuses on regional collaboration with India and Bangladesh for better access to maritime trade routes. The country emphasizes sustainable practices, eco-friendly shipping, and responsible resource management. Bhutan is also committed to capacity building in logistics management and maritime safety, while developing a comprehensive maritime policy to address challenges and ensure compliance with international regulations

Challenges

1. Dependence on neighbouring countries: Bhutan relies on India and Bangladesh for maritime access, creating vulnerabilities in trade negotiations and logistics. Disruptions in these relationships can impact imports and exports.
2. Limited maritime infrastructure: Bhutan lacks ports and maritime infrastructure, necessitating overland transportation to neighbouring ports, which increases transit times and costs.
3. Regulatory challenges: Navigating complex regulatory frameworks and differing customs, tariffs, and trade policies with neighbouring countries complicates trade processes.
4. Lack of maritime policy framework: Bhutan lacks a comprehensive maritime policy framework to address its unique challenges as a landlocked nation reliant on neighbouring countries for maritime trade.
5. Limited awareness and capacity building: There is a need for increased awareness and capacity building in maritime trade, logistics, and environmental sustainability.

BIMSTEC support

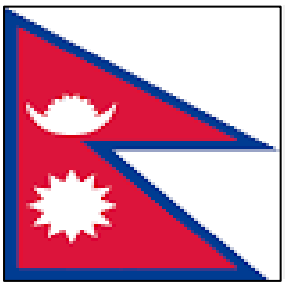
1. Facilitation of regional agreements: Assist Bhutan in negotiating regional maritime agreements to establish common standards and address transboundary issues like pollution, resource management, and security.
2. Development of integrated maritime policy: Help Bhutan develop a cohesive maritime policy framework covering trade, security, and sustainability, drawing on best practices from member states.

3. Capacity building and technical assistance: Offer training programs to enhance Bhutan's institutional capacity in maritime governance, policy development, and implementation.
4. Regional cooperation and knowledge sharing: Promote platforms for knowledge exchange to facilitate discussions on maritime policy and share successful strategies from other member states.
5. Alignment with international standards: Support Bhutan in aligning its maritime policies with global standards, ensuring compliance with international conventions and enhancing cooperation with neighbouring countries.

IOCE-SMarT contributions

1. Enhancing maritime access and trade facilitation: Facilitate partnerships with India and Bangladesh to improve Bhutan's access to maritime trade routes. By promoting regional cooperation, IOCE-SMarT can help Bhutan negotiate better terms for transit agreements, ensuring more efficient movement of goods through ports in neighbouring countries. This includes advocating for streamlined customs procedures and reduced tariffs that would benefit Bhutanese exporters and importers.
2. Capacity building for maritime governance: To address the lack of a comprehensive maritime policy framework in Bhutan, IOCE-SMarT can provide technical assistance in developing policies that align with international standards. This includes capacity-building programs focused on maritime governance, trade logistics, and environmental sustainability. By sharing best practices from other member states, IOCE-SMarT can help Bhutan establish a robust maritime policy that integrates national security, trade, and environmental considerations.
3. Research and innovation in maritime technologies: Facilitate research collaborations focused on innovative maritime technologies that could benefit Bhutan's transportation logistics. This includes exploring advancements in logistics management systems that optimise overland transport routes to ports, thereby reducing costs and improving efficiency. Research initiatives could also focus on developing alternative transportation methods that enhance Bhutan's connectivity with maritime trade routes.
4. Training programs for maritime professionals: To build local capacity in maritime governance and logistics management, IOCE-SMarT can offer training programs tailored for Bhutanese professionals involved in trade and transportation sectors. This training would enhance skills related to customs procedures, logistics optimisation, and sustainable practices, ultimately improving Bhutan's ability to engage effectively in regional maritime activities.

3.2.6. Nepal



BIMSTEC - Sector of Cooperation

Sector: People-to-People Contact

Sub-sectors: Culture, Tourism, Poverty Alleviation, People-to-People Contact (forums of think tanks, media etc.)

Overview

As a landlocked nation, Nepal focuses on regional connectivity for access to global trade routes. Key priorities include improving inland logistics, cross-border infrastructure (dry ports, rail connectivity), and diversifying trade routes to reduce dependency. Nepal aims to balance economic growth with environmental sustainability while seeking greater regional cooperation through frameworks like BIMSTEC and SAARC for equitable access to maritime trade opportunities

Challenges

1. Lack of direct maritime access: Nepal's landlocked geography limits its ability to engage in maritime trade independently, relying on neighbouring countries for port access, which increases costs and logistical challenges.
2. Dependence on transit agreements: Nepal's access to maritime trade routes depends on agreements with India and Bangladesh, making it vulnerable to changes in diplomatic relations and external political factors.
3. Limited maritime infrastructure: Nepal lacks ports and shipping facilities, requiring goods to be transported overland to neighbouring countries, which increases transit times and costs.
4. Lack of maritime policy framework: Nepal lacks a comprehensive maritime policy to address its unique challenges as a landlocked nation dependent on neighbouring countries for maritime trade.
5. Limited awareness and capacity building: There is a need for greater awareness and capacity building in maritime trade practices, logistics management, and environmental sustainability

BIMSTEC support

1. Facilitating access to maritime trade routes: BIMSTEC can help Nepal negotiate favorable transit agreements with India and Bangladesh, streamline customs, and reduce tariffs to boost trade competitiveness.
2. Capacity building for maritime governance: Assist Nepal in developing a maritime policy framework with technical support and capacity-building programs, sharing best practices from member states.
3. Improving infrastructure development: Advocate for better overland transport networks connecting Nepal to ports in India and Bangladesh, reducing transit times and costs.
4. Research and innovation in trade logistics: Facilitate research on innovative logistics solutions to optimize overland transport routes, improving efficiency and reducing costs.
5. Training programs for maritime professionals: Offer training in logistics management, customs procedures, and sustainable practices to build local capacity in trade and transportation.
6. Regional cooperation for policy development: Provide platforms for knowledge exchange to help Nepal align its maritime policies with regional strategies and international standards.

IOCE-SMarT contributions

1. Facilitating regional partnerships and strengthening negotiation capacity: Promote agreements with India and Bangladesh to improve Nepal's access to maritime routes. Support Nepal in enhancing its negotiation skills through training on trade laws and best practices for securing favorable terms.
2. Advocacy for infrastructure and policy development: Advocate for investments in infrastructure linking Nepal to ports and assist in creating a comprehensive maritime policy addressing trade, sustainability, and regional cooperation.
3. Training and knowledge exchange: Implement training programs on maritime trade, logistics, and sustainability while establishing platforms for knowledge exchange to enhance Nepal's capacity in maritime governance

4. Benchmarking

The IOCE SMarT is expected to function as an independent institution, with values and strategic vision conformed to the development of the maritime sector in the Indian Ocean region. However, to ensure benefitting from the large network of inter country and intercompany alliances that exist globally, the centre must align with the broader sustainability goals of the participating countries as well as collaborate to derive maximum value through partnerships and alliances with other relevant programs. LR has identified a list

4.1. Integration with Global MTCC Network

The Global MTCC Network (GMN) is a collaborative initiative that supports the development and implementation of Maritime Technology Cooperation Centres (MTCCs) around the world. The initiative is aimed at enhancing energy efficiency and reducing greenhouse gas (GHG) emissions in the maritime sector. It is an important part of the International Maritime Organization's (IMO) efforts to address climate change by improving the environmental performance of ships.

The MTCCs are regional centres that provide technical assistance, training, and advisory services to maritime stakeholders, such as ship owners, operators, and manufacturers. These centres aim to facilitate the adoption of energy-efficient technologies and practices, helping the maritime industry reduce its carbon footprint. It offers developing countries, in particular least developed countries (LDCs) and small island developing states (SIDS), technical assistance and capacity building to reduce GHG emissions from shipping and encourages the uptake of energy-efficiency technologies through dissemination of technical information and know-how.

The Global MTCC Network brings together these centres across different regions and provides a platform for sharing knowledge, experiences, and best practices. It also plays a role in supporting the IMO's Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII), as well as other regulatory frameworks that promote sustainable shipping.

Key goals of the Global MTCC Network include:

1. Enhancing the energy efficiency of the global fleet.
2. Helping ship operators reduce fuel consumption and GHG emissions.
3. Promoting the use of cleaner technologies and solutions.
4. Facilitating regional cooperation and knowledge sharing within the maritime sector.

Funded by the European Union and implemented by the International Maritime Organisation (IMO), the Global Maritime Technologies Cooperation Centres (MTCC) Network (GMN) project unites five MTCCs situated in Africa, Asia, Caribbean, Latin America and the Pacific.

The project is implemented by the International Maritime Organization Secretariat, through a dedicated Project Coordination Unit (PCU) established within the Sub-Division for Major Projects within the Marine Environment Division of IMO.

The PCU is responsible for day-to-day management of the project including acting as IMO’s focal point for the Maritime Technology Cooperation Centres (MTCCs). The PCU is responsible for all reporting aspects of the project, and it is also the focal point for IMO Member States. It acts as the secretariat for all project activities, management and liaison with MTCCs and other relevant stakeholders. The Project Steering Committee (PSC) ensures overall governance and monitoring of the project and consists of senior IMO and EU representatives.

When it comes to making strategic decisions about the project, the PSC is the ultimate decision maker. The role of the PSC includes monitor the project performance, review and approval of project management documents, take major decisions and serve as the advisor to PCU as required.

A Global Stakeholder Committee (GSC) has been established to ensure wide dissemination of the project information and success stories. The members of the GSC participate in the project activities on a volunteer basis. The GSC members have an opportunity to: disseminate information on the project, advise the PCU on the role of

MTCCs beyond 2019, provide guidance on regional and/or global priority issues related to climate change and shipping, and advise the project on potential partnership opportunities.

In addition, particular members of the GSC may be identified to serve as technical experts to provide technical input on activities, such as pilot projects when required by the PCU and/or PSC.

4.1.1. MTCC Africa – Nairobi [17]

The Jomo Kenyatta University of Agriculture and Technology (JKUAT), in partnership with Kenya Maritime Authority (KMA) and Kenya Ports Authority (KPA)

Building capacity for climate change mitigation in the African maritime shipping industry

MTCC Africa (Maritime Technology Cooperation Centre Africa) is one of the regional centres within the Global MTCC Network (GMN). It specifically focuses on promoting energy efficiency and sustainable shipping practices across the African region. MTCC Africa's main objective is to assist the maritime industry in Africa in reducing greenhouse gas (GHG) emissions, improving fuel efficiency, and implementing environmentally friendly technologies and practices.

Key Functions of MTCC Africa:

The key functions of MTCC Africa include the following –

1. Capacity Building and Training
   MTCC Africa provides training and workshops to maritime stakeholders, including ship owners, operators, and maritime professionals, on energy efficiency measures and technologies.
2. Technical Assistance:
   The center offers technical support and advisory services to help maritime companies improve their energy efficiency and reduce their carbon footprint.
3. Promotion of Best Practices: MTCC Africa promotes best practices in the maritime industry to enhance the environmental performance of vessels operating in the region. This includes the adoption of technologies to optimize fuel consumption and reduce emissions.
4. Supporting International Regulations: MTCC Africa works in alignment with global maritime regulatory frameworks like the International Maritime Organization's (IMO) Energy Efficiency Existing Ship Index (EEXI) and Carbon Intensity Indicator (CII) to help shipping companies comply with international standards and targets on emissions.
5. Research and Development: MTCC Africa is involved in research initiatives to identify and promote the use of sustainable technologies and practices that are particularly suited to the African maritime context.
6. Regional Cooperation: The center fosters collaboration between African countries and stakeholders, encouraging joint efforts to reduce the environmental impact of the maritime sector.

Pilot Projects:

1. Uptake of Port Energy Efficient Technologies and Operations: This pilot project involved assessing the effects of energy-saving and emission-reduction strategies at the Port of Mombasa and performing an energy audit on few African ports to gather baseline data to identify ways of enhancing energy efficiency.
2. Fuel Consumption and Emissions Data Collection and Reporting: The study seeks to measure greenhouse gas emissions from the shipping industry at selected African ports and waterways. Certain ships are equipped with tablets that track fuel consumption in real time which is processed to calculate each ship's Energy Efficiency Operation Index (EEOI)
3. Quantification of Emissions within the Port of Mombasa Limits: The pilot conducted an emissions inventory for ships within Mombasa's port which provides decision-makers with data on ship emissions and supports emissions reduction strategies. The study, focusing on Ocean Going Vessels (OGVs), followed guidelines from the IMO's Glomeep project

[17] http://mtccafrica.jkuat.ac.ke/

Through these activities, MTCC Africa contributes to the global effort to combat climate change and ensures that African nations can align with global environmental goals for the maritime industry.

Possible integration with IOCE-SMarT:

Indian and African ports face similar challenges and opportunities with their strategic importance in economic development of the respective regions, and infrastructure/ technology needs. Knowledge exchange could be mutually beneficial.

4.1.2. MTCC Pacific– Suva, Fiji[18]

The Pacific Community (SPC) and the Secretariat of the Pacific Regional Environment Programme (SPREP)

Promote a Pacific low-carbon maritime transport that supports the sustainable development goals of Pacific Islands countries and territories (PICTs)

The MTCC-Pacific envisions fostering low-carbon maritime transport to advance sustainable development in Pacific Island countries and territories (PICTs) while facilitating their transition to greener economies. Its primary objective is to assist selected PICTs in reducing greenhouse gas emissions and dependence on fossil fuels by adopting standards, best practices, and innovative solutions within the maritime transport sector.

Key Functions of MTCC Pacific:

1. Capacity Building: MTCC Pacific organizes training programs, workshops, and seminars to equip maritime stakeholders in the Pacific region with the knowledge and skills required to improve energy efficiency in shipping. This includes engaging with seafarers, shipowners, port operators, and government agencies to foster sustainable practices.
2. Data Collection and MRV: The Centre supports Pacific Island countries in establishing systems for Monitoring, Reporting, and Verification (MRV) of greenhouse gas (GHG) emissions from ships. It collects and analyzes data to identify trends and areas for improvement, contributing to global efforts in reducing maritime emissions.
3. Technology Promotion: MTCC Pacific introduces and facilitates the adoption of innovative technologies that enhance energy efficiency and reduce emissions. This includes promoting renewable energy solutions, such as wind and solar power, and energy-saving devices for ships and port infrastructure.
4. Awareness Campaigns: The Centre runs initiatives to raise awareness about the importance of low-carbon shipping and the economic and environmental benefits of sustainable maritime practices. These campaigns target policymakers, industry players, and the public to encourage collaborative efforts in decarbonizing the maritime sector.
5. Technical Assistance: MTCC Pacific provides direct technical support to Pacific Island countries, helping them implement IMO conventions like MARPOL Annex VI, which addresses air pollution from ships. This includes guidance on compliance, regulatory frameworks, and operational changes for energy efficiency.
6. Policy and Strategy Support: The Centre works with governments in the region to develop and refine national policies, strategies, and action plans aimed at achieving low-carbon shipping. It ensures these policies align with international regulations while addressing the unique challenges faced by Pacific Island nations.

[18] http://mtccpacific.spc.int/

Pilot Projects

The pilot-projects consider the unique circumstances of Pacific Islands countries in terms of capacity to incorporate and implement international instruments and to progress energy efficiency in a shipping industry composed mainly by small domestic shipping companies and small ports, heavily reliant on costly fossil fuels. The approach to implement the pilot-projects is two-fold:

1. Provide all Pacific Island Countries and Territories (PICTs) with technical support through templates, guidelines, generic law for energy efficient operations of ships and ports; and
2. Provide targeted countries (Fiji, Kiribati, Marshall Islands, Samoa, Solomon Islands, Tuvalu and Vanuatu) with in-country technical assistance through the implementation of adapted Ship Energy Efficiency Management Plan (SEEMP) on board domestic ships and energy audits in ports.

Through these activities MTCC Pacific contributes to the vision of a low-carbon Pacific maritime transport that contribute to global climate mitigation efforts and reduction of greenhouse gas emissions

Possible integration with IOCE-SMarT:

The smaller ports in India could benefit from the knowledge derived from the pilot projects in the pacific island countries

4.1.3. MTCC Asia– Shanghai, China[19]

The Shanghai maritime university

Promoting IMO-EU MTCC projects and discovering ways to reduce the carbon emission and shipping cost

The center acts as a regional hub in Asia for IMO-EU MTCC projects, promoting innovative technologies to mitigate greenhouse gas emissions. It facilitates the sharing of technical expertise and explores cost-effective strategies to reduce carbon emissions and shipping expenses through conferences, workshops, maritime education, training, and technological cooperation and transfer.

Key Functions of MTCC Asia:

1. Capacity Building and Training: MTCC Asia provides technical training and workshops for maritime stakeholders, including seafarers, ship operators, and port authorities, to improve energy efficiency and implement best practices for reducing GHG emissions.
2. Technology Demonstration and Transfer: The Centre identifies, showcases, and facilitates the adoption of low-carbon technologies and energy-efficient solutions suitable for the Asian maritime sector, such as fuel optimization systems and renewable energy integration.
3. GHG Emissions Monitoring and MRV Support: MTCC Asia assists countries in developing systems for Monitoring, Reporting, and Verification (MRV) of GHG emissions from ships, ensuring compliance with international regulations and enabling data-driven decision-making.
4. Awareness and Knowledge Sharing: The Centre promotes awareness of low-carbon maritime technologies and practices through conferences, publications, and knowledge-sharing platforms, fostering collaboration among stakeholders across the region.
5. Policy Development Assistance: MTCC Asia supports national governments in developing and implementing policies and strategies that align with IMO regulations, such as MARPOL Annex VI, and address regional challenges in reducing maritime emissions.

[19] http://www.mtccasia.com/

6. Regional Collaboration: It facilitates cooperation among Asian countries to address common challenges in decarbonizing the shipping sector, encouraging regional partnerships and sharing of best practices and resources.
7. Research and Innovation: MTCC Asia conducts research to identify innovative approaches and technologies that can enhance energy efficiency and sustainability in the maritime industry, tailored to the specific needs of the Asian region.

Pilot Projects:

1. Uptake of ship energy efficient technologies and operations: The project promotes ship energy efficiency in Asian LDCs. Proven and easy to adopt without retrofits, challenges like stability will be addressed via training.
2. Fuel consumption data collection and reporting in line with IMO regulations: MTCC-Asia hosts annual seminars to train personnel on fuel data collection and reporting, using a real-time system aligned with IMO regulations.
3. Some of the seminars and workshops includes:
    I. Virtual Regional Ship Energy Efficiency Technology Conference
    II. 3rd Global Green Shipping Forum
    III. Virtual Regional Ship Energy Efficiency Technology Promotion campaign jointly Bangladesh
    IV. Third Virtual Regional Ship Energy Efficiency Technology Promotion Campaign jointly with Philippines

Through these activities MTCC Asia aids in promoting green shipping and low-carbon maritime transport across one of the world's busiest shipping regions.

Possible integration with IOCE-SMarT:

MTCC Asia and IOCE-SMarT can collaborate for pilot projects in the Indian context and for organising seminars and workshops on green shipping practices in Asia.

4.1.4. MTCC Caribbean – Trinidad & Tobago[20]

The University of Trinidad and Tobago

Data gathering and establishing the legal and institutional baselines of each territory

The MTCC Caribbean aims to serve as a hub for regional and international collaboration, focusing on improving ocean governance and shipping, with an emphasis on GHG monitoring and energy-efficient technologies. Similarly, one of the key objectives of UTT's Marine and Maritime Campus is to promote integrated coastal, ocean, and maritime governance.

Key Functions of MTCC Caribbean:

1. Support for Small Island States: MTCC Caribbean offers specialized support to Small Island Developing States (SIDS) in the Caribbean, which face unique challenges due to their geographical isolation and smaller maritime economies. The Centre provides tailored solutions to help these nations reduce maritime emissions and adopt green technologies.
2. Integration of Maritime and Coastal Ecosystems: The Centre promotes the integration of sustainable shipping practices with coastal conservation efforts, recognizing the Caribbean's dependency on marine ecosystems for livelihoods and tourism. It fosters approaches that reduce the environmental footprint of shipping while protecting the region's coastal and marine environments.

[20] https://utt.edu.tt/mtcc-caribbean/

3. Collaboration with Tourism and Cruise Industry: Considering the Caribbean's significant cruise tourism sector, MTCC Caribbean focuses on working with cruise operators to introduce low-carbon solutions for cruise ships, supporting the development of sustainable tourism that minimizes the maritime sector's impact on the environment.
4. Disaster Resilience and Adaptation: MTCC Caribbean emphasizes building disaster-resilient maritime infrastructure in the face of climate change, helping Caribbean nations to not only reduce emissions but also adapt their shipping and port operations to the impacts of rising sea levels and extreme weather events.

Pilot Projects:

1. Uptake of Ships Energy Efficiency: The project aims to guide decision-makers in adopting sustainable energy-efficient solutions.
   Key objectives included:
   I. Identifying technologies and best practices used on Caribbean vessels in 2017-2018.
   II. Highlighting major onboard energy consumers and the emissions-reduction measures applied.
   III. Analysing the cost-effectiveness of energy-efficient initiatives, including new technology adoption.
   IV. Promoting energy-efficient measures through workshops and online resources.
2. Data Collection on Ships Fuel Consumption: This project aimed to create a fuel consumption data collection system for Caribbean ships, establishing a baseline across various operating and load conditions. It involved tracking fuel consumption, fuel types, ship speed, and in-port fuel use for vessels in the region.

Through these activities MTCC Caribbean aims to support the Caribbean's transition to sustainable, low-carbon maritime transport, addressing unique needs with a focus on environmental sustainability, economic resilience, and regional development.

Possible integration with IOCE-SMarT:

Caribbean ports can be considered comparable in terms of vulnerability to environmental challenges and climate change. IOCE-Smart can benefit from the research and data gathered through the pilots in MTCC Caribbean

4.2. Collaboration with other Global Institutions

In addition to the global MTCC network, the IOCE SMarT centre can also be globally positioned to collaborate with other regional and international institutes focussed on the improvement of sustainability in the maritime sector.

There are numerous such centres and institutions which are funder and maintained by national agencies, governments, private corporations etc, LR studied a select few which are focussed on various segments within the maritime domain and have had significant impact on the sector and the geographies they operate in.

4.2.1. Singapore Maritime Institute[21]

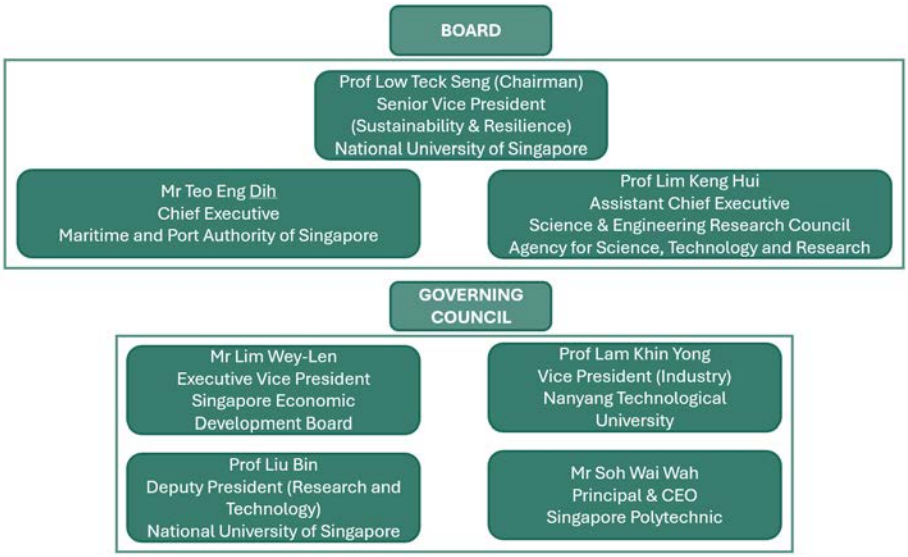
The Singapore Maritime Institute (SMI), established in April 2011, is a collaborative initiative between the Maritime and Port Authority (MPA), the Agency for Science, Technology and Research (A*STAR), and the Singapore Economic Development Board (EDB).

SMI focuses on developing strategies and programs to strengthen sectors such as port, shipping, and maritime services. It formulates maritime research strategies and fosters industry-academia collaborations in Singapore. By adopting a whole-of-government approach, SMI drives initiatives that enhance the competitiveness of the local

[21] https://www.maritimeinstitute.sg/

maritime industry and bolster research and development (R&D) capabilities, supporting Singapore's position as a global maritime knowledge hub.

Figure 6: Governance Structure SMI



The Singapore Maritime Institute (SMI) operates under a structured governance framework designed to integrate expertise from academia, industry, and government agencies. This framework comprises two primary bodies:

1. Board:
   I. **Role:** Provides high-level strategic direction and oversight for SMI's initiatives.
   II. **Composition:** Includes senior representatives from key organizations, ensuring alignment with national maritime objectives.
2. Governing Council:
   I. **Role:** Offers comprehensive guidance on SMI's programs and activities, ensuring they meet the evolving needs of the maritime sector.
   II. **Composition:** Comprises a broader spectrum of stakeholders, including leaders from educational institutions, research agencies, and industry partners.

This dual-tiered governance structure ensures that SMI's strategies and programs are well-coordinated and effectively address the challenges and opportunities within Singapore's maritime industry. By leveraging the collective expertise of its Board and Governing Council, SMI fosters collaboration and innovation, reinforcing Singapore's position as a leading global maritime knowledge hub.

Key Functions or Services offered by SMI:

The Singapore Maritime Institute (SMI) offers a range of services aimed at advancing Singapore's maritime sector through research, development, and innovation. Key service offerings include:

1. Research and Development (R&D) Funding:
   A. **SMI Fund:** The SMI Fund is designed to support programs, projects, and initiatives that align with the Institute's goals and strategies for the maritime industry, focusing on research and development (R&D), education and training, and thought leadership.
   Through the SMI Fund, the aim is to cultivate a pipeline of maritime researchers, scientists, engineers, and thought leaders to drive the industry's growth. SMI actively seeks collaboration with various stakeholders to develop strategic programs and initiatives that will position the maritime industry for future success.

As part of its R&D strategies, SMI will focus on developing new capabilities and supporting translational efforts, including breakthrough research applications, to advance the maritime industry.

2. Programmes and Initiatives:
   A. MTP Fund:
      The Maritime Transformation Programme (MTP) plays a crucial role in implementing the Sea Transport ITM Innovation thrust. It leverages the National Research Foundation (NRF) Research, Innovation, and Enterprise Funds (RIE Funds) to enhance maritime R&D capabilities and transform the sector.
      SMI collaborates with stakeholders to identify and fund new programs and initiatives aligned with the Singapore Maritime R&D Roadmap, focusing on the following five Strategic Research Thrusts:
      i. Efficient and Intelligent World-Class Next Generation Port
      ii. Strategic Sea Space and Maritime Traffic Management
      iii. Smart Fleet Operations and Autonomous Vessels
      iv. Effective Maritime Safety & Security
      v. Sustainable Maritime Environment & Energy
   B. SMI Maritime Research Centres of Excellence (CoES)
      i. To support Maritime Singapore as a global maritime knowledge hub, SMI, with MPA's support, has established four Centres of Excellence (CoEs) with Institutes of Higher Learning (IHLs) in areas such as Next Generation Ports, Maritime Energy, Maritime Safety, and Maritime Autonomous Surface Ships (MASS).
      ii. As technologies like big data and AI shape the maritime sector, SMI is focused on leveraging these to maintain global competitiveness while ensuring safety and efficiency. To further research in maritime AI and cybersecurity, SMI has partnered with IHPC, A*STAR, and iTrust at SUTD.
   C. SMI Fellows Scheme
      The SMI Fellows Scheme aims to:
      i. Promote the development and retention of senior researchers in strategic R&D areas vital to Maritime Singapore and MPA at local Centres of Excellence (CoEs), Institutes of Higher Learning (IHLs), and Research Institutes (RIs).
      ii. Recognize their role in mentoring junior researchers and fostering the broader maritime R&D community.
      iii. Expand their exposure and contributions beyond CoEs/IHLs/RIs by supporting MPA/SMI as technical experts.
3. R&D Resources:
   A. R&D Roadmap 2030: Outlines strategic research directions to guide the maritime industry's development over the next decade.
   B. Project & Researcher Directory: Maintains a comprehensive database of ongoing projects and researchers in the maritime field, facilitating collaboration and information sharing.
   C. SMI Horizon and Research Spotlight Series: Publishes insights, articles, and reports on emerging maritime technologies and research findings, contributing to the dissemination of knowledge within the industry.

Through these services, SMI plays a pivotal role in establishing Singapore as a leading global maritime knowledge hub, driving innovation, and enhancing the competitiveness of the maritime industry.

Possible integration with IOCE-SMarT:

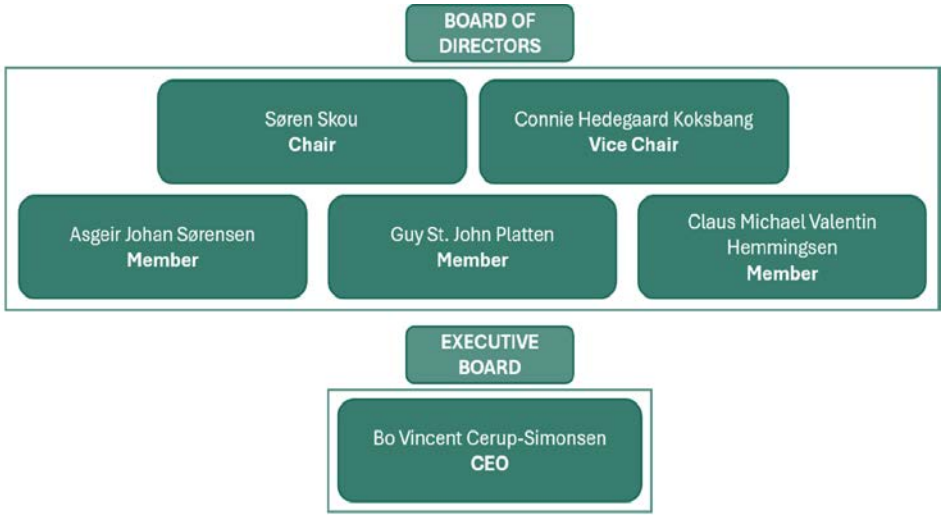
The partnership of IOCE-SMarT with the Singapore Maritime Institute (SMI) can foster regional leadership in sustainable maritime practices through joint research, knowledge sharing, and capacity building. Collaborative efforts could focus on decarbonization technologies, smart ports, digital tools, and regional policy advocacy. By leveraging Singapore's technological expertise and wider Indian Ocean region's emerging maritime potential, the partnership can drive innovation, secure green financing, and create a shared platform for maritime data, advancing sustainable growth across the Indian Ocean and Southeast Asia.

4.2.2. Mærsk McKinney Møller Center for Zero Carbon Shipping[22]

The Mærsk McKinney Møller Center for Zero Carbon Shipping is a not-for-profit, independent R&D center established in 2020 to accelerate the maritime industry's transition to net zero. With 33 nationalities represented, the Center collaborates with partners to develop and implement new technologies, build confidence in innovative concepts, and drive systemic and regulatory change.

Combining deep expertise with an industry-wide perspective, the Center focuses on advancing technological solutions and providing strategic guidance. Its R&D efforts assess individual solutions, identify gaps and risks, and enhance transparency to support informed decision-making and de-risk the transition.

Figure 7: Governance Structure MMM Center for Zero Carbon Shipping



The Mærsk McKinney Møller Center for Zero Carbon Shipping operates under a structured governance framework comprising two primary bodies:

1. Board of Directors:
   A. Role: Serves as the supreme authority of the Foundation, holding overall responsibility for its activities. The Board ensures that the Center's operations are organized, managed, and conducted in accordance with relevant legislation and the Foundation's statutes.
   B. Composition: Comprises individuals with professional insight and relevant experience at both national and international levels within or related to shipping, marine technology, and low-carbon energy. The Board continuously assesses and determines the competencies required to fulfil the Foundation's objectives effectively.

[22] https://www.zerocarbonshipping.com/

2. Executive Board:
    A. **Role:** Manages the day-to-day operations of the Center, implementing the strategic direction set by the Board of Directors.
    B. **Composition:** Chief Executive Officer (CEO)

This governance structure ensures that the Center operates with a high level of expertise and oversight, facilitating its mission to drive the transition towards a net-zero future for the maritime industry through collaboration, applied research, and regulatory reform.

Key Functions:

1. Applied Research: Conducting studies to develop and assess new technologies and alternative fuels that can reduce greenhouse gas emissions in shipping. This includes evaluating the feasibility and impact of various decarbonization pathways.
2. Collaboration: Facilitating partnerships among industry stakeholders, including shipping companies, technology providers, and regulatory bodies, to share knowledge and resources. This collaborative approach aims to drive collective action toward sustainable shipping practices.
3. Regulatory Engagement: Engaging with policymakers and international organizations to influence the development of regulations and standards that support the adoption of zero-carbon technologies in shipping. This involves providing expertise and data to inform policy decisions.
4. Modelling and Analysis: Developing tools like the NavigaTE model to simulate the global fleet's evolution under various scenarios. This helps stakeholders understand the potential impacts of different decarbonization strategies and make informed decisions.
5. Knowledge Sharing: Disseminating research findings, reports, and publications to the maritime community and the public to raise awareness and promote the adoption of sustainable practices. This includes hosting events, webinars, and publishing articles on relevant topics

Key Projects:

1. Ammonia Safety: The Mærsk McKinney Møller Center for Zero Carbon Shipping (MMMCZCS) is leading efforts to make ammonia a viable alternative fuel for maritime decarbonization, addressing its challenges of toxicity and flammability. The Center has developed key safety guidelines, including the 2023 report on ammonia-fuelled vessel operations and the 2024 bunkering guidelines, in collaboration with SGMF.
    A. MMMCZCS is also involved in projects like the EU-funded MAGPIE project and ammonia bunkering feasibility studies in Singapore and Savannah to establish ammonia supply chains and infrastructure. A survey of maritime professionals showed interest in ammonia-fuelled vessels, though concerns about safety and training persist.
    B. Through these initiatives, MMMCZCS is advancing ammonia as a safe, efficient, and sustainable maritime fuel, supporting the industry's decarbonization goals.

2. Chilean Green Corridors Network Project: The Chilean Green Corridors Network Project aims to establish green shipping corridors leveraging Chile's abundant solar and wind energy to produce low-carbon fuels, positioning the country as a key player in maritime decarbonization.
    A. The project, progressing through three phases—Pre-Feasibility, Feasibility Analysis, and Deployment—begins with identifying and shortlisting domestic and international routes. Phase 1 identified 17 potential corridors, with 15 showing promise, despite challenges such as transporting ammonia from remote energy projects and the limited availability of e-methanol for passenger vessels.

3. Accelerating deployment of low-LCI Biomethane in shipping: The project explores the potential of biomethane from biogenic residues as a viable decarbonization solution for the maritime industry. By repurposing residues through anaerobic digestion, the process not only produces biomethane and

biogenic CO2 for biofuel manufacturing but also mitigates methane emissions from mismanaged waste, offering environmental benefits and opportunities for carbon credits. However, challenges such as limited biomass availability, small-scale plant capacities, fugitive methane emissions, and the need for rapid industry scaling hinder widespread adoption.

A. The project aims to assess biomethane's potential and develop a strategy to accelerate its deployment. Key areas of study include:
   I. Consolidating global biomass availability data.
   II. Evaluating production costs for biomethane and biomethanol from residues, factoring in capacity dependencies.
   III. Conducting a life cycle assessment (LCA) of production and supply chains, including fugitive emissions.
   IV. Mapping ports and biogenic residue availability to identify new production opportunities.
   V. Developing strategies for the most promising pathways.

The project's outcome will include position papers, updates to NavigaTE, and a comprehensive strategy to fast-track biomethane deployment in maritime applications.

Possible integration with IOCE-SMarT:

The partnership of IOCE-SMarT with the Mærsk McKinney Møller Center for Zero Carbon Shipping can foster collaborative research and development of green technologies, such as alternative fuels and energy-efficient systems. The two centres can share knowledge through joint training programs and pilot projects, while aligning their policy advocacy to support decarbonization and digital transformation. This collaboration would also help localize zero-carbon shipping technologies and strengthen the region's capacity to meet IMO's sustainability targets.

5. Institutional Mechanism and Focus of IOCE-SMarT

5.1. IOCE-SMarT – Mission

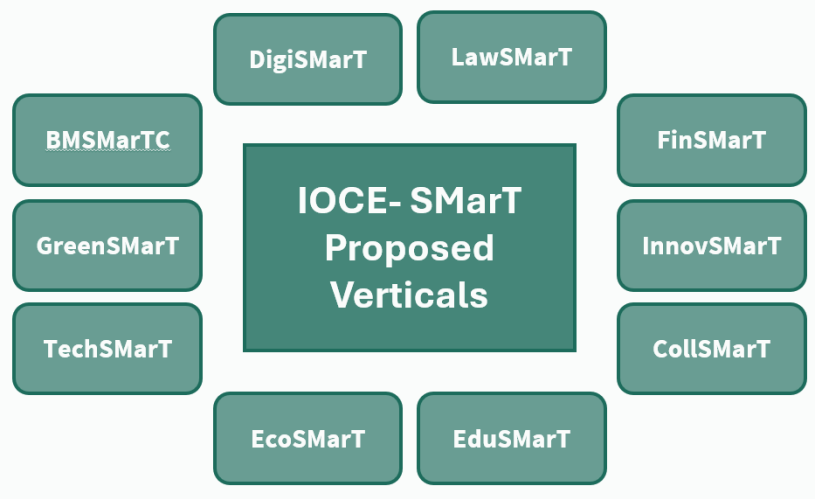
To establish the Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT) as a regional leader in advancing the maritime sector of India and wider Indian Ocean region. Through technological innovation, environmentally sustainable practices, and digital transformation, IOCE-SMarT seeks to reduce greenhouse gas emissions, foster technical cooperation, and build capacity to create a digitally proficient and sustainable maritime future

5.2. Proposed Verticals under IOCE-SMarT

The Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT) is envisioned as a transformative platform for addressing critical challenges in the maritime sector. By establishing specialized verticals, IOCE-SMarT aims to foster targeted expertise, innovation, and collaboration across key areas of maritime development. These verticals are strategically designed to align global best practices with the region's unique needs, enabling IOCE-SMarT to serve as a catalyst for sustainable progress in the maritime domain.

Each vertical under IOCE-SMarT focuses on bridging the gap between theoretical advancements and their practical applications. By leveraging international partnerships, region-specific solutions, and cutting-edge technologies, these verticals ensure a comprehensive approach to maritime challenges. From promoting green technologies and enhancing digital integration to fostering legal and financial frameworks, IOCE-SMarT's verticals collectively contribute to the sustainable growth of the Indian Ocean maritime ecosystem.

Figure 8: Proposed verticals under IOCE-SMarT



5.2.1. BMSMarTC: Regional Collaboration for BIMSTEC Countries

BMSMarTC is proposed as a dedicated vertical under IOCE-SMarT to foster maritime collaboration among BIMSTEC countries, addressing the region's shared challenges and opportunities in the maritime domain. This initiative aims to strengthen regional capacity by facilitating knowledge exchange, promoting standardized practices, and encouraging joint maritime policies. By organizing training programs, workshops, and research collaborations tailored to the unique maritime context of BIMSTEC nations, BMSMarTC envisions equipping stakeholders with the skills and tools necessary for sustainable maritime development.

There are several global examples demonstrating regional collaboration in the maritime sector that can serve as models for BMSMarTC:

European Maritime Safety Agency (EMSA) supports EU member states by enhancing maritime safety, security, and pollution prevention. It provides technical assistance, organizes capacity-building programs, and develops standardized regulations across member states. EMSA also operates platforms like SafeSeaNet, which enhances

vessel monitoring and maritime domain awareness. This structure could inspire BMSMarTC to develop similar systems tailored to BIMSTEC's needs.

ASEAN Maritime Forum promotes maritime cooperation among ASEAN nations, addressing issues like maritime security, safety, environmental protection, and economic collaboration. It serves as a platform for dialogue, aligning member countries' maritime policies and fostering shared growth. The AMF's approach to regional dialogue and collaboration provides a template for BMSMarTC in uniting BIMSTEC nations.

Table 1: BMSMarTC - Possible Workstreams/Activities:

Joint Research and Innovation	Promote collaborative research on green technologies, climate resilience, and regional challenges.
Maritime Safety and Security	Establish a regional safety network and shared maritime domain awareness system.
Economic Cooperation and Blue Economy Development	Facilitate joint ventures, investments, and sustainable exploration of blue economy resources.
Information Sharing and Digital Transformation	Develop shared platforms for data exchange and introduce smart technologies in port operations.
Collaborative Platforms and Forums	Host annual conferences and working groups for dialogue and innovation in regional maritime issues.
Public Awareness and Community Engagement	Launch awareness campaigns and support community-based maritime and environmental initiatives.

5.2.2. DigiSMarT: Digital Integration and Smart Technologies

DigiSMarT, a proposed vertical within IOCE-SMarT, focuses on integrating advanced digital technologies into the maritime sector in the Indian Ocean region. This initiative will facilitate the adoption of innovations like autonomous ships, AI, IoT, and blockchain, aiming to improve efficiency, safety, and sustainability in ports, shipping, and logistics. DigiSMarT will work on developing frameworks that support the digital transformation of maritime operations, including enhancing port automation and supply chain logistics.

The vertical's core objective is to promote collaboration among technology developers, port authorities, shipowners, and policymakers to optimize operations and enhance cybersecurity. DigiSMarT will also support the development of smart ports, leveraging AI, IoT, and big data analytics to create more efficient and interconnected environments. By fostering research, digital infrastructure, and regional interoperability, DigiSMarT will contribute to building a more responsive and efficient maritime network in the region.

Several global real-life examples exist that are like the proposed DigiSMarT initiative, demonstrating the integration of digital technologies in the maritime sector:

1. Port of Rotterdam – Smart Port Initiative: The Port of Rotterdam is one of the most advanced smart ports in the world, using AI, IoT, and digital twins to optimize port operations. With sensors, real-time data analytics, and AI algorithms, the port can monitor traffic flows, optimize logistics, reduce emissions, and enhance safety. DigiSMarT could replicate this model to implement smart ports in the Indian Ocean region, focusing on operational efficiency and environmental sustainability.
2. Maersk and IBM – TradeLens Blockchain Platform: Maersk, in collaboration with IBM, developed the TradeLens blockchain platform to enhance supply chain transparency and traceability in the shipping

industry. TradeLens uses blockchain to provide secure and transparent data sharing between various stakeholders, reducing paperwork, improving efficiency, and enabling real-time tracking. DigiSMarT could adopt blockchain-based systems for improving transparency and compliance within the Indian Ocean region's maritime supply chains.

Table 2: DigiSMarT - Possible Workstreams/Activities:

Autonomous Shipping Systems	Develop frameworks and pilot projects for autonomous vessels, ensuring safety and regulatory compliance.
Blockchain Integration	Introduce blockchain-based platforms for secure and transparent supply chain tracking and data sharing.
Real-Time Data Analytics	Deploy big data analytics for optimizing vessel traffic, cargo handling, and predictive maintenance.
Cybersecurity Frameworks	Establish robust cybersecurity protocols to safeguard digital maritime infrastructure.
IoT Implementation in Logistics	Integrate IoT devices to enable real-time cargo tracking and improve operational efficiency in logistics.
Digital Transformation in Ship Operations	Promote AI-driven systems for navigation, fuel efficiency, and emissions monitoring.
Collaborative Platforms for Innovation	Create digital forums to connect tech developers, policymakers, and industry stakeholders for co-innovation.

5.2.3. LawSMarT: Maritime Legal Expertise

LawSMarT, a proposed vertical within IOCE-SMarT, aims to advance maritime legal expertise and policy development, focusing on addressing legal and regulatory challenges in the maritime sector. It will develop regional and international legal frameworks for sustainable shipping, dispute resolution, and arbitration, ensuring alignment with global maritime conventions like the United Nations Convention on the Law of the Sea (UNCLOS). The vertical will provide training and capacity-building programs for maritime professionals to address emerging legal issues such as pollution, human rights, and shipping regulations.

In addition to policy development, LawSMarT will focus on creating regional arbitration frameworks for maritime dispute resolution, reducing reliance on global bodies. Drawing inspiration from the International Tribunal for the Law of the Sea (ITLOS), it aims to become a regional hub for legal research, training, and arbitration. By enhancing legal capabilities and promoting cooperation among BIMSTEC countries, LawSMarT seeks to contribute to a more harmonized and effective maritime legal system in the Indian Ocean region.

Several global real-life examples exist that are like the proposed LawSMarT initiative:

1. International Tribunal for the Law of the Sea (ITLOS) is a global institution that resolves disputes related to the interpretation and application of the United Nations Convention on the Law of the Sea (UNCLOS). ITLOS provides advisory opinions and adjudicates cases concerning maritime boundaries, marine environmental protection, and the rights of coastal and landlocked states. LawSMarT could take inspiration from ITLOS by developing a regional platform for dispute resolution, focused on the Indian Ocean region's unique legal and maritime challenges.
2. The Singapore Chamber of Maritime Arbitration (SCMA) serves as a leading institution for resolving maritime and shipping disputes in Asia. It provides an arbitration framework specifically tailored to the

maritime industry, helping parties resolve issues related to shipping contracts, maritime boundaries, and vessel operations. LawSMarT could similarly develop an arbitration center or network within the Indian Ocean region to handle local maritime legal issues, ensuring more efficient and specialized dispute resolution.

Table 3: LawSMarT - Possible Workstreams/Activities:

Workstream/Activity	Description
Legal Training and Capacity Building	Offer specialized training programs on maritime law, arbitration, and emerging legal issues for maritime professionals.
Regional Harmonization of Maritime Laws	Facilitate the alignment of BIMSTEC countries' maritime laws and regulations to promote cooperation and standardization.
Advisory Services for Legal Compliance	Provide guidance on compliance with international regulations, including pollution control, human rights, and labor standards.
Digitalization of Legal Processes	Introduce digital tools for efficient case management, legal documentation, and arbitration procedures in the maritime sector.
Collaboration with International Bodies	Work closely with organizations like ITLOS and IMO to ensure alignment with global legal standards and best practices.

5.2.4. FinSMarT: Sustainable Financing Mechanisms

FinSMarT is a proposed vertical within IOCE-SMarT designed to develop sustainable financing mechanisms for the maritime sector, particularly for green shipping projects, renewable energy adoption, and climate-resilient infrastructure. It aims to identify innovative financial solutions, such as green bonds and sustainable investment funds, to support decarbonization efforts and ensure the economic viability of environmentally friendly maritime initiatives.

The core goal of FinSMarT is to create a framework for financing green maritime projects, collaborating with financial institutions, governments, and investors to unlock capital for emission reduction technologies and green port infrastructure. Additionally, the vertical will focus on capacity-building, providing training on green finance and facilitating partnerships to ensure that stakeholders have access to the resources needed for sustainable development in the maritime sector.

Several global examples align with the goals of FinSMarT in fostering sustainable financing for maritime decarbonization and infrastructure development:

Green Climate Fund (GCF) is a global initiative designed to support the transition to low-emission, climate-resilient development. It funds projects that aim to reduce emissions and enhance resilience to climate change, including those in the maritime sector. GCF has been involved in financing clean energy projects, climate adaptation measures, and emission reduction technologies in various industries, including shipping. FinSMarT could draw inspiration from GCF's approach to mobilize financing for green maritime projects in the Indian Ocean region.

Table 4: FinSMarT - Possible Workstreams/Activities:

Green Bonds for Maritime Projects	Develop and promote the issuance of green bonds to fund environmentally sustainable maritime initiatives.

Sustainable Investment Funds	Create dedicated funds to finance green shipping technologies, renewable energy adoption, and low-carbon infrastructure.
Collaboration with Global Financial Institutions	Partner with entities like the Green Climate Fund (GCF) to mobilize international financing for regional green initiatives.
Innovative Financial Models	Explore and implement innovative financial tools like climate risk insurance and blended finance models for maritime projects.
Support for SMEs in Green Shipping	Offer financial assistance and incentives to small and medium enterprises (SMEs) involved in sustainable maritime solutions.
Tax Incentives for Sustainable Projects	Advocate for tax benefits and subsidies to encourage investment in eco-friendly maritime infrastructure and technologies.

5.2.5. InnovSMarT: Driving Innovation and Technological Advancement

InnovSMarT is a proposed vertical under IOCE-SMarT focused on advancing innovation and technology in the maritime sector. It will promote research and development of cutting-edge technologies to enhance energy efficiency, reduce emissions, and improve operational performance in shipping. InnovSMarT will foster collaboration between academia, industry, and technology developers to support the adoption of emerging solutions such as alternative fuels, energy-efficient ship designs, and sustainable shipping practices.

The core goal of InnovSMarT is to accelerate the development and commercialization of transformative technologies, including renewable energy integration, hydrogen and ammonia fuels, and advanced hull designs. It will collaborate with research institutions, maritime companies, and governments to pilot and scale these innovations. Additionally, InnovSMarT will support startups and entrepreneurs through incubation programs, promoting the growth of maritime technologies and positioning the Indian Ocean region as a hub for maritime innovation.

Several global initiatives and organizations focus on advancing innovation and technology in the maritime sector, like InnovSMarT:

The European Union's Horizon 2020 funding program has supported several maritime innovation projects, with a focus on reducing the environmental impact of the sector. Initiatives like SHIFT (Sustainable Innovation in Freight Transport) and Wind Hunter (exploring wind-powered ships) are examples of projects aimed at improving energy efficiency and sustainability in maritime transport. InnovSMarT can align with these efforts by seeking funding and promoting innovation in similar areas to drive technological advancements in the Indian Ocean region.

Table 5: InnovSMarT - Possible Workstreams/Activities (1):

Autonomous Vessel Development	Prototype designs and testing of autonomous vessels. Collaboration with AI developers.
Renewable Energy Integration	Feasibility studies for solar, wind, and hydrogen integration. Pilot projects in ports
Maritime Logistics Digitization	Creation of a digital platform for maritime operations. Implementation of AI analytics.
Collaborative Research with Academia	Joint studies with universities on emission-reduction technologies. Hosting innovation workshops.

Green Maritime Technology Symposium	Annual event showcasing advancements in renewable energy and digitization
Industry-Academia Partnership Programs	Annual event showcasing advancements in renewable energy and digitization

It can also further evolve to provide consultancy services revolving around delivering tailored, expert-driven solutions that address the evolving challenges of the maritime industry. By fostering innovation, ensuring compliance with international standards, and optimizing operations, this focus area can aim to support stakeholders in enhancing sustainability across the sector. Key goals -

1. Delivery of tailored solutions to address complex challenges in maritime operations and management.
2. Enhanced support for stakeholders in areas such as sustainability, compliance, and operational efficiency.
3. Establishment of a trusted advisory network for maritime organizations globally.
4. Development of data-driven approaches for decision-making and strategic planning.
5. Increased adoption of innovative practices through expert guidance and implementation frameworks.
6. Strengthened policy frameworks to address emerging challenges and promote maritime growth.

Table 6: InnovSMarT - Possible Workstreams/Activities (2):

Sustainability Advisory Programs	Support for organizations to achieve compliance with IMO's decarbonization goals.
Operational Efficiency Reviews	Tailored assessments to identify inefficiencies and improve processes across the maritime value chain.
Technical Due Diligence Services	Comprehensive evaluations of assets, facilities, and operations to guide investments and decisions.
Risk and Safety Management Consultancy	Development of frameworks to enhance risk mitigation and ensure HSE compliance.
Digital Transformation Advisory	Guidance on implementing digital tools like AI, IoT, and blockchain in maritime operations.
Policy Advisory Services	Assistance in drafting and reviewing maritime policies to align with international standards and emerging trends.
Customized Training for Clients	Creation of tailored training modules to upskill workforce aligned with consultancy recommendations.
Strategic Roadmap Development	Assistance in building long-term strategies for green shipping and business growth.

5.2.6. CollSMarT: International Partnerships and Cooperation

CollSMarT is proposed as a vertical under IOCE-SMarT, focusing on fostering international partnerships and cooperation in the maritime sector. These vertical aims to address the industry's challenges by facilitating joint projects, knowledge exchange, and collaborative research between governments, maritime organizations, and

industry stakeholders. By promoting synergies between the Indian Ocean region and global maritime players, CollSMarT will ensure the adoption of best practices and sustainable solutions across borders.

The core objective of CollSMarT is to enhance collaboration on maritime safety, sustainability, and technological innovation. It will facilitate partnerships for joint research, capacity-building, and the development of region-specific solutions. By aligning regional efforts with global frameworks, such as the IMO's decarbonization targets, and encouraging international collaborations, CollSMarT will position the Indian Ocean region as a leader in maritime governance, innovation, and sustainability.

Several global initiatives share similarities with CollSMarT by promoting international collaboration and partnerships within the maritime sector.

1. The International Maritime Organization (IMO) Integrated Technical Cooperation Programme (ITCP) is a key example of fostering international collaboration to build capacity in the maritime sector. It supports the implementation of international conventions, enhances safety, promotes sustainable shipping, and builds technical and regulatory capacity in developing countries. By providing technical assistance, training, and workshops, the ITCP facilitates partnerships between countries and international organizations.
2. The European Union's Blue Growth Strategy aims to promote sustainable economic growth in the maritime sector by encouraging cooperation among EU member states and international partners. It focuses on sectors like marine energy, coastal and maritime tourism, and maritime technologies, while aligning with global sustainability goals. The Blue Growth Strategy also involves partnerships with research institutions, industry stakeholders, and non-governmental organizations to foster innovation in the maritime sector.

Table 7: CollSMarT - Possible Workstreams/Activities:

Maritime Industry Consortium	- Establishment of a consortium to promote collaborative problem-solving and knowledge exchange.
Public-Private Partnerships (PPPs)	- Launch of joint projects between government bodies and private organizations to drive innovation.
Industry-Academia Joint Programs	- Creation of platforms for shared research and development projects.
Global Maritime Forums	- Hosting annual forums for international dialogue on industry best practices and emerging trends.
Technology Incubators	- Setting up incubation centers for startups focusing on maritime technology solutions.
Sustainability Alliances	- Formation of alliances to promote green shipping practices and reduce environmental impact.
Collaborative Pilot Projects	- Execution of pilot projects on autonomous vessels, green fuels, and digital innovations.

5.2.7. EduSMarT: Maritime Education and Skill Development

EduSMarT is a proposed vertical under IOCE-SMarT focused on enhancing maritime education and skill development. The vertical will address the need for a highly skilled workforce by offering training, certification

programs, and specialized curricula in areas such as decarbonization, digitalization, green technologies, and maritime safety. Collaborating with maritime academies, universities, and industry experts, EduSMarT will ensure professionals are well-equipped for the evolving maritime sector, utilizing technologies like virtual reality and simulations for practical, hands-on learning experiences.

EduSMarT will also facilitate accessible online platforms and e-learning modules to provide flexible learning opportunities across the Indian Ocean region. It will focus on bridging skill gaps and keeping maritime personnel updated with the latest technologies and regulations. Through its initiatives, EduSMarT will create a pipeline of skilled talent, fostering leadership, policy knowledge, and international cooperation, while contributing to a sustainable, digitalized, and resilient maritime workforce.

There are several global initiatives and programs that are like EduSMarT, focusing on maritime education, skill development, and the integration of sustainability and digitalization in the sector:

1. Singapore Maritime Academy (SMA) offers a wide range of maritime courses, including programs in maritime studies, shipping management, and maritime safety. It collaborates with industry stakeholders to provide hands-on training and ensure graduates are equipped with the necessary skills to meet the demands of a modern, sustainable maritime industry. They also emphasize the use of technology and innovation in maritime operations.
2. Norwegian Maritime Competence Centre focuses on advancing maritime skills through research and education in Norway. It offers programs related to sustainable shipping, digitalization, and automation in maritime operations. The Centre works with various stakeholders, including universities, research institutions, and maritime companies, to address industry challenges and promote a more sustainable and efficient maritime sector.

Table 8: EduSMarT - Possible Workstreams/Activities:

Green Shipping Training Modules	- Launch of online and in-person courses on sustainable maritime practices.
Advanced Simulation-Based Learning	- Establishment of simulation centers for safety and operational training.
Leadership Development Workshops	- Regular workshops for enhancing leadership and decision-making skills in the maritime sector.
Digital Logistics Certification Program	- Certification programs on AI, IoT, and blockchain technologies in maritime logistics.
Seafarer Well-being and Mental Health	- Introduction of programs addressing physical and mental health challenges faced by seafarers.
Collaborative Training with Academia	- Joint training initiatives between maritime institutes and universities.
Global Knowledge Exchange Forums	- Annual events bringing international experts to share insights on training advancements.

5.2.8. EcoSMarT: Environmental Sustainability

EcoSMarT, a proposed vertical under IOCE-SMarT, aims to drive environmental sustainability within the maritime sector by reducing marine pollution, enhancing waste management, and promoting renewable energy use in maritime operations. It will focus on aligning the Indian Ocean region with international environmental goals, such

as the UN Sustainable Development Goals and the Paris Agreement, through the adoption of sustainable practices across the maritime industry.

The core objectives of EcoSMarT include reducing emissions, improving fuel efficiency, and preventing pollution from ships and ports. The vertical will explore clean energy solutions like wind, solar, and biofuels, as well as developing waste management systems to reduce ship-generated waste. Additionally, EcoSMarT will advocate for the conservation of marine ecosystems, working with governments, industry stakeholders, and environmental organizations to create a sustainable and resilient maritime environment in the region.

Several global initiatives focus on environmental sustainability in the maritime sector, which are similar to the proposed EcoSMarT vertical:

1. Baltic Sea Action Plan (BSAP) focuses on environmental sustainability in the Baltic Sea region, addressing marine pollution, biodiversity conservation, and ecosystem restoration. It involves international cooperation among the nine Baltic Sea countries and regional organizations to reduce nutrient pollution, protect marine life, and promote sustainable maritime practices, aligning with goals similar to EcoSMarT's focus on marine pollution and ecosystem conservation.
2. Green Marine Program, a North American environmental certification program for the maritime industry focuses on reducing the environmental impact of ports, terminals, and shipping companies. It covers areas such as greenhouse gas emissions, oil spills, ballast water management, and eco-efficiency. Green Marine promotes best practices and solutions for sustainable port and vessel operations, similar to EcoSMarT's goals of waste reduction and emission management.

Table 9: EcoSMarT - Possible Workstreams/Activities:

Emission Reduction Technologies	Develop and deploy cutting-edge technologies such as carbon capture systems, exhaust gas cleaning systems (scrubbers), and hydrogen fuel cells for maritime operations.
Renewable Energy Integration	Facilitate the integration of renewable energy sources such as offshore wind farms, floating solar panels, and biofuels to power port operations and vessels.
Zero-Waste Port Initiatives	Create ports equipped with advanced waste management systems, including automated segregation and recycling facilities, and promote circular economy models in port operations.
Green Port Certification Program	Establish a certification system for ports that meet stringent environmental benchmarks, such as energy efficiency, low emissions, and sustainable resource use.
Decarbonized Shipping Corridors	Design and operationalize emission-free shipping routes in the Indian Ocean region, supported by alternative fuel bunkering facilities and energy-efficient navigation technologies.
Eco-Innovation Hubs	Create innovation hubs focused on designing and prototyping eco-friendly technologies, such as biodegradable ship coatings, noise-reducing propellers, and energy-efficient vessels.
Sustainable Fisheries Collaboration	Partner with regional fisheries to develop eco-friendly fishing practices, reduce bycatch, and ensure sustainable exploitation of marine resources.

Blue Carbon Ecosystem Projects	Engage in blue carbon initiatives, such as seagrass meadow restoration and mangrove conservation, to enhance carbon sequestration and biodiversity.
Environmental Awareness and Training Programs	Organize workshops, e-learning modules, and certification courses for maritime professionals on sustainable practices and environmental management.

5.2.9. TechSMarT: Promoting Maritime Technology Development

TechSMarT is a proposed vertical under IOCE-SMarT aimed at promoting technological innovation in the maritime sector. It will focus on advancing the adoption of cutting-edge technologies such as automation, digitalization, AI, and data analytics to improve operational efficiency, safety, and sustainability in maritime operations. The vertical will promote the use of autonomous vessels, smart ports, digital twins, and predictive maintenance, with an emphasis on enhancing supply chain efficiency, fuel optimization, and operational safety.

In addition to supporting the integration of these technologies, TechSMarT will foster research and development collaborations between technology developers, academia, and industry stakeholders. It will also focus on blockchain for supply chain transparency, smart contracts, and cybersecurity to protect maritime digital infrastructure. TechSMarT will offer training programs to upskill maritime professionals, ensuring they are prepared for the digital transformation of the industry and contributing to a more sustainable and technologically advanced maritime sector.

Several global initiatives and programs align with the goals of TechSMarT in promoting technological advancements in the maritime sector:

1. Japan's Maritime Bureau emphasizes the integration of advanced shipbuilding technologies and AI-driven port operations to enhance maritime efficiency and sustainability. By leveraging cutting-edge innovations such as automated systems, digital twins, and predictive analytics, Japan has significantly improved operational safety, reduced costs, and minimized environmental impact. TechSMarT could adopt similar practices, promoting the use of smart technologies across the maritime value chain in the Indian Ocean region.
2. Autonomous Ship Projects like Norway's Yara Birkeland project aims to develop the world's first fully autonomous container ship, which integrates advanced technologies like AI, automation, and digital mapping to reduce emissions, improve operational efficiency, and transform shipping logistics.

Table 10: TechSMarT - Possible Workstreams/Activities:

Development of Autonomous Vessels	Support R&D and pilot projects for autonomous ships, including AI-based navigation, collision avoidance, and remote operation systems.
Smart Port Infrastructure	Promote the adoption of digital twins, IoT-enabled sensors, and automated cargo handling systems to optimize port efficiency and reduce turnaround times.
Predictive Maintenance Systems	Implement AI-driven predictive maintenance solutions to monitor vessel and port equipment health, reducing downtime and repair costs.
Blockchain for Supply Chain Management	Develop blockchain platforms for real-time tracking, smart contracts, and enhanced transparency in maritime logistics.

Maritime Simulation and Training Systems	Utilize virtual reality (VR) and augmented reality (AR) for realistic training simulations, improving the skills of maritime professionals.
Smart Shipbuilding Technologies	Promote additive manufacturing (3D printing) and modular construction techniques for more efficient and sustainable shipbuilding.
Marine Spatial Planning Tools	Develop GIS-based tools for marine spatial planning, aiding in effective use of ocean resources and mitigating conflicts.
AI-Powered Safety Systems	Deploy AI-driven monitoring systems to enhance safety, such as automated fire detection, crew health monitoring, and hazard identification.

5.2.10. GreenSMarT: Providing Sustainable Maritime Solutions

GreenSMarT, a vertical under IOCE-SMarT, focuses on promoting environmentally sustainable practices in the maritime sector. It aims to drive the adoption of green technologies and operations, including alternative fuels, emission reduction technologies, and sustainable port and shipping practices. GreenSMarT will focus on decarbonization, energy efficiency, and protecting marine ecosystems by supporting the use of renewable energy like wind, solar, and hydrogen, as well as low-emission fuels such as ammonia, LNG, and biofuels.

The vertical will foster collaboration between governments, industry stakeholders, and environmental organizations to develop frameworks and policies that promote green practices. GreenSMarT will also support research in carbon capture, green ship designs, and zero-emission vessels, and promote sustainability certifications. Additionally, it will offer capacity-building programs to enhance the maritime industry's understanding and implementation of sustainable practices, aiming to accelerate the transition to a greener and more environmentally responsible maritime sector.

Several global initiatives focus on promoting sustainable practices in the maritime industry, like the proposed GreenSMarT vertical.

Denmark's Green Shipping Program is a leading initiative aimed at reducing carbon emissions in the maritime sector through the adoption of innovative technologies such as alternative fuels, energy-efficient ship designs, and digital solutions for optimized operations. The program also emphasizes collaboration between governments, industry stakeholders, and research institutions to accelerate the transition to greener shipping practices. GreenSMarT can adapt a similar approach for the Indian Ocean region by promoting the development and deployment of low-carbon technologies like hydrogen, ammonia, and biofuels, as well as fostering partnerships to create sustainable shipping and port operations.

Table 11: GreenSMarT - Possible Workstreams/Activities:

Zero-Emission Vessel (ZEV) Programs	Promote the design, development, and deployment of vessels powered by renewable energy and zero-emission technologies.
Marine Renewable Energy	Explore renewable energy solutions, such as offshore wind farms and wave energy, to power maritime operations.
Energy-Efficient Ship Designs	Encourage R&D in hull optimization, air lubrication systems, and lightweight materials for improved fuel efficiency.
Emission Reduction Technologies	Deploy scrubbers, exhaust gas cleaning systems, and other technologies to reduce SOx, NOx, and particulate matter emissions.

Ship Recycling Programs	Develop frameworks for safe and sustainable ship recycling, adhering to international standards like the Hong Kong Convention.
Hybrid and Electric Propulsion Systems	Support the development and adoption of hybrid-electric and fully electric propulsion systems for vessels.

5.2.11. Summary of Proposed Verticals under IOCE-SmarT

Table 12: Proposed verticals under IOCE-SMarT

Vertical	Objective	Scope and Functions	Global Example
BMSMarTC	Foster maritime collaboration among BIMSTEC nations	Knowledge exchange, capacity building, joint maritime policies, standardized practices, and training programs	European Maritime Safety Agency (EMSA), ASEAN Maritime Forum (AMF)
DigiSMarT	Integrate digital technologies in maritime sector	Adoption of AI, IoT, blockchain, smart ports, port automation, and supply chain logistics improvement	Port of Rotterdam – Smart Port Initiative, Maersk and IBM – TradeLens Blockchain Platform
LawSMarT	Advance maritime legal expertise and policy	Develop regional and international legal frameworks, dispute resolution, arbitration, and capacity building	International Tribunal for the Law of the Sea (ITLOS), Singapore Chamber of Maritime Arbitration (SCMA)
FinSMarT	Develop sustainable financing for green maritime	Create financing frameworks, green bonds, investment funds for decarbonization and green projects	Green Climate Fund (GCF)
InnovSMarT	Drive innovation and technological advancement	Promote R&D in energy efficiency, renewable energy, alternative fuels, and sustainable shipping practices	EU's Horizon 2020 Maritime Projects
CollSMarT	Foster international partnerships and cooperation	Facilitate joint research, capacity building, public-private partnerships, and collaborative projects	IMO Integrated Technical Cooperation Programme (ITCP), EU's Blue Growth Strategy
EduSMarT	Enhance maritime education and skills	Training, certification, e-learning, simulation-based learning, leadership development, and mental health support	Singapore Maritime Academy
EcoSMarT	Promote environmental sustainability	Reduce emissions, enhance waste management, use renewable energy, conserve marine ecosystems	Baltic Sea Action Plan

TechSMarT	Advance maritime technology	Shipbuilding technologies, port automation, technology transfer, equipment trials	Japan’s Maritime Bureau Norway’s Yara Birkeland Project
GreenSMarT	Foster green technologies and practices	Promote alternative fuels, energy efficiency, carbon capture, green ship designs, and sustainability certifications	Denmark's Green Shipping Program

5.3. Integrated Approach for Sustainable Maritime Excellence

The Indian Ocean Centre for Excellence in Sustainable Maritime Transport (IOCE-SMarT) adopts a holistic and integrated approach to transform the region's maritime sector into a globally competitive, environmentally sustainable, and technologically advanced industry. Through its dedicated verticals, IOCE-SMarT addresses critical challenges and fosters innovation, collaboration, and capacity building across diverse domains. By aligning with regional needs and global standards, the Centre bridges gaps between research, policy, and practice, driving sustainable growth and enhancing the maritime sector's resilience and efficiency.

1. Sustainable Practices

   IOCE-SMarT prioritizes environmental stewardship by promoting green technologies, alternative fuels, and renewable energy solutions. Vertical EcoSMarT spearheads initiatives for reducing emissions, protecting marine ecosystems, and developing cleaner propulsion systems. Additionally, vertical GreenSMarT focuses on advancing decarbonization technologies to mitigate the maritime sector's environmental impact and align with global sustainability standards.

2. Research and Innovation

   Driving technological advancement and operational efficiency is a cornerstone of IOCE-SMarT's mission. Vertical InnovSMarT leads research in alternative fuels, energy-efficient systems, and innovative propulsion technologies, ensuring actionable solutions for industry challenges. Supporting this effort is TechSMarT, which focuses on port optimization, and cutting-edge maritime technologies.

3. Digital Transformation

   The maritime sector's digital evolution is enabled through DigiSMarT, which promotes smart technologies, autonomous shipping systems, and digital twins for operational optimization. This vertical ensures that the maritime industry remains competitive and future-ready through state-of-the-art digital innovations.

4. Capacity Building and Knowledge Exchange

   Preparing a skilled and adaptable workforce is central to IOCE-SMarT's goals. Vertical EduSMarT provides advanced training, virtual simulations, and e-learning platforms to equip professionals for emerging challenges. Meanwhile, CollSMarT facilitates international partnerships and collaboration, fostering knowledge exchange and collective expertise to strengthen global maritime capabilities.

5. Sustainable Financing and Legal Frameworks

   Ensuring economic viability and regulatory clarity for maritime initiatives is addressed by two key verticals:

   A. FinSMarT: Mobilizes resources for sustainable projects, including decarbonization and green investments like green bonds.

   B. LawSMarT: Develops maritime-specific legal frameworks, including arbitration and compliance solutions, tailored to industry needs.

6. Regional Collaboration and Development

   IOCE-SMarT is dedicated to addressing the socio-economic and environmental challenges of the Indian Ocean region. Vertical BMSMarTC promotes collaboration among BIMSTEC countries to foster trade, improve logistics, and protect marine ecosystems. This ensures inclusive and sustainable regional growth while building a resilient maritime economy.

7. Distinctive Value Proposition

   The integration of these verticals ensures:

   A. EcoSMarT & GreenSMarT: Leadership in environmental sustainability and decarbonization.

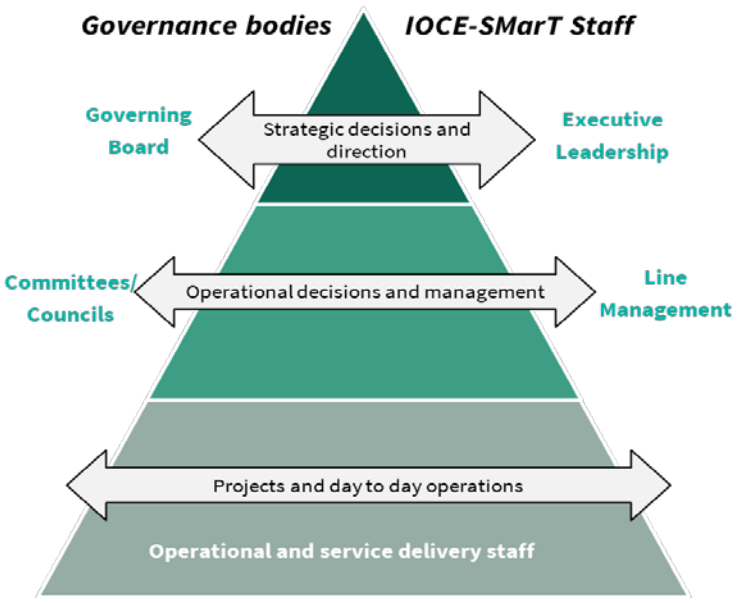
B. InnovSMarT & TechSMarT: Research and technology driving innovation.
C. DigiSMarT: Cutting-edge digital transformation.
D. EduSMarT & CollSMarT: Capacity building and global partnerships.
E. FinSMarT & LawSMarT: Sustainable financing and robust legal frameworks.
F. BMSMarTC: Regional collaboration for inclusive development.

Through these efforts, IOCE-SMarT aims to establishes itself as a global leader in sustainable maritime development while fostering innovation, regional cooperation, and a cleaner, greener maritime future.

6. Governance and Management framework

A Governance and Management framework will provide a clear structure for decision-making, resource allocation, and accountability, ensuring that all goals of IOCE-SMarT are met effectively. A robust governance model will be essential in driving the vision of IOCE-SMarT to become a comprehensive hub for excellence in sustainable maritime globally.

Figure 9: Characteristics of the required governance and management framework

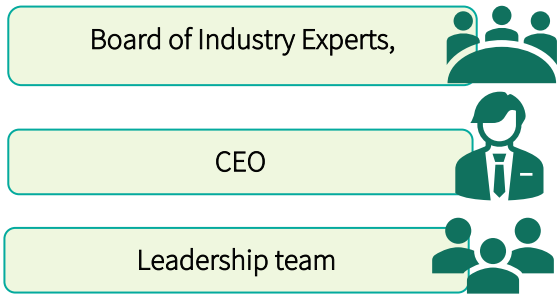


6.1. Governance Structures Review

To align with the vision of IOCE-SMarT, we reviewed five potential governance models: Advisory Model, Cooperative Governance Model, Patron Governance Model, Policy Board Model, and Management Team Model. Each model offers unique advantages in terms of structure and strategic direction. These models are designed to enhance collaboration, foster innovation, and ensure effective management of the center. The ideal governance structure for IOCE-SMarT may not strictly follow a single model but will instead combine elements from each to create a mixed model tailored to the center's specific needs and priorities.

6.1.1. Advisory Model

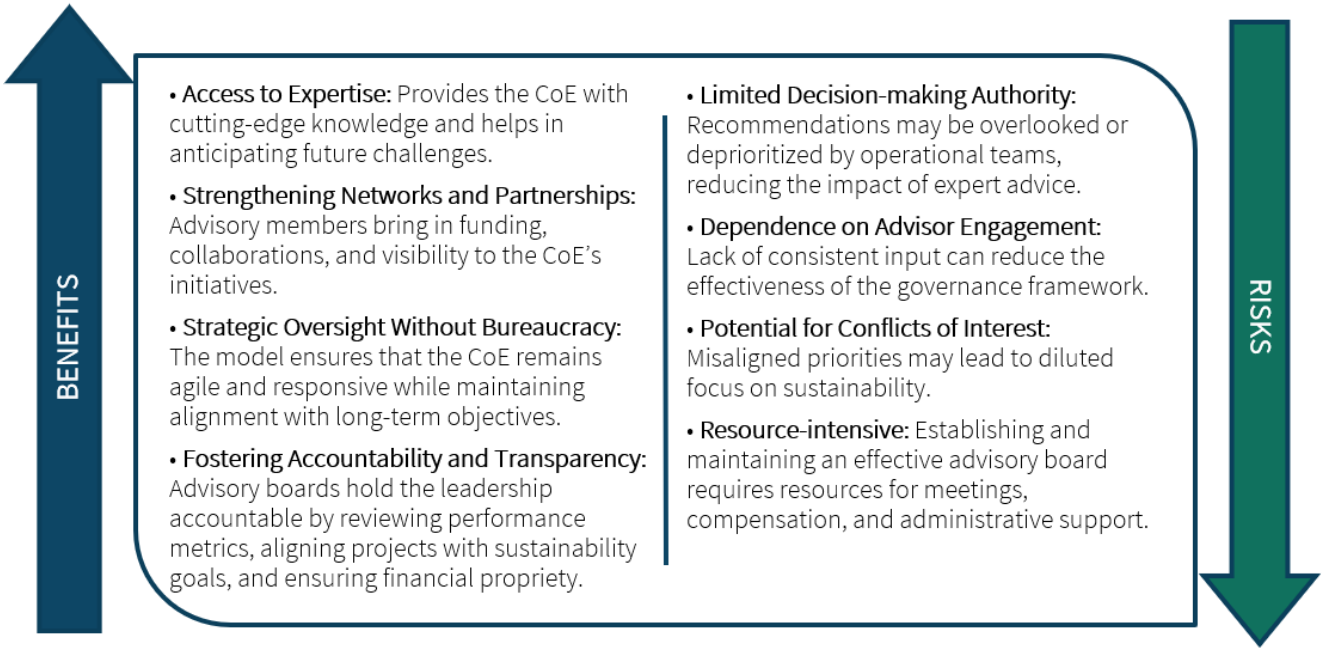
The Advisory Model of Governance is a framework wherein a governing body or advisory board provides strategic guidance, expertise, and recommendations to the leadership team of a CoE, without directly managing or



controlling day-to-day operations. The focus is on leveraging the knowledge and networks of experts to steer the CoE toward its objectives while allowing operational autonomy. The board is often formed in addition to the organization's main board and operates in an informal, non-hierarchical structure.

Key Features

1. **Expert-driven:** Advisory boards consist of domain experts, industry leaders, and academics who provide insights into emerging trends, funding opportunities, and partnerships.
2. **Flexible and non-intrusive:** The advisory board serves as a sounding board, ensuring that decisions align with long-term goals without micromanaging operations.
3. **Diverse representation:** Members come from varied sectors, such as government, industry, academia, and non-profits, ensuring a balanced perspective.
4. **Focus on strategic alignment:** The model emphasizes aligning the CoE's activities with national or global sustainability goals, such as the UN Sustainable Development Goals (SDGs).



Suitability of the model for IOCE-SMarT

The model can provide specialized inputs and expert knowledge to IOCE-SMarT for anticipating challenges and risks and shaping the focus areas in alignment with long term objectives. With national and international members across specialised maritime domains, the model can enhance credibility and quality of decisions, and foster accountability. However, the model's effectiveness will hinge on alignment of priorities and active engagement from advisors.

Source[23]

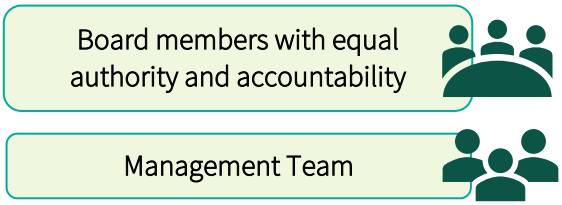
Advisory Model in Action: ARIES, U.S.A

Advanced Research on Integrated Energy Systems (ARIES) is the U.S. Department of Energy's advanced research platform to validate their future integrated energy system with increasing integration of renewables, storage, and interactive loads at a size and scale that matters. Its oversight and management is a coordinated effort among a steering committee, advisory boards, and R&D subcommittees for research and governance. The advisory board comprises experts from academia, industry, and government to provide insights into renewable energy trends. The board has successfully guided research on wind energy and development of advanced

[23] https://www.nrel.gov/aries/advisory-committees.html

6.1.2. Cooperative Governance Model

The Cooperative Governance Model emphasizes collaboration and equal participation among members, fostering a democratic structure where decision-making is consensus driven. There is no centralized leadership (e.g., CEO or president) and all members share equal authority and accountability. This model fosters resource pooling, and joint ownership, aiming to leverage the strengths of each participant to achieve common sustainability objectives.



Key Features

1. Shared Decision-Making: Decisions are made collectively, ensuring that all stakeholders have a voice in the CoE's direction and priorities.
2. Resource Sharing: Partners contribute resources—such as funding, expertise, and facilities—to support the CoE's initiatives.
3. Joint Ownership: Members share ownership of both the successes and challenges, fostering a sense of collective responsibility.

4. Diverse Expertise: The model brings together varied perspectives and stakeholders as members - such as industry partners, academic institutions, government agencies, and non-profit organizations- enhancing innovation through interdisciplinary collaboration

Suitability of the model for IOCE-SMarT

The model can be beneficial for IOCE-SMarT with respect to resource sharing of funding, expertise and infrastructure. However, complex decision making and potential conflict of interest will require careful management to fully realise the model's benefits.

Cooperative Governance Model in Action: SolarPower Europe

SolarPower Europe represents 320 companies and organisations across the entire solar value chain. Member companies (manufacturers, installers, and developers) collaborate on innovation and policy goals. Decisions are made collectively, ensuring alignment across the solar value chain. All SolarPower Europe's political positions are approved by the Board, where 19 out of 20 of Board members represent European-headquartered companies. It has successfully driven innovation in photovoltaic technologies and grid integration

Source[24]

6.1.3. Patron Governance Model

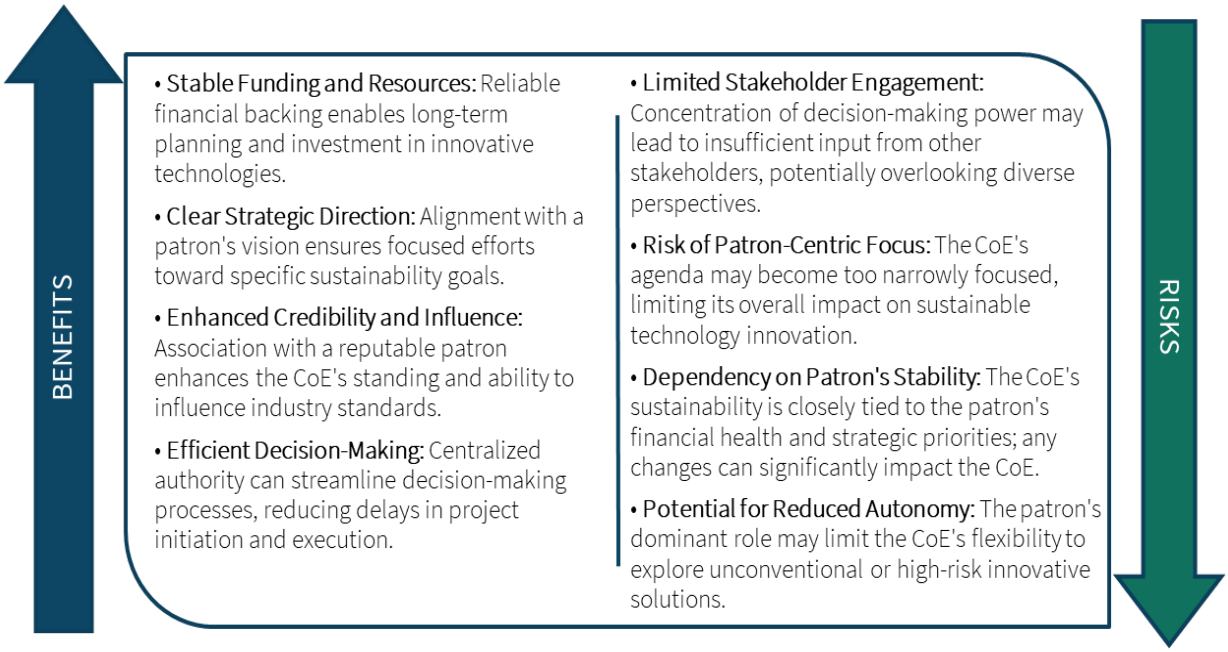
The Patron Model is centred on leveraging the wealth, influence, and networks of affluent board members to secure funding and elevate the organization's visibility. This model centralizes authority and funding, and the focus is on fundraising and resource mobilization, not day-to-day governance. The board works in tandem with the executive leadership but with limited direct influence.

Key Features

1. **Centralized Decision-Making:** The patron holds significant authority over strategic decisions, guiding the CoE's objectives and priorities.
2. **Primary Funding Source:** The patron provides the majority, if not all, of the financial resources necessary for the CoE's operations and projects.
3. **Strategic Alignment:** The CoE's initiatives are closely aligned with the patron's goals, policies, or business interests.

[24] https://www.solarpowereurope.org/about/our-story

4. **Operational Autonomy:** While strategic direction is set by the patron, the CoE typically retains autonomy in day-to-day operations and implementation.



Suitability of the model for IOCE-SMarT

The model does not align with how the IOCE-SMarT is envisaged, that is to function within the framework of international cooperation and public-sector funding and not rely on wealthy or influential board members to secure funding or visibility. Visibility and resources should come from international organizations and regional partnerships, and not from the personal networks of the Patron board.

Patron Governance Model in Action: Breakthrough Energy (BE)

Breakthrough Energy founded by Bill Gates, supports cutting-edge research and development, investing in companies that turn green ideas into clean products, and advocating for policies that speed innovation from lab to market. Through investment vehicles, philanthropic programs, policy and advocacy efforts, and other initiatives, Breakthrough Energy works to accelerate the technologies needed to build a carbon-free economy. Gates and co-founders provide financial backing, visibility, and strategic direction, enabling BE ventures to fund high-risk, high-reward technologies like advanced nuclear power, carbon capture, and hydrogen fuel.

6.1.4. Policy Board Model

The Policy Board Governance Model has a board comprising representatives from various stakeholders—which provides strategic direction, oversight, and policy guidance. This model emphasizes collaborative decision-making, ensuring that the CoE's initiatives align with the interests and expertise of diverse parties, including industry, academia, government, and civil society. It focuses on strategic governance, with operational authority delegated to the CEO, and ensures a clear division between governance and management.

Key Features

1. Diverse Representation: The policy board includes members from multiple sectors, bringing a wide range of perspectives and expertise to the CoE's governance
2. Strategic Oversight: The board is responsible for setting the CoE's strategic direction, approving major initiatives, and ensuring alignment with broader industry and societal goals.
3. Collaborative Decision-Making: Decisions are made through consensus or majority voting, promoting inclusivity and shared ownership among stakeholders.
4. Operational Independence: While the board provides strategic guidance, the CoE maintains autonomy in day-to-day operations and implementation of projects.

Suitability of the model for IOCE-SMarT

The model can benefit IOCE-SMarT as it distinguishes oversight from daily management and keeps governance focused on high-level decisions such as policy making, high level oversight, and partnerships. The CEO can have significant autonomy in day-to-day operations.

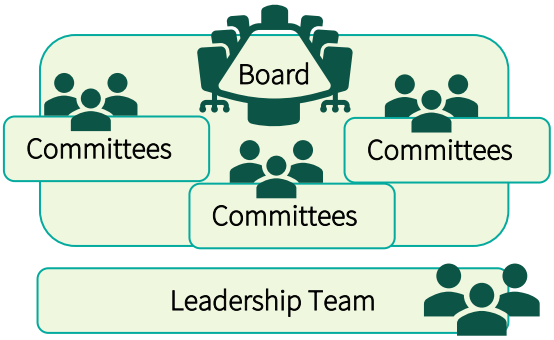
Policy Board Governance Model in Action: IMO

International Maritime Organisation (IMO) is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine and atmospheric pollution by ships. The IMO Assembly, which is its policy board, and the highest Governing Body of the Organization, consists of all Member States. The Assembly is responsible for approving the work programme, voting the budget, setting policies and conventions, and determining the financial arrangements of the Organization. Operational aspects are managed by the technical committees and subcommittees

Source[25]

6.1.5. Management Team model

The Management team model has a board where governance responsibilities are assigned to specific domain committees within the board. The board committees oversee strategic, operational, and compliance related functions. They are often formed in addition to another board or have a centralised management team to keep the distinct committees work integrated.



Key Features

1. **Specialised committees:** Governance responsibilities distributed across dedicated committees for specialised attention across key focus areas

[25] https://www.imo.org/en/About/Pages/Structure.aspx

2. **Operational involvement:** The board committees are involved in strategic direction as well as execution and implementation.

Suitability of the model for IOCE-SMarT

The model from a governance point of view may be complex during the inception of IOCE-SMarT due to coordination complexity and potential conflict of priorities within the board. However, elements of this model may be beneficial at a managerial level through technical or steering committees focussed on critical areas of operations. Robust communication and reporting mechanisms can mitigate the risks of the model and enhance its effectiveness at the managerial level

Source[26]

Management team Governance Model in Action: Wärtsilä

Wärtsilä is a global leader in innovative technologies and lifecycle solutions for the marine and energy markets. Wartsila has a Board of Management in addition to the board of directors, which is comprised of eight members: the President & CEO, the Chief Financial Officer, the Executive Vice Presidents of the businesses Wärtsilä Energy, Wärtsilä Marine Power and Wärtsilä Marine Systems, as well as the Executive Vice Presidents heading the Marketing and Communications; Corporate Relations & Legal Affairs; and Human Resources functions. The board of management considers strategic issues related to the Group and its businesses, as well as investments, product policy, and the Group's structure and corporate steering systems.

6.2. Proposed Governance Structure

The proposed governance and management structure has been developed by integrating the suitable elements from models, across governance, oversight, strategic direction and operations. It will ensure effective leadership, coordination, and operational oversight. IOCE-SMarT will serve as the parental establishment providing strategic direction, while the BIMSTEC Centre of Excellence for Sustainable Maritime Transport (BMSMarTC) will operate as an autonomous vertical to address the specific needs of BIMSTEC member nations.

[26] https://www.wartsila.com/docs/default-source/investors/corporate-governance-statements/corporate-governance-statement-2023.pdf?sfvrsn=f1471943_1

Figure 10: Proposed governance and management framework

Policy and Administrative Control Authority: Ministry of Ports, Shipping, and Waterways (MoPSW)

Policy and administrative control of IOCE-SMarT will be with the Ministry of Ports, Shipping, and Waterways to ensure that the Ministry retains authority over the center's operations and alignment with national maritime goals. The Ministry will provide overarching policy direction and administrative support to IOCE-SMarT. Its responsibilities would include -

1. Aligning IOCE-SMarT objectives with national and regional maritime goals
2. Facilitating intergovernmental collaboration and resource mobilization
3. Overseeing funding and financial accountabilities
4. Providing strategic policy direction
5. Ensuring alignment with broader maritime policies

Chairman/ Director General

A seasoned maritime professional preferably seconded from the Ministry or DG Shipping. The Chairman/Director General will be the governing head of IOCE-SMarT, responsible for strategic leadership and operational oversight. Specific responsibilities include:

1. Representing IOCE-SMarT in international forums and fostering collaborations.
2. Ensuring alignment between IOCE-SMarT's objectives and global maritime sustainability goals.
3. Supervising all verticals under IOCE-SMarT, including BMSMarTC, and ensuring efficient resource utilization.

Governing Board

The Governing Board would serve as the primary decision-making body for IOCE-SMarT.The Board would consist of a diverse representation of institutions across sectors relevant to sustainable maritime transport. The representation would entail permanent members from relevant ministries and government bodies, as well as

nominated members across maritime associations and organisations with fixed terms. The total membership, including the Chairman, will not exceed 11 members, ensuring balanced representation and effective decision-making. Nominated members will have a fixed term of two years.

Key functions of the governing board would include:

1. Approving policies, budgets, and performance reports.
2. Facilitating collaboration among IOCE-SMarT's verticals and external partners.
3. Providing strategic oversight to align activities with global maritime sustainability goals.

Table 12 : Proposed Constitution of Governing Board

Role	Representation
Chairman	Chairman/Director General of IOCE-SMarT
Ex-officio Members	Representatives from the Ministry of Ports, Shipping, and Waterways (MoPSW)
	Representatives from the Ministry of External Affairs (MEA)
	Director General of Shipping
	Representative from the Shipping Corporation of India (SCI)
	Representative from SCILAL
Nominated Members.	Representatives from Indian Port Association
	Representatives from leading maritime organizations
	Independent maritime policy experts

Technical Advisory Board

The Technical Advisory Board would provide technical guidance to IOCE-SMarT, including BMSMarTC. The Board will have a maximum of 11 members, ensuring a broad and balanced representation of expertise while maintaining governance efficiency, and the nominated members will have fixed term of two years. The Board will report to the IOCE-SMarT Governing Board and ensure technical coherence across all operational activities.

Key functions of the governing board would include:

1. Provide technical consultation and support
2. Inform key updates and best practices from industry, academia, and government institutions engaged in sustainable maritime innovation
3. Ensure the alignment of projects and activities with the latest sustainability trends

Table 13: Proposed Constitution of Technical Advisory Board

Role	Representation
Chairman	Director General of Shipping or his nominee
Ex-officio Members	Representatives from MoPSW

Role	Representation
	Representative from MEA
	Representative from M/s Shipping Corporation of India
	Representative from Indian Maritime University
Nominated Members.	Representatives from Classification Societies (e.g., IRS, DNV, Lloyd's)
	Representatives from leading shipping companies
	Maritime academicians and researchers
	Experts from maritime professional organizations

Chairman/ Director General

The Chairman to be a seasoned maritime professional with practical experience in maritime research, innovation, energy transition and education. Possibly seconded from the Ministry. The purpose is to consolidate feedback and guidance from the governing and advisory board into a strategic workstreams and drive its implementation

6.3. Proposed Operational Structure

Chief Executive Officer (CEO)

The CEO would be a maritime professional with practical experience in maritime research, innovation, energy transition and education. The CEO consolidate the guidance from the governing and advisory boards into a strategic workstreams and drive its implementation. The CEO will be responsible for the day-to-day management of IOCE-SMarT, reporting directly to the Chairman/Director General. Key responsibilities include:

1. Implementing policies and strategies approved by the Governing Board.
2. Coordinating with department heads, technical experts, and external stakeholders.
3. Overseeing operational activities and ensuring compliance with IOCE-SMarT's mission.

Heads of Departments

Each department within IOCE-SMarT would be led by a Head of Department, responsible for specific operational domains such as research, training, or technology development. The Heads would report to the CEO and ensure alignment with IOCE-SMarT's strategic objectives.

Programme Managers and Project Managers

These managers would be responsible for implementing specific projects and programs within their domains. Their responsibilities would include:

1. Managing timelines, resources, and stakeholders.
2. Monitoring project outcomes and reporting progress to department heads

Academic Experts, Domain Experts, and Research Fellows

These professionals would provide specialized knowledge to guide research, policy formulation, and capacity-building programs. Their contributions would ensure IOCE-SMarT remains at the forefront of maritime innovation.

Steering Committees

Steering committees often consist of senior representatives, stakeholders, or experts in specific domains. Steering committees may be formed consisting of the CEO along with members of the advisory board and executive management (CEO, Heads of departments, experts) relevant to the domain or area of focus of the respective committees. Each committee would focus on specific areas of expertise critical to advancing sustainable technology and innovation in maritime. These committees would guide research, oversee technical initiatives, and align projects with sustainability goals.

Support Staff

Support staff, under the supervision of the Registrar, would assist in administrative, financial, and logistical functions, ensuring smooth operations across the organization.

6.4. Proposed Governance and Operational Structure of BMSMarTC

Governance Structure

Autonomous Status

BMSMarTC would operate as an autonomous vertical within IOCE-SMarT, focusing on the priorities of BIMSTEC member nations while aligning with IOCE-SMarT's broader objectives.

Governing Board

The BMSMarTC Governing Board would comprise of one representative from each BIMSTEC member nation. Responsibilities would include:

1. Developing policies and programs tailored to BIMSTEC's needs.
2. Approving budgets and monitoring the implementation of initiatives.
3. Ensuring regional ownership and equitable representation among member nations.

Scientific Advisory Committee:

The Scientific Advisory Committee, composed of domain experts from BIMSTEC countries, would provide technical guidance for BMSMarTC's initiatives. Its role would include:

1. Advising on regional research priorities and training programs.
2. Reviewing project proposals and recommending funding allocations.
3. Promoting knowledge exchange and fostering innovation

Operational Structure

Director

The Director would manage the day-to-day operations of BMSMarTC and reports directly to the Chairman/Director General of IOCE-SMarT. Key responsibilities include:

1. Implementing strategies approved by the BMSMarTC Governing Board.
2. Managing resources and ensuring alignment with regional objectives.
3. Reporting on performance and coordinating with IOCE-SMarT leadership.

Registrar

The Registrar would handle all administrative, financial, and logistical functions for BMSMarTC. The Registrar would support the Director in ensuring smooth operations.

Programme Managers

Programme Managers oversee specific initiatives and coordinate with domain experts to ensure effective implementation. They would report to the Director of BMSMarTC.

Domain Experts and Research Fellows

These professionals would contribute to the research, training, and technical activities of BMSMarTC, ensuring the Centre's programs are impactful and regionally relevant.

Support Staff

Support staff would assist in daily operations, providing logistical and administrative support to all functional entities within BMSMarTC.

Figure 11: Proposed governance and management framework

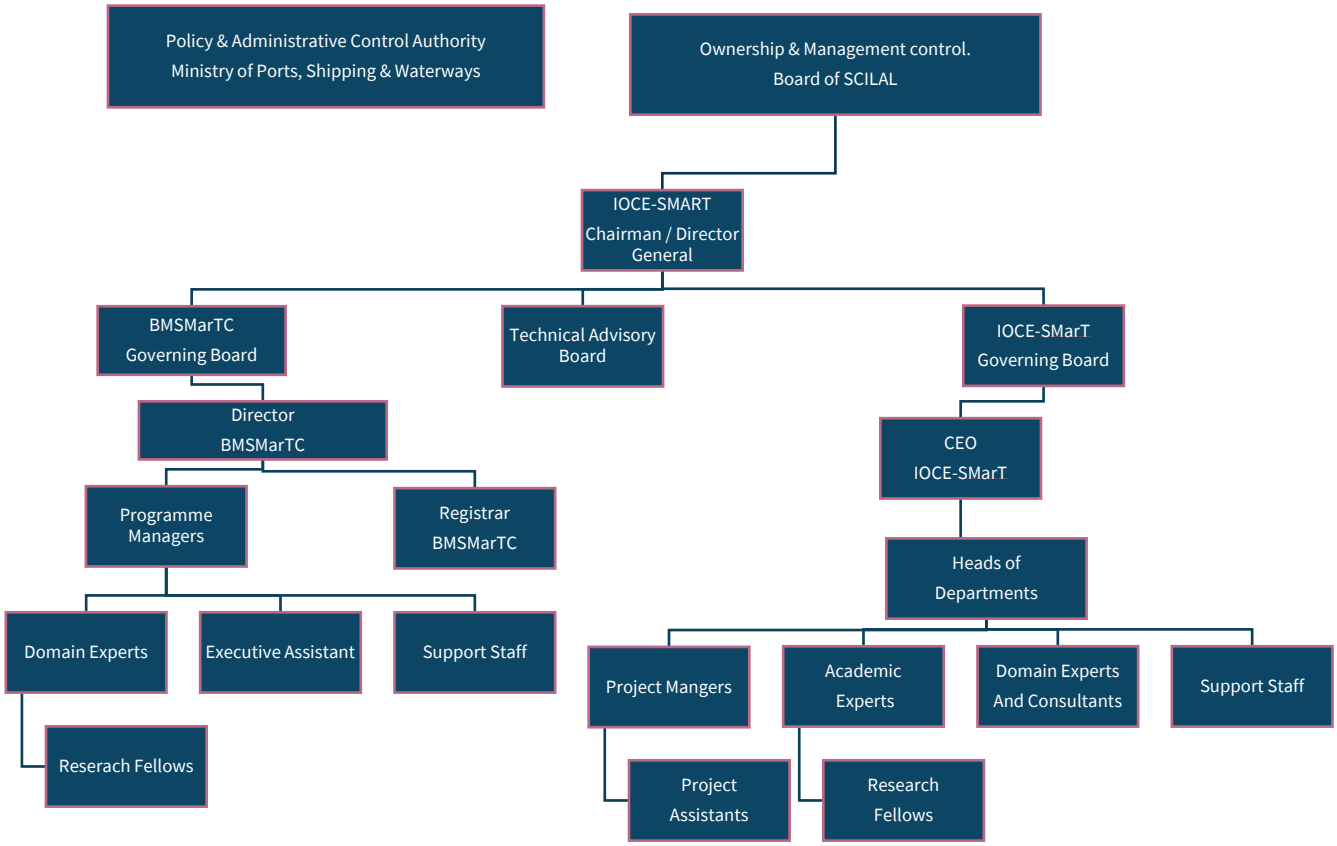


Table 14: Summary of responsibilities

Entity	Role and Responsibilities
SCILAL	Ownership of premises, infrastructure management, financial oversight, and shareholder protection.
MoPSW	Policy direction, alignment with maritime goals, and funding facilitation.
IOCE-SMarT Governing Board	Approves policies, budgets, and strategic initiatives for IOCE-SMarT.
Technical Advisory Board	Provides technical guidance for research, training, and capacity-building programs.
BMSMarTC Governing Board	Independently manages administrative and functional matters of BMSMarTC.
Chairman/Director General of IOCE-SMarT	Highest executive authority overseeing operations and administration of both IOCE-SMarT and BMSMarTC.
CEO of IOCE-SMarT	Operational head of IOCE-SMarT, responsible for managing its functions, supported by a team of Registrar, HODs, and Project Managers.
Director of BMSMarTC	Manages BIMSTEC-specific programs and aligns them with IOCE-SMarT objectives, supported by a dedicated team.

7. Maritime Training Institute (MTI) – Powai, Mumbai

The Maritime Training Institute (MTI) – Shipping Corporation of India Ltd (SCI). established in 1988 is a 35 years old institute built for the purpose of providing maritime training to seafarers. The institute was established with an excellent vision and had state of the art facilities.

The ownership of the "Maritime Training Institute" (MTI), Powai, Mumbai post demerger/ disinvestment of M/s Shipping Corporation of India Ltd will be with the Board of "Shipping Corporation of India Land and Assets Limited" (SCILAL).

MTI's location, physical infrastructure, expertise, and government support collectively position it as an ideal candidate for transformation into a Center of Excellence. With a strong focus on sustainable maritime practices, collaboration with the IMO, and the dedication to shaping the maritime industry's future, MTI's evolution into the IOCE-SMarT promises to be a significant milestone in the region's maritime education and sustainability efforts

Table 15: Summary of the Mechanism for Establishing IOCE-SMarT within MTI Premises

Aspect	Description	Responsible Authority	Notes
Ownership and Control	SCILAL retains ownership of MTI premises and management of infrastructure and financial aspects.	SCILAL	Ensures compliance with shareholder obligations and lease conditions.
Policy Direction	Provides strategic guidance and policy alignment with national maritime goals.	Ministry of Ports, Shipping, and Waterways (MoPSW)	Overarching authority for maritime policy and strategic objectives.
Shared Facilities	IOCE-SMarT utilizes MTI classrooms, conference facilities, and residential spaces, in the initial phases	SCILAL and IOCE-SMarT	Formal agreement ensures shared use while maintaining SCILAL's ownership.
International Collaboration	Partnerships with IMO and BIMSTEC countries for training, capacity building, and research.	IOCE-SMarT	Strengthens regional and global maritime collaboration.
Initial Funding	Government of India funds capital expenditures for infrastructure upgrades and equipment.	Government of India	Enables foundational development and operational readiness.
Operational Funding	Generated through collaborations, training programs, and managed by SCILAL.	SCILAL and IOCE-SMarT	Revenue reinvested into development, ensuring non-profit compliance.

Aspect	Description	Responsible Authority	Notes
Governance Structure	Includes a Governing Board and Technical Advisory Board for oversight and guidance.	IOCE-SMarT	Representation from SCILAL, MoPSW, international organizations, and experts.
Overall Leadership	Chairman/Director General will be topmost executive of both IOCE-SMarT & BMSMarTC, who will be overall administrative control authority of the entire establishment.	IOCE-SMarT	Central leadership will ensure clear direction and faster decision making.
Operational Leadership	1. CEO of IOCE-SMarT serves as the operational head, overseeing day-to-day operations. 2. The Director of BMSMarTC manages BIMSTEC-specific initiatives. 3. Both are supported by a team including a Registrar, HODs, Project Managers, and other staff.	IOCE-SMarT and BMSMarTC	Ensures effective execution of operational and strategic goals.
BMSMarTC Governance	Independent vertical within IOCE-SMarT with its own Governing Board for administrative and functional autonomy.	BMSMarTC Governing Board	Aligns BIMSTEC-specific programs with regional and IOCE-SMarT objectives.
Implementation Steps	DPR Preparation, stakeholder consultations, Approval of DPR, Planning, MOUs, infrastructure upgrades, operationalization, and monitoring.	SCILAL, MoPSW, IOCE-SMarT, and BMSMarTC	Sequential milestones ensure systematic progress and accountability.
Financial Accountability	Independent audits and annual reports ensure transparency and statutory compliance.	SCILAL, IOCE-SMarT, and BMSMarTC	Protects shareholder interests and enhances asset value.

8. Infrastructure Requirement

Setting up a maritime training institute requires careful planning and provision of infrastructure to ensure the facility can offer effective, high-quality training in a safe and realistic environment. The infrastructure must accommodate both theoretical and practical training aspects of maritime education, focusing on areas like navigation, safety, engineering, communication, and emergency response. Here are the key infrastructure requirements:

Classrooms and Lecture Halls

1. Adequate space: Classrooms should be designed to accommodate diverse group sizes, with flexible seating arrangements to facilitate discussions and group activities. The design should also consider soundproofing to minimise distractions during lectures.

2. Advanced equipment: Each classroom must be equipped with state-of-the-art technology, including interactive whiteboards, projectors, multimedia systems for presentations, and computers loaded with maritime simulation software. This will enhance the teaching and learning experience by providing access to real-time data and simulations.

3. Comfort and accessibility: Proper ventilation, natural lighting, ergonomic seating, and acoustic design are essential for creating a conducive learning environment. Classrooms should also be accessible to individuals with disabilities.

Simulators and Practical Training Rooms

1. Comprehensive simulation facilities: The hub should feature state-of-the-art bridge simulators capable of replicating various maritime scenarios, including navigation under different weather conditions and emergency situations. Engine room simulators must also provide realistic training on machinery operations.

2. Emergency response training areas: Dedicated spaces for fire safety drills, oil spill response simulations, and evacuation procedures will prepare trainees for real-world maritime emergencies.

3. Cargo handling simulators: These should replicate port environments to train students in loading/unloading procedures and managing different types of cargo.

Ship and Port Facilities (for Practical Hands-On Training)

1. Dedicated training vessel: A full-scale ship or multiple smaller vessels must be available for onboard training. This vessel should be equipped with modern navigation and safety equipment to provide realistic training experiences.

2. Access to operational ports: The hub should have partnerships with nearby ports for practical training in cargo handling, mooring, and docking exercises. This access will allow trainees to engage directly with port operations.

3. Dry docks for maintenance training: Facilities equipped with dry docks will enable hands-on experience in ship repairs, maintenance procedures, and inspections.

Engineering Workshops

1. Advanced machinery workshops: These workshops should include equipment for mechanical and electrical training, allowing trainees to work on real engines and machinery.
2. Welding and fabrication facilities: Workshops dedicated to welding techniques, fabrication processes, and shipbuilding will provide essential skills for future maritime engineers.
3. Electrical systems laboratories: Labs should be equipped with tools for understanding shipboard electrical systems, including troubleshooting practices.

Laboratories

1. Hydrographic laboratory: A lab focused on hydrographic surveying techniques where trainees can practice charting water depths using modern surveying equipment.
2. Navigation laboratory: This facility should include navigational instruments like radar systems, GPS devices, and traditional tools such as sextants for practical navigation exercises.
3. Communication laboratory: Equipped with radio communication systems, satellite communication setups, and emergency signalling devices for hands-on training in maritime communication protocols.

Research & Development Centre

Establish a dedicated R&D centre focusing on innovative maritime technologies such as renewable energy applications in shipping (e.g., solar-assisted propulsion), waste management solutions (e.g., biodegradable materials), and smart shipping technologies (e.g., autonomous vessels). This centre can collaborate with universities and industries globally to foster innovation.

Accommodation and Facilities for Trainees

1. On-Campus Accommodation: Safe housing facilities that offer comfortable living conditions for trainees attending long-term programs. These accommodations should include communal areas for social interaction.
2. Dining facilities: A cafeteria that provides nutritious meals catering to diverse dietary needs is crucial for supporting trainees during intensive training schedules.
3. Recreational areas: Facilities such as gyms, sports courts, and relaxation lounges will promote a balanced lifestyle among trainees.

Safety Equipment and Facilities

1. Safety training zones: Designated areas for conducting regular safety drills, including fire evacuations and lifeboat training exercises.
2. Survival equipment access: Lifeboats, life jackets, first aid kits, and other survival gear must be readily available for practical survival training sessions at sea.
3. First Aid training rooms: Equipped with medical supplies and mannequins for emergency medical response training.

Library and Resource Center

1. Comprehensive maritime library: A well-stocked library featuring books on maritime law, navigation techniques, environmental studies, technology advancements, research papers, and journals related to maritime studies.

2. Digital learning resources: Access to online databases, e-learning platforms offering courses from global institutions (e.g., MIT OpenCourseWare), digital libraries focusing on maritime issues.

Collaboration Space

Create collaborative spaces designed specifically for group projects where trainees can work together on real-world challenges facing the maritime industry. These spaces can facilitate brainstorming sessions, workshops with industry experts, and networking events.

Administrative Facilities

1. Efficient office spaces: Dedicated offices for administrative staff responsible for managing operations effectively; this includes faculty offices designed for collaboration with students.
2. Student support services area: A helpdesk providing career counselling services that guide students on internships or job placements in the maritime sector.
3. Registration area: For issuing course completion certificates as well as handling license applications related to maritime certifications.

IT Infrastructure

1. Robust high-speed internet access: Essential for research activities across various disciplines within maritime studies; supports online training sessions as well as communication needs among faculty members.
2. Advanced computer labs: Equipped with computers running specialised software for simulations and administrative functions.

Transportation and Access

1. Parking facilities: Adequate parking space should be available not only for trainees but also faculty members visiting the institute regularly.
2. Transport arrangements: Local transportation options must be arranged to facilitate easy access to maritime training locations such as ships or ports.

Maintenance and Support Services

1. Technical support team: For maintaining simulators used in training sessions alongside machinery equipment; ensuring all systems operate efficiently is critical to educational success.
2. Cleaning services: Regular upkeep of facilities is necessary to maintain hygiene standards across the campus; this includes daily cleaning schedules along with periodic deep cleaning.

Sustainability Initiatives

Incorporate green building practices into the infrastructure design of IOCE-SMarT by utilising renewable energy sources (solar panels), rainwater harvesting systems, energy-efficient lighting solutions, and sustainable materials in construction. This commitment will serve as a model of sustainability in maritime education.

Regulatory Compliance

1. Conformance to maritime regulations: Ensuring that all facilities comply with local regulations as well as international maritime standards set by organisations like the IMO (International Maritime Organisation) conventions; adherence is vital for legitimacy in certification processes.

2. Accreditation processes: Obtaining necessary approvals from regulatory bodies (e.g., Directorate General of Shipping) is crucial to deliver recognised maritime training programs.

9. Financial Requirement

The Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT) is poised to revolutionize the maritime sector through a commitment to innovative training, research, and sustainable practices. This pioneering initiative seeks to tackle both regional and global challenges by promoting knowledge-sharing, technological advancements, and strategic industry partnerships. To successfully achieve its mission, IOCE-SMarT requires a comprehensive financial strategy that ensures long-term sustainability, operational efficiency, and alignment with its strategic objectives.

Developing a robust financial strategy is critical for navigating the complexities associated with funding requirements, which include significant capital investments (CAPEX) and ongoing operational expenditures (OPEX). This strategy must consider diverse revenue streams, foster international collaborations, and explore innovative funding models to support IOCE-SMarT's ambitious goals. The financial framework will categorize funding needs into CAPEX—focused on infrastructure development and technological advancements—and OPEX—dedicated to human resources, facility maintenance, and programmatic activities.

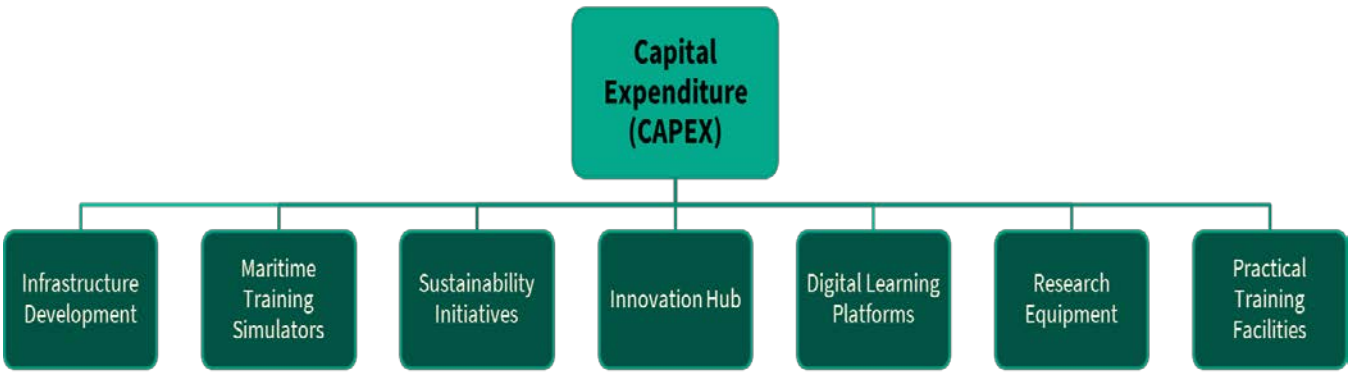
The financial strategy emphasizes the integration of global best practices while actively seeking partnerships with international organizations. By leveraging IOCE-SMarT's unique capabilities and regional expertise, the initiative aims to attract substantial investments. This framework is designed to establish IOCE-SMarT as a self-sustaining and globally recognized center of excellence that drives innovation and sustainability in maritime transport.

9.1. Funding Requirements: Infrastructure and Operational Requirements

The Indian Ocean Centre of Excellence for Sustainable Maritime Transport (IOCE-SMarT) requires comprehensive funding to establish state-of-the-art infrastructure and sustain its operations. The funding needs are categorized into Capital Expenditures (CAPEX) and Operating Expenditures (OPEX), encompassing all infrastructure requirements for high-quality maritime training and research.

Capital Expenditures (CAPEX)

Figure 12: Proposed CAPEX elements



9.1.1 Infrastructure Requirements for IOCE-SMarT

1. Classrooms: The creation of modern classrooms equipped with the latest audiovisual technologies, ergonomic seating arrangements, interactive boards, and smart projectors.
2. Laboratories: Specialized labs will be constructed, including maritime engineering labs, hydraulic testing facilities, and navigation labs. These labs will be equipped with state-of-the-art equipment like engine simulators, ship model kits, and tools for practical training.
3. Research Centers: The establishment of dedicated research centers focusing on sustainable maritime transport, marine biology, and oceanographic research. These centers will have high-end computers, oceanographic data acquisition systems, and dedicated spaces for researchers to collaborate.
4. Library and Study Spaces: A digital library with access to maritime research journals, e-books, and online databases. The physical space will be designed to encourage quiet study and group discussions.
5. Administration and Faculty Buildings: Spaces for administrative offices, faculty rooms, and staff facilities, all designed for optimal workflow and collaboration.
6. Recreational Areas: Spaces such as a gym, sports facilities, and break areas to promote the well-being of students and staff.
7. Parking and Transportation Facilities: Parking spaces for students, staff, and visitors, along with transport facilities to ensure ease of access to and from the campus.

Estimated Capital Expenditure

The infrastructure development of IOCE-SMarT will require a significant capital investment to meet international maritime education and training standards. The estimated capital expenditure (CapEx) for classrooms, laboratories, administrative offices, and other essential facilities is projected at INR 85 crore. This investment will ensure that IOCE-SMarT is equipped with cutting-edge infrastructure to foster innovation, research, and high-quality training in sustainable maritime transport.

9.1.2 Simulators and Practical Training Rooms

1. Ship Navigation Simulators: High-fidelity simulators that replicate real-life ships for training maritime professionals in navigation, manoeuvring, and safety procedures. The simulators will include full-mission bridges with integrated controls, navigation systems, and visual displays for realistic training experiences.
2. Cargo Handling Simulators: These simulators will help students practice cargo loading, unloading, and stowage planning. The system will include virtual cranes, cargo holds and unloading equipment for practice.
3. Emergency Response Simulators: Designed to train students in dealing with emergencies at sea, including fire outbreaks, flooding, and rescue operations. These will involve advanced virtual reality or mixed-reality setups with interactive emergency scenarios.
4. Maintenance: An estimated INR 3 crore will be dedicated to maintaining these simulators annually, covering software upgrades, hardware servicing, calibration, and additional scenario development.

Estimated Capital Expenditure

The development of these advanced maritime training simulators represents a critical investment in IOCE-SMarT's capability-building initiatives. The estimated capital expenditure (CAPEX) for procuring and installing simulation infrastructure is INR 15 crore, with an additional INR 3 crore allocated annually for maintenance and upgrades. This investment will ensure that IOCE-SMarT remains at the forefront of maritime training excellence, equipping professionals with cutting-edge skills aligned with global industry standards.

9.1.3 Sustainability Initiatives

Energy-Efficient HVAC Systems: Installation of advanced heating, ventilation, and air conditioning systems designed to reduce energy consumption while maintaining optimal indoor air quality. These systems will include smart sensors for temperature regulation.

1. Solar Panels: The installation of solar panels on the roofs of all buildings to generate renewable energy and reduce the center's reliance on grid power. This initiative will provide energy savings over the long term.
2. Water Recycling Facilities: Systems for treating and recycling wastewater from the campus, including rainwater harvesting units and greywater treatment plants. The treated water will be used for landscaping and non-potable applications.
3. LED Lighting and Smart Sensors: Replacement of traditional lighting systems with energy-efficient LED lights throughout the campus. Additionally, motion sensors will be installed to ensure that lights are only on when needed.
4. Sustainable Construction Materials: Using eco-friendly materials for the construction of buildings, such as recycled concrete, low-emission paints, and insulation materials with a lower carbon footprint.

Estimated Capital Expenditure

The implementation of these sustainability initiatives will require an estimated capital expenditure (CAPEX) of INR 12 crore. Additionally, an allocation of INR 2 crore is projected for first-year operational expenses, covering system integration, maintenance, and optimization. This investment will position IOCE-SMarT as a leader in sustainable maritime education, reinforcing its commitment to environmental stewardship and energy efficiency.

9.1.4 Innovation Hub

1. Research Laboratories: Cutting-edge research labs focused on marine technology, renewable energy in maritime sectors, and sustainable shipping practices. These labs will be equipped with advanced equipment for testing and prototyping new technologies.
2. Co-working Spaces: Flexible office spaces for students, entrepreneurs, and researchers to collaborate on innovative maritime projects. These spaces will be furnished with ergonomic furniture, high-speed internet, and collaboration tools.
3. Incubation Cells: Dedicated areas for startups and entrepreneurs in the maritime field. These will provide office space, mentorship programs, and access to venture capital for developing maritime innovations.
4. Technology and Equipment: Investments in high-tech equipment like 3D printers, AR/VR systems, and simulation tools for creating new maritime solutions.
5. Networking and Event Spaces: A multi-functional hall for organizing events such as conferences, workshops, and exhibitions. It will be equipped with presentation tools, audiovisual equipment, and seating arrangements.

Estimated Capital Expenditure

The Innovation Hub is projected to require a capital investment of INR 10 crore, which will cover infrastructure development and initial setup costs. Additionally, INR 3 crore will be allocated for operational expenses in the first year, including staffing, technology acquisition, and startup support programs. This strategic investment will lay a strong foundation for sustained technological progress and industry collaboration within the maritime sector.

9.1.5 Digital Learning Platforms for Maritime Training

1. E-learning Software Development: Investment in the creation of a robust digital learning platform, including course management systems, virtual classrooms, and multimedia learning tools. The platform will support both live and asynchronous learning modes.
2. Virtual Reality (VR) Training Modules: The development of VR-based maritime training modules for ship navigation, cargo handling, and emergency response. These modules will be immersive and allow learners to practice real-life scenarios in a virtual environment.
3. Content Creation and Licensing: Costs related to creating educational content, including video lessons, simulations, and interactive modules. This will also include licensing fees for access to global maritime databases and resources.
4. Platform Maintenance and Support: Ongoing operational costs of maintaining the e-learning platform, ensuring software updates, and providing technical support to users. This will amount to INR 5 crore annually for content updates, system improvements, and user support services.

Estimated Capital Expenditure

The establishment of digital learning platforms within the maritime sector is a transformative step towards enhancing training accessibility and effectiveness. With an estimated CAPEX of INR 5 crore, these platforms will not only improve the skill sets of maritime professionals but also contribute to the overall efficiency and sustainability of the industry. By leveraging modern technology, we can ensure that maritime training meets the demands of a rapidly evolving global landscape.

9.1.6 Research Equipment for Maritime Innovation

1. Oceanographic Instruments: Acquisition of advanced instruments for marine research, including multi-beam sonar systems, water quality testing kits, and ocean current monitoring systems.
2. Emission Monitoring Devices: Installation of state-of-the-art equipment to monitor emissions from ships and other maritime activities. This includes sensors for measuring CO2, nitrogen oxide, and sulphur emissions.
3. Data Analytics Software: Investment in software for processing and analysing data collected from oceanographic research and maritime operations. This will include geographic information systems (GIS), machine learning algorithms for predictive analytics, and simulation software for marine forecasting.
4. Field Research Equipment: Funding for the purchase of equipment needed for conducting field research, such as drones for aerial surveys, robotic underwater vehicles (ROVs), and research vessels.
5. Initial Operational Costs: INR 5 crore will be allocated for the first year to cover the operational costs of running these research instruments, including data storage, staff training, and equipment calibration.

Estimated Capital Expenditure

The estimated capital expenditure (CAPEX) for acquiring this equipment is INR 8 crore, with INR 5 crore allocated for first-year operational expenses to ensure that the equipment is effectively utilized and maintained.

Phased Capital Investment Plan for IOCE-SMarT

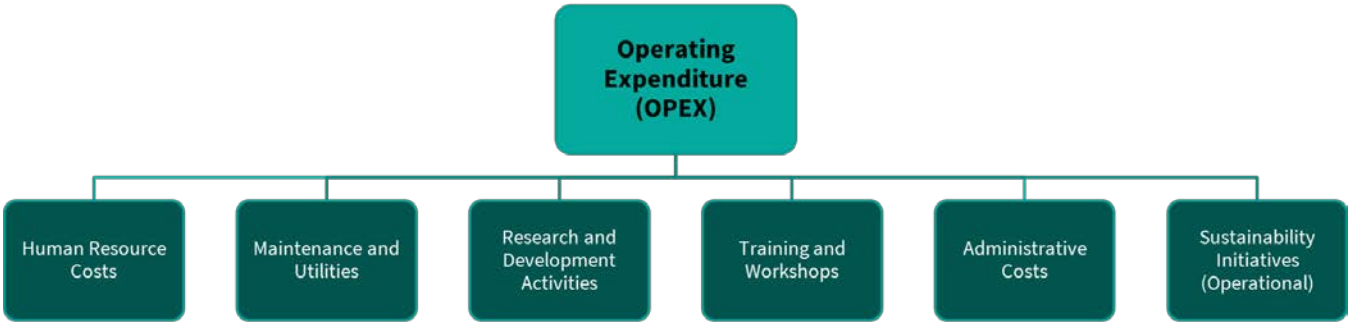
Phase 1 (2025): The initial phase will focus on launching IOCE-SMarT's operations using existing Maritime Training Institute (MTI) facilities, requiring an investment of INR 7.5 crore. This phase will ensure that essential academic and training activities can begin without delays while laying the groundwork for future expansions. Temporary adaptations of existing infrastructure will be made to accommodate core faculty, administrative teams, and initial batches of students. This approach allows IOCE-SMarT to commence its mission while larger infrastructural developments are planned and executed in the subsequent phases.

Phase 2 (2026-28): This phase will be the most critical and capital-intensive, with an estimated expenditure of INR 98.5 crore. It will focus on large-scale infrastructure upgrades, including the construction of classrooms, laboratories, research centres, and administrative buildings. Additionally, this phase will involve the installation of advanced maritime training simulators, digital learning platforms, and sustainability initiatives such as solar panels and energy-efficient HVAC systems. Key offices and departments will be fully operationalized to ensure smooth academic and research activities, allowing IOCE-SMarT to function at full capacity and establish itself as a leading centre for maritime education and innovation.

Phase 3 (2029-30): The final phase, with a budget of INR 28 crore, will focus on expansion and sustainability. This will include strengthening existing research capabilities, enhancing digital learning platforms, and integrating additional sustainability initiatives such as water recycling systems and emission monitoring devices. The innovation hub will also be further developed to support maritime startups and technological advancements. This phase ensures the long-term sustainability of IOCE-SMarT, allowing it to remain at the forefront of maritime education, research, and industry collaboration while continuously evolving to meet future challenges in sustainable maritime transport.

9.2 Operating Expenditures (OPEX)

Figure 13: Proposed OPEX elements



9.2.1 Human Resource Costs

Recruiting and retaining highly skilled academic, technical, and administrative personnel is essential for ensuring world-class maritime education and research at IOCE-SMarT. Human resources will be carefully structured to support academic excellence, research innovation, and seamless institutional operations.

Faculty and Academic Staff

1. Professors and Associate Professors: Experts in core maritime disciplines such as marine engineering, naval architecture, ship navigation, logistics, sustainability, and maritime law. They will lead research projects, mentor students, and develop industry-relevant curricula.
2. Lecturers and Instructors: Practical training specialists with industry experience in areas such as offshore operations, marine safety protocols, ship automation, and decarbonization efforts.
3. Visiting Professors and Industry Experts: Collaboration with international maritime professionals, regulators, and corporate leaders to deliver guest lectures and specialized modules on emerging industry trends.

4. Training Captains and Engineers: Retired captains and marine engineers will provide hands-on training, focusing on real-world challenges faced in the maritime sector.

Research and Project Assistants

1. Doctoral and Postdoctoral Researchers: Dedicated to high-impact research on key maritime advancements, including next-generation fuels, digitalization of ports, AI-driven shipping logistics, and smart navigation.
2. Lab Technicians: Responsible for maintaining high-tech research labs, assisting in experiment setups, operating oceanographic and emission monitoring instruments, and calibrating equipment.
3. Interns and Research Fellows: Opportunities for national and international scholars to contribute to maritime research while receiving hands-on experience in cutting-edge projects.

Administrative and Support Staff

1. Campus Administration: Comprising admissions officers, student coordinators, and academic managers to ensure efficient academic and student-related operations.
2. IT and Digital Infrastructure Support: A specialized team dedicated to the smooth functioning of e-learning platforms, cybersecurity measures, and IT hardware maintenance.
3. Facility Management: Security personnel, transport operators, and housekeeping staff to manage the upkeep of the campus, ensuring a safe and well-maintained learning environment.

Estimated Operational Expenditure

To attract and retain top talent, a competitive compensation structure will be established. The first-year expenditure for salaries and benefits is projected at INR 10 crore, covering the remuneration of core faculty, technical experts, and operational staff. Additionally, INR 5 crore will be specifically allocated for research assistants, ensuring the recruitment of highly skilled young professionals and scholars who will contribute to the center's research output and technological advancements.

9.2.2 Maintenance and Utilities

Ensuring the longevity of infrastructure, simulators, and research equipment is crucial for seamless operations and sustainability. Regular maintenance and efficient utility management will be essential to uphold world-class standards.

Facility Maintenance

1. Structural Maintenance: Periodic repairs, repainting, and upkeep of academic buildings, research centers, dormitories, and administrative blocks.
2. Cleaning and Sanitation Services: Waste disposal, campus-wide sanitation, and bio-waste treatment to ensure a clean and healthy environment.
3. Security Systems: Installation and maintenance of CCTVs, biometric access systems, emergency response infrastructure, and cybersecurity defences for digital resources.

Equipment Maintenance

1. Maritime Simulators: Regular software updates, recalibration of navigation systems, and repair of motion-based training simulators to ensure accuracy in maritime training programs.
2. Green Infrastructure: Inspection and servicing of renewable energy systems, including solar panel arrays, energy-efficient HVAC units, and water recycling facilities.

3. Research Equipment: Regular servicing and replacement of oceanographic sensors, high-performance computing systems for data analytics, and emission monitoring tools.

Utility Expenses

1. Electricity and Renewable Energy Costs: Grid-based and renewable energy sources will power campus facilities, including high-energy-consuming simulators and laboratories.
2. Water Supply and Recycling: Integrated systems for desalination, rainwater harvesting, and wastewater treatment to ensure sustainability in water consumption.
3. Internet and IT Infrastructure: Continuous maintenance of high-speed connectivity, cloud storage solutions, and digital learning platforms to facilitate seamless education and research collaboration.

Estimated Operational Expenditure

A structured budget will be allocated to support the ongoing maintenance and utility expenses of IOCE-SMarT. The estimated annual cost for routine facility and simulator maintenance, along with electricity, water, and internet services, is projected at INR 15 crore. This budget will be periodically reviewed and optimized to ensure cost-effectiveness without compromising operational excellence. By investing in robust maintenance protocols and reliable utility infrastructure, IOCE-SMarT will ensure operational continuity, enhanced efficiency, and sustained technological leadership in the maritime research and innovation ecosystem.

9.2.3 Research and Development Activities

Driving innovation in maritime technology and sustainability will be a core function of IOCE-SMarT. Collaborative research projects with industry partners, universities, and regulatory bodies will enhance the institute's global impact.

Core Research Areas

1. Green Fuel Innovation: Development of alternative fuels such as hydrogen, ammonia, biofuels, and electrification technologies for shipping.
2. Digital Shipping Technologies: AI-driven automation for smart ports, blockchain-based trade documentation, and digital twins for real-time vessel tracking.
3. Maritime Decarbonization: Research on carbon capture, emission-reduction strategies, and the development of energy-efficient vessel designs.

Project Funding Allocation

1. Sponsored Research Programs: Collaborative projects with shipbuilding companies, logistics firms, and government agencies to test and implement emerging maritime technologies.
2. Prototype Development and Testing: Grants and funding support for startups, researchers, and entrepreneurs working on next-generation maritime solutions.
3. Publication and Dissemination: Participation in global maritime summits, publication in leading scientific journals, and hosting international conferences to share research findings.

Estimated Operational Expenditure

To support these initiatives, a dedicated annual budget of INR 10 crore has been allocated for R&D activities. This funding will cover experimental research, prototype development, pilot programs, and technology validation studies. Resources will also be directed toward acquiring advanced research tools, conducting feasibility studies,

and organizing industry-academic workshops to foster innovation. The budget will be periodically reviewed to optimize resource allocation and maximize the impact of R&D efforts.

9.2.4 Training and Workshops

Continuous learning and professional development programs will ensure students, faculty, and industry professionals stay ahead in maritime innovation and regulatory compliance.

Specialized Training Sessions

1. Certification Programs: Advanced courses in areas such as Arctic navigation, offshore wind farm logistics, and cybersecurity for maritime operations.
2. Maritime Safety Drills: Practical emergency response simulations, including fire safety, oil spill containment, and crisis management training.
3. Green Shipping Workshops: Training professionals on new environmental regulations, zero-emission shipping strategies, and sustainable port management.

Industry Collaborations and Knowledge Sharing

1. Guest Lectures and Seminars: Regular sessions with maritime CEOs, policymakers, and sustainability leaders discussing the latest industry trends and challenges.
2. Exchange Programs: Facilitating study-abroad and faculty-exchange initiatives with leading international maritime universities and research institutions.

Skill Development Programs

1. Simulation-Based Training: Hands-on learning using high-fidelity VR and AR-based ship navigation modules to enhance practical expertise.
2. Entrepreneurship Workshops: Supporting maritime-focused startups with mentorship, incubation facilities, and funding opportunities.

Estimated Operational Expenditure

A dedicated annual budget of INR 5 crore has been allocated for training and workshops. This funding will cover program development, expert faculty engagement, infrastructure setup, and participant support. Investments will also be made in e-learning platforms and virtual training modules, expanding accessibility and enabling continuous skill development beyond physical training centers. The budget will be periodically reviewed to optimize the effectiveness and reach of these programs.

9.2.5 Administrative Costs

Smooth and efficient operations will require robust administrative support, including branding, compliance, and logistical functions.

Marketing and Outreach

1. Branding and Promotion: Establishing IOCE-SMarT as a premier maritime institute through digital marketing, industry partnerships, and student engagement programs.
2. Student Recruitment Initiatives: Awareness programs in top universities, participation in global education fairs, and partnerships with maritime training institutes to attract top talent.

Operational Expenses

1. Stationery and Office Supplies: Printing, documentation, and general office supplies for academic and administrative functions.

2. Travel and Conference Participation: Funding for faculty and researchers to attend maritime innovation forums, present papers, and engage in global discussions.

Regulatory and Compliance Costs

1. Legal and Licensing Fees: Ensuring regulatory approvals, compliance with international maritime education standards, and intellectual property rights management for research outcomes.
2. Accreditation Processes: Obtaining global accreditations and partnerships to maintain academic excellence and recognition.

Estimated Operational Expenditure

A dedicated annual budget of INR 2 crore has been allocated to cover these administrative expenses. This funding will support marketing campaigns, stakeholder engagement activities, travel logistics, and essential office operations. The budget will be periodically reviewed and optimized to ensure cost efficiency while maintaining the highest standards of administrative excellence.

Trends in Operational Expenditure for IOCE-SMarT: Growth Phases and Key Changes

The operational expenditure (OPEX) at IOCE-SMarT evolves over three distinct phases—Initial Setup (First Year), Expansion (Years 2-5), and Maturity (Years 5-10)—reflecting the institution's growth, increasing research intensity, and technological advancements. Each phase sees strategic budget allocations, balancing infrastructure investments, faculty hiring, research expansion, and sustainability initiatives.

First Year: Establishing the Foundation

1. Total OPEX: INR 33 crore
2. Key Focus Areas: Human resources (45% of total OPEX), maintenance and utilities (45%), and research and development (30%).
3. Growth Drivers:
    I. Significant investment in recruiting top-tier faculty, technical staff, and administrative personnel to ensure world-class academic and research capabilities.
    II. Initial infrastructure setup, including maritime training simulators, digital learning platforms, and research equipment, laying the groundwork for future technological advancements.
    III. Strong focus on R&D (INR 10 crore), signalling IOCE-SMarT's commitment to innovation in maritime sustainability, AI-driven logistics, and alternative fuels.
    IV. Administrative costs remain minimal, focused on regulatory compliance, branding, and student recruitment efforts.

Expansion Phase (Years 2-5): Scaling Up Operations and Research

1. Total OPEX: INR 87 crore by Year 5 (~2.6x increase from Year 1).
2. Key Focus Areas: Increased R&D spending (17% of total OPEX), rising faculty and staff costs, and expansion of training and digital infrastructure.
3. Growth Drivers:
    I. Human resource costs grow steadily (7% CAGR) as faculty hiring expands, along with salary adjustments to retain top talent.
    II. Maritime training simulators and research equipment investments increase, ensuring state-of-the-art training and innovation facilities.

III. R&D spending rises to INR 14.6 crore, reflecting deeper industry collaborations, prototype development, and technology commercialization.

IV. Green infrastructure and sustainability initiatives gain traction, supporting energy-efficient operations and environmental compliance.

V. The Innovation Hub sees gradual growth, fostering maritime entrepreneurship, incubating startups, and attracting funding partnerships.

Maturity Phase (Years 5-10): Technological Leadership and Sustained Growth

1. Total OPEX: INR 126 crore by Year 10 (~3.8x increase from Year 1).
2. Key Focus Areas: R&D (19% of total OPEX), human resources (22%), and maintenance/utilities (20%).
3. Growth Drivers:
   I. R&D becomes the fastest-growing segment, reaching INR 23.58 crore, driving breakthroughs in digital shipping, decarbonization, and AI-driven logistics.
   II. Digital learning platforms and research equipment investments peak, ensuring IOCE-SMarT remains at the cutting edge of maritime education.
   III. Training and workshops expand significantly (INR 9.19 crore), strengthening industry partnerships and workforce upskilling.
   IV. Green infrastructure adoption accelerates, integrating sustainable energy solutions across campus operations.
   V. The Innovation Hub continues to grow, attracting global maritime leaders, investors, and entrepreneurs.

Key Takeaways on OPEX Trends

1. What's Changing?
   I. R&D grows exponentially, becoming a key driver of IOCE-SMarT's global reputation in maritime innovation.
   II. Infrastructure investments in simulators, digital platforms, and research tools increase significantly over time.
   III. Training programs and industry collaborations gain prominence, enhancing practical learning and workforce readiness.
2. What Remains Consistent?
   I. Human resource costs remain a core component of OPEX (~22%), reflecting the sustained need for academic and research excellence.
   II. Maintenance and utilities remain a significant expense (20%), ensuring the longevity of infrastructure and operational efficiency.
   III. Administrative costs grow in line with expansion but remain a smaller proportion of total OPEX.

9.3 Summary of Financial Requirements for Establishing IOCE-SMarT

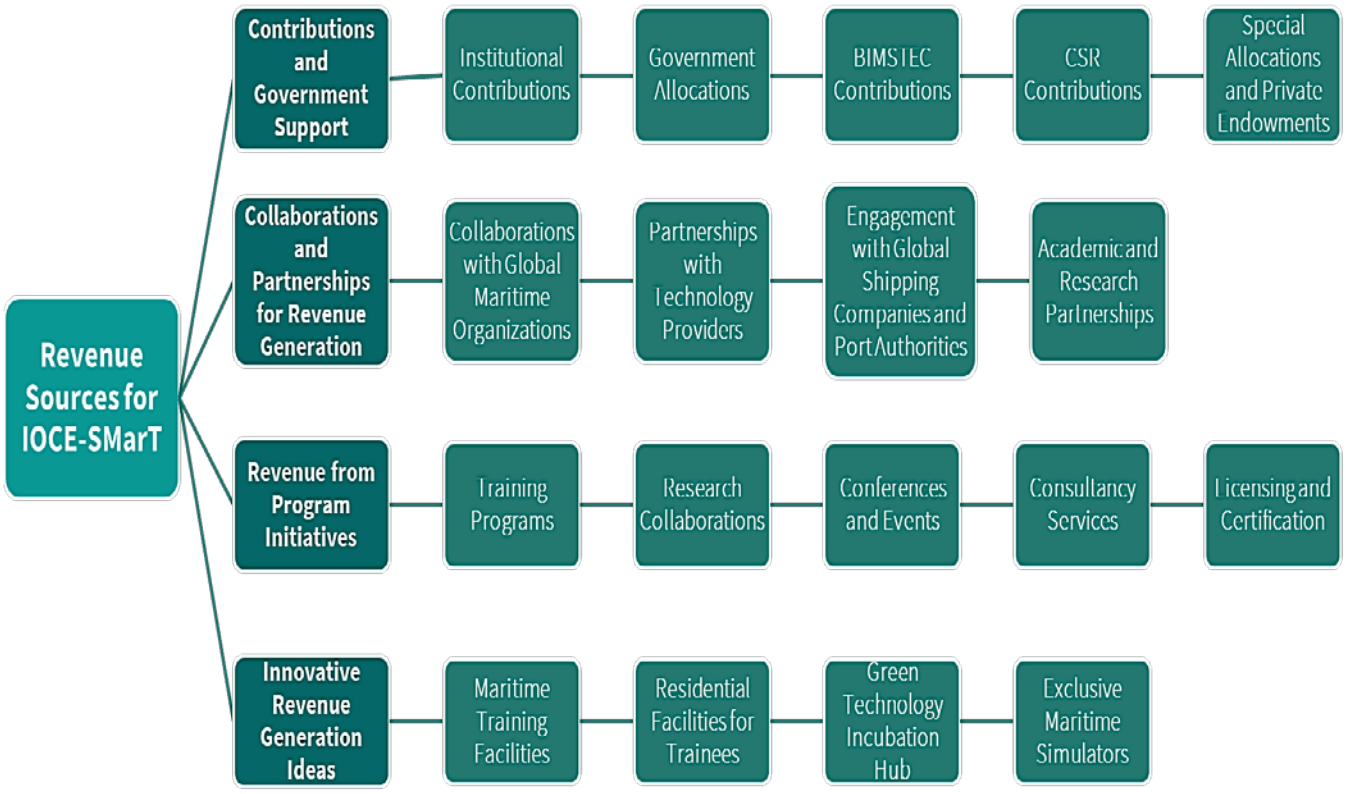
Category	Items	Description	Capex Estimate	First-Year OPEX Estimate
Infrastructure	Facility Upgrades	Enhancing existing facilities, constructing classrooms, labs, and research centers. Includes modernizing existing spaces to meet international standards.	INR 85 Cr	
	Maritime Training Simulators	Procurement of advanced simulators for ship navigation, cargo handling, and emergency response training. These will enhance hands-on learning for trainees.	INR 15 Cr	INR 3 Cr
	Green Infrastructure	Installation of energy-efficient HVAC systems, renewable energy sources like solar panels, and water recycling facilities.	INR 12 Cr	INR 2 Cr
	Innovation Hub	Development of state-of-the-art research labs, co-working spaces, and entrepreneurship cells to foster innovation in maritime technologies.	INR 10 Cr	INR 3 Cr
Technology	Digital Learning Platforms	Creation and maintenance of advanced e-learning platforms and virtual reality training modules.	INR 5 Cr	INR 5 Cr
	Research Equipment	Acquisition of specialized tools for maritime research, such as oceanographic instruments, emission monitoring devices, and data analytics software.	INR 8 Cr	INR 5 Cr
Human Resources	Faculty and Staff Salaries	Recruitment and retention of highly qualified academic, technical, and administrative staff.	-	INR 10 Cr
	Research and Project Assistants	Hiring of skilled personnel to support ongoing research, training programs, and operational activities.	-	INR 5 Cr
Operational Costs	Maintenance	Routine and preventive maintenance of all facilities, including simulators, labs, and green infrastructure.	-	INR 10 Cr
	Utilities	Expenses for electricity, water, internet connectivity, and other essential services.	-	INR 5 Cr

Category	Items	Description	Capex Estimate	First-Year OPEX Estimate
	Administrative Costs	Operational expenditures such as stationery, marketing, travel, and other administrative needs.	-	INR 2 Cr
Program Development	Research and Development	Funding for collaborative research with industry partners, universities, and government bodies. Projects may include green fuel innovation and digital shipping technologies.	-	INR 10 Cr
	Training and Workshops	Conducting specialized training sessions, certifications, and seminars aimed at enhancing maritime skills and awareness.	-	INR 5 Cr

The total Capital Expenditures (CAPEX) are projected at INR 135 crore, encompassing critical investments in infrastructure development, maritime training simulators, green technologies, innovation hubs, and advanced research facilities. Concurrently, the Operating Expenditures (OPEX) for the first year are estimated at INR 65 crore, addressing key areas such as human resource development, maintenance, utilities, research initiatives, and training programs. Together, this financial framework underscores IOCE-SMarT's strategic commitment to establishing itself as a premier global institution in sustainable maritime transport.

9.3. Potential Revenue Sources for IOCE-SMarT

Figure 14: Potential revenue streams



9.4.1 Contributions and Government Support

A strong foundation of government funding, institutional contributions, regional collaborations, and private sector support will be essential for ensuring the financial sustainability of IOCE-SMarT (Indian Ocean Centre of Excellence for Sustainable Maritime Transport). By strategically aligning its research and operational goals with national policies, regional partnerships, and corporate sustainability initiatives, the hub can secure diverse revenue streams to support its long-term vision.

1. Government Allocations: IOCE-SMarT can leverage significant funding from the Ministry of Ports, Shipping, and Waterways (MoPSW) to support both its establishment and ongoing operational needs. Aligning research and infrastructure projects with key national initiatives such as the Sagarmala Program, Green Ports Policy, and the National Hydrogen Mission will enhance funding opportunities. For instance, Sagarmala's port connectivity initiatives could provide financial support for the development of digital infrastructure, port automation, and AI-driven logistics solutions. Similarly, projects focusing on green shipping corridors, alternative fuels, and electrification of port operations could receive funding under the Green Ports Policy.

   In addition, by integrating its objectives with flagship national programs like Make in India, Digital India, and the Maritime India Vision 2030, IOCE-SMarT can position itself as a critical enabler of India's maritime modernization and decarbonization efforts. This alignment will not only strengthen the center's case for securing government grants but also increase its influence in shaping future maritime policies and technological advancements.

2. Institutional Contributions: Several public sector undertakings (PSUs) and maritime institutions are well-positioned to provide financial support for IOCE-SMarT's research, training, and infrastructure development. Entities such as Cochin Shipyard Limited (CSL), Shipping Corporation of India (SCI), and the Indian Ports Association (IPA) can contribute project-specific funding for innovation in shipbuilding, digitalization, and sustainability-driven port operations.

Additionally, the Maritime Training Trust (MTT), which promotes maritime education and skill development, could finance specialized capacity-building initiatives in renewable energy, port automation, and maritime cybersecurity. Collaborative agreements with these institutions could also open avenues for joint R&D funding, technology exchange programs, and pilot project implementation.

3. BIMSTEC Contributions: IOCE-SMarT can establish itself as a key maritime research hub under the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) framework. Through the BIMSTEC Maritime and Shipping Training Centre (BMSMarTC) vertical, IOCE-SMarT could secure co-financing for regional research initiatives, maritime security programs, and capacity-building efforts.

   As BIMSTEC member states collectively address pressing maritime challenges such as climate adaptation, decarbonization, and marine pollution control, IOCE-SMarT can position itself as a regional center of excellence for sustainable maritime solutions. This would facilitate financial and intellectual contributions from member nations, supporting collaborative projects, infrastructure development, and knowledge-sharing networks.

4. CSR Contributions: Corporate Social Responsibility (CSR) funding from major private sector players in the maritime and logistics industries represents a significant revenue opportunity. Leading port operators such as Adani Ports, Essar Ports, and DP World India could contribute funding for initiatives related to environmental sustainability, workforce development, and technological innovation.

   For example, CSR funds could be directed toward research on carbon-neutral shipping, alternative fuels like hydrogen and ammonia, and AI-based emissions monitoring systems. Similarly, private shipping companies and logistics firms may be interested in supporting advanced training programs in maritime safety, autonomous navigation, and AI-powered vessel monitoring, aligning with their long-term corporate sustainability goals.

5. Special Allocations and Private Endowments: Dedicated funding aligned with global decarbonization targets and industry-led sustainability initiatives could provide additional financial resources for IOCE-SMarT. Philanthropic endowments from maritime-focused trusts, international maritime foundations, and global shipping conglomerates could support groundbreaking research on topics such as hydrogen bunkering, carbon capture technologies, and zero-emission vessel development.

   For instance, the International Maritime Organization (IMO), the Global Maritime Forum, and private shipping alliances could offer grants for pioneering studies on green port initiatives and smart shipping solutions. Maritime-focused endowments from organizations like the Maersk Mc-Kinney Møller Center for Zero Carbon Shipping and the Lloyd's Register Foundation could also be explored for long-term research collaborations.

6. Private Donations and Industry Sponsorships: Beyond institutional grants, IOCE-SMarT can explore direct donations from philanthropic organizations, high-net-worth individuals (HNWIs), and private maritime investors who have a vested interest in advancing sustainable maritime technology. Wealthy individuals and shipping industry veterans may be willing to establish named endowments, research fellowships, or sponsored innovation programs at the center.

   For example, major global shipping companies such as Maersk, MSC, and CMA CGM could provide financial backing for R&D initiatives that align with their sustainability goals, such as development of energy-efficient vessel designs, autonomous ship operations, and blockchain-based maritime logistics solutions. Industry sponsorships could also support annual conferences, international research collaborations, and emerging technology showcases, further enhancing IOCE-SMarT's global profile.

9.4.2 Collaborations and Partnerships

Strategic collaborations and partnerships will be crucial for generating sustainable revenue streams for IOCE-SMarT (Indian Ocean Centre of Excellence for Sustainable Maritime Transport). By aligning with global maritime organizations, leading technology providers, top shipping companies, port authorities, and academic institutions, the hub can access funding opportunities, co-develop innovative solutions, and engage in research commercialization efforts. These collaborations will also enhance IOCE-SMarT's reputation, expand its global

footprint, and enable the successful implementation of cutting-edge maritime technologies and sustainable infrastructure.

1. Collaborations with Global Maritime Organizations: Strategic alliances with global maritime organizations such as the International Maritime Organization (IMO), the World Bank, and the Green Climate Fund (GCF) offer valuable opportunities to secure funding for capacity building, sustainable infrastructure, and green maritime projects.

   The IMO's decarbonization initiatives align directly with IOCE-SMarT's goals, particularly in advancing carbon-neutral shipping, emission reduction systems, and sustainable shipping technologies. Collaborative projects with the IMO can secure funding for research on alternative fuels (e.g., hydrogen, ammonia) and carbon capture technologies, further supporting the maritime industry's transition to low-emission operations.

   Additionally, the World Bank has a long history of financing infrastructure projects in developing regions, particularly those focused on port modernization, sustainable transport, and environmental protection. With the global shift towards green maritime practices, the World Bank's funding mechanisms can support IOCE-SMarT's port automation, energy-efficient infrastructure, and sustainable shipping corridors initiatives.

   The Green Climate Fund (GCF), a global financing mechanism dedicated to climate change mitigation and adaptation, is another promising avenue for funding. The GCF's focus on supporting emission-reduction technologies and offshore renewable energy projects makes it an ideal partner for IOCE-SMarT to co-develop cutting-edge solutions such as offshore wind farms, solar-powered port facilities, and advanced emission monitoring systems.

2. Partnerships with Technology Providers: Partnerships with leading technology providers such as Siemens, Wartsila, and ABB will be instrumental in driving technological innovation in port automation, alternative propulsion systems, and digital shipping technologies.

   Collaborating with Siemens could result in the co-development of smart grid systems for ports, energy management systems for vessels, and AI-driven logistics platforms that optimize shipping operations while reducing energy consumption. Such collaborations can also lead to the establishment of innovation labs within IOCE-SMarT, where new green technologies and digital solutions can be developed and tested in real-world maritime environments.

   Wartsila, a leader in marine propulsion and energy solutions, offers significant potential for joint research in the development of clean fuels, autonomous vessels, and hybrid propulsion systems. Partnerships with Wartsila could facilitate the creation of joint research hubs, where both parties invest in developing next-generation technologies and share the resulting intellectual property (IP), creating new revenue streams from IP commercialization.

   Similarly, collaboration with ABB could lead to the development of digital twin technologies for ship operations, predictive maintenance systems, and electric propulsion systems. These innovations would directly align with IOCE-SMarT's goals of enhancing energy efficiency, reducing emissions, and digitizing shipping operations.

3. Engagement with Global Shipping Companies and Port Authorities: Forming strategic partnerships with global shipping companies such as Maersk, MSC, and CMA CGM, as well as port authorities like the Rotterdam Port Authority, can create opportunities for joint research, development, and operational collaboration. These partnerships can focus on critical areas such as digitalization, decarbonization, emissions reductions, and autonomous vessel technologies.

   By engaging with major industry players, IOCE-SMarT can co-develop and pilot innovative solutions that address the shipping industry's most pressing challenges. Maersk, for example, is deeply invested in green shipping and decarbonization initiatives and could collaborate with IOCE-SMarT on developing low-carbon logistics chains or testing zero-emission vessels. Such projects could be financed through revenue-sharing models for intellectual property (IP) and research commercialization, ensuring long-term financial returns for the center.

Further, collaborating with Rotterdam Port Authority, a global leader in port sustainability and digitalization, would enable IOCE-SMarT to co-create smart port solutions, AI-driven cargo tracking systems, and renewable energy-powered port facilities, driving sustainable development while securing additional funding. Revenue from the commercialization of these technologies can provide sustained financial support for IOCE-SMarT's operations.

4. Academic and Research Partnerships: Collaborations with renowned academic and research institutions such as the World Maritime University (WMU), the Maritime and Port Authority of Singapore (MPA), and other global maritime research bodies will facilitate knowledge exchange, joint research efforts, and additional funding opportunities for IOCE-SMarT.

   The World Maritime University (WMU), a center of excellence for maritime education and research, could partner with IOCE-SMarT on a range of projects related to sustainable shipping, marine energy, and port development. These partnerships could include joint funding proposals for international research collaborations, government-backed maritime training programs, and shared research facilities.

   Similarly, the Maritime and Port Authority of Singapore (MPA), known for its cutting-edge work in port automation and green maritime technologies, could provide financial support and expertise in smart port systems and digital maritime ecosystems. Collaborating with such institutions can generate funding for both basic and applied research and increase IOCE-SMarT's recognition as a global leader in maritime sustainability and innovation.

9.4.3 Revenue from Program Initiatives

Generating revenue through program initiatives will be an essential component of IOCE-SMarT's (Indian Ocean Centre of Excellence for Sustainable Maritime Transport) financial sustainability model. By leveraging its expertise in maritime sustainability, digital technologies, and decarbonization, IOCE-SMarT can tap into multiple revenue streams. Offering specialized training programs, research collaborations, global conferences, and consultancy services will not only provide financial returns but also enhance the center's reputation as a global leader in maritime innovation.

1. Training Programs

IOCE-SMarT will offer a diverse range of training programs designed to cater to various stakeholders in the maritime sector. These programs will be structured to provide foundational, advanced, and specialized training in sustainable maritime transport, digital transformation, and regulatory compliance.

I. Academic Courses and Certifications: The institute will offer structured programs modelled after MTI Powai, including pre-sea training courses, certification programs for maritime professionals, and higher education degrees in maritime studies. These programs will cover crucial areas such as navigation, marine engineering, logistics, and maritime law.

II. Corporate Training and Upskilling Programs: Tailored programs for industry professionals will include short-term courses and executive education modules covering maritime risk management, international regulations, and digital transformation. Collaborations with shipping firms and port authorities will generate revenue through corporate training contracts and customized learning solutions.

III. Maritime Simulation and Practical Training: The institute will invest in state-of-the-art maritime simulators, including bridge, engine room, and cargo-handling simulators, to provide hands-on training. Fees will be charged for simulator-based courses, competency assessments, and customized training programs for corporate clients and regulatory bodies.

2. Research Collaboration

IOCE-SMarT will establish itself as a research leader in sustainable maritime development by collaborating with government agencies, private companies, and international organizations. Revenue will be generated through the following channels:

I. Industry-Sponsored Research: The institute will engage in cutting-edge research on topics such as decarbonization, digital port management, and alternative fuels. Companies will fund projects focused on their specific operational needs, ensuring a steady flow of research funding.

II. Government and Institutional Grants: IOCE-SMarT will apply for national and international grants to support research on sustainable shipping practices, smart port infrastructure, and emerging maritime technologies. Organizations like the World Bank and Green Climate Fund will be key funding sources.

III. Joint Research Initiatives: Collaborations with universities and maritime research centers will facilitate joint studies on policy frameworks, green technologies, and regulatory developments, generating additional funding through academic partnerships.

3. Conferences and Events

Hosting industry events will be a major revenue stream, positioning IOCE-SMarT as a thought leader while fostering industry-wide engagement.

I. Flagship Conferences: Annual events like the "Sustainable Maritime Forum" will attract industry leaders, policymakers, and researchers, generating revenue through sponsorships, delegate fees, and exhibitor partnerships.

II. Workshops and Seminars: Smaller-scale events on niche topics such as "Green Hydrogen Bunkering" and "Digital Twins in Shipping" will provide specialized knowledge to participants while generating revenue through ticket sales and partnership funding.

III. Exhibitions and Networking Events: IOCE-SMarT will organize exhibitions showcasing the latest maritime innovations. Sponsorship opportunities from technology firms and registration fees from attendees will further boost revenue.

4. Consultancy Services

IOCE-SMarT will offer specialized consultancy services to maritime stakeholders, helping them navigate industry challenges and implement sustainable solutions.

I. Sustainability Advisory: The institute will provide consultancy services on implementing IMO's decarbonization goals, green port strategies, and emission-reduction frameworks, attracting shipping companies and government agencies as clients.

II. Technology Implementation Support: Consulting services on deploying advanced technologies such as energy-efficient propulsion systems, AI-driven maritime analytics, and automation in ports will generate substantial fees.

III. Policy Advisory Services: Governments and international organizations will seek IOCE-SMarT's expertise in shaping regulatory frameworks, safety protocols, and harmonized shipping policies, ensuring a continuous revenue stream.

5. Licensing and Certification

To further establish itself as a key maritime knowledge hub, IOCE-SMarT will generate revenue through intellectual property and certification programs.

I. **Proprietary Training Content:** The institute will develop and license proprietary training materials on topics such as "Digital Port Management" and "Alternative Fuel Safety" to other maritime training institutions.

II. **Certifications:** IOCE-SMarT will issue premium certifications such as "Certified Green Maritime Professional," establishing a benchmark for maritime expertise and attracting professionals seeking industry-recognized credentials.

III. **Intellectual Property Licensing:** Technologies and research developed within the institute, such as emission-reduction software and digital twin platforms, will be licensed to industry stakeholders for commercial use.

6. Industry Partnerships

Strategic collaborations with key industry players will ensure financial sustainability while enhancing IOCE-SMarT's influence in the maritime sector.

I. **Public-Private Partnerships:** Engaging with port authorities, shipping companies, and technology firms to co-develop training programs, research projects, and sustainability initiatives.

II. **International Collaborations:** Partnering with global maritime institutions for joint degree programs, faculty exchanges, and cross-border research projects, generating revenue through tuition-sharing agreements and sponsorships.

III. **Maritime Incubation and Innovation Hub:** Establishing an incubation center for startups focused on maritime sustainability and innovation. IOCE-SMarT will generate revenue through incubation fees, equity stakes in successful startups, and partnerships with venture capital firms investing in maritime technology.

Evolving Revenue Model: IOCE-SMarT's Shift from Training Dominance to a Diversified Growth Strategy

The revenue trend for IOCE-SMarT shows a steady growth trajectory, increasing from INR 60 crore in 2026 to INR 136 crore by 2035, with an average annual growth rate of around 9%. In the initial years, training programs contribute the largest share of revenue, accounting for INR 42 crore (70%) in 2026. However, after the third year, the revenue mix starts diversifying as research collaborations, conferences, consultancy services, and licensing programs experience faster growth. Notably, research collaboration revenue rises significantly from INR 6 crore in 2026 to INR 17.8 crore in 2035, driven by increasing partnerships with academic and industrial stakeholders. Similarly, conference and event revenues grow from INR 0.6 crore to INR 14.8 crore by 2035, indicating an expansion in global outreach and thought leadership.

By the 10th year (2035), while training programs still contribute significantly (INR 70.4 crore), their dominance has reduced to around 52% of total revenue, down from 70% in the first year. In contrast, research collaborations, consultancy, and licensing have collectively grown from INR 12.6 crore in 2026 to INR 47 crore in 2035, accounting for nearly 35% of total revenue. Industry partnerships, however, show slower growth, increasing from INR 4.8 crore to INR 3.9 crore, indicating limited scalability in this segment. Overall, the revenue model shifts from being heavily dependent on training programs in the early years to a more balanced mix, driven by research, consultancy, and events, enhancing IOCE-SMarT's long-term financial sustainability.

Table 16: Projected revenue from program initiatives

Revenue Stream	Projected Revenue for year 1 (₹ Crore)	Projected Revenue for year 5 (₹ Crore)	Projected Revenue for year 10 (₹ Crore)
Training & Certification	42	49.2	70.4
Research Collaboration	6	10.7	17.8
Conferences & Events	0.6	9	14.8
Consulting & Advisory	2.4	9	14.8
Licensing & Digital Products	4.2	9	14.4
Industry Partnerships	4.8	2.5	3.9
Total Revenue	**78**	**89**	**136**

9.4.4 Innovative Revenue Generation Ideas

To ensure financial sustainability and long-term growth, IOCE-SMarT (Indian Ocean Centre of Excellence for Sustainable Maritime Transport) must explore innovative revenue streams beyond traditional funding models. By leveraging its expertise in maritime training, sustainability, and technology-driven research, the center can establish multiple self-sustaining income sources. These strategies will ensure financial resilience while reinforcing IOCE-SMarT's position as a leader in maritime innovation and sustainability.

1. **Maritime Training Facilities:** Investing in specialized maritime training facilities equipped with advanced simulators for ship navigation, cargo handling, emergency response, and engine room management will provide a consistent revenue stream for IOCE-SMarT. These state-of-the-art training resources can be utilized for in-house programs, while also being leased to external organizations, including maritime training institutes, shipping companies, and naval academies. The increasing global demand for simulation-based maritime training offers IOCE-SMarT an opportunity to provide high-quality, hands-on training to ship officers, port operators, and logistics professionals.

   Offering customized simulation-based training solutions to industry players will further enhance revenue potential. Organizations seeking tailored training programs can collaborate with IOCE-SMarT to develop industry-specific modules, ensuring recurring revenue through specialized course offerings. Additionally, partnerships with certification bodies such as the International Maritime Organization (IMO) and the Directorate General of Shipping (DGS) can establish IOCE-SMarT as an authorized training and examination center for professional maritime certifications. This will drive continuous demand from seafarers, naval personnel, and port authorities, ensuring long-term financial sustainability.

2. **Residential Facilities for Trainees:** Developing on-campus accommodations for trainees, visiting faculty, and international delegates will serve as an additional revenue stream while enhancing IOCE-SMarT's appeal as a comprehensive maritime training hub. These facilities will allow the center to host long-term courses, executive training programs, and international exchange programs, increasing its attractiveness to global participants. The availability of residential accommodations will enable maritime professionals to engage in intensive training programs without logistical constraints, fostering a more immersive learning experience.

   Revenue from these facilities can be generated through short-term rentals for trainees attending certification programs, workshops, and executive education courses. Premium lodging packages can be offered to visiting scholars, guest faculty, and industry professionals, ensuring steady financial inflows. Additionally, IOCE-SMarT can lease these accommodations to external maritime institutions that require short-term residential infrastructure for their training initiatives. Integrating sustainable infrastructure and green building practices into these facilities will further enhance their appeal, potentially attracting

sponsorships and grants from organizations promoting environmentally friendly infrastructure in the maritime sector.

3. Green Technology Incubation Hub: Establishing a maritime sustainability incubation hub within IOCE-SMarT will create dual revenue streams by attracting investments from venture capitalists, corporate sponsors, and maritime technology funds while also generating revenue through incubation fees, equity partnerships, and revenue-sharing agreements with startups. This incubation hub will focus on fostering innovation in green maritime technologies, supporting startups that specialize in hydrogen-based fuel systems, AI-driven port efficiency solutions, autonomous vessel technologies, and carbon capture systems for maritime transport.

   By positioning itself as an incubation center for cutting-edge maritime innovations, IOCE-SMarT can attract funding from global sustainability initiatives and government-backed innovation funds. Corporate sponsorships from leading maritime firms will provide financial backing while allowing companies to leverage the hub's expertise in sustainable maritime solutions. Additionally, IOCE-SMarT can license proprietary research and patented technologies developed within the incubation hub, creating long-term revenue streams through intellectual property commercialization.

4. Exclusive Maritime Simulators: Developing and maintaining high-tech maritime simulators tailored for advanced training applications will provide a lucrative revenue stream. The global maritime industry is rapidly adopting simulation-based training for critical operations such as engine room management, autonomous vessel navigation, crisis response, and port automation. By offering access to these exclusive, cutting-edge simulators, IOCE-SMarT can position itself as a global leader in maritime training and technological advancement.

   Revenue generation from these simulators can be structured through training contracts with shipping companies, port authorities, and naval forces, which require high-precision simulation environments. IOCE-SMarT can also develop subscription-based access models for maritime professionals seeking continuous training in evolving technologies. Additionally, these simulators can be integrated into distance learning platforms, enabling global professionals to access training remotely through cloud-based simulation systems. This expansion into digital learning solutions will further enhance IOCE-SMarT's reach while diversifying its revenue streams.

5. Testing and Validation Services for Maritime Technologies: With state-of-the-art simulation facilities, IOCE-SMarT can offer testing and validation services for maritime technologies such as autonomous vessels, emissions-reduction solutions, and digital twin applications. By becoming a recognized testing center for regulatory compliance and performance validation, the hub can establish an additional revenue stream while contributing to the global advancement of maritime technology.

9.4. Financial Sustainability Challenges: IOCE-SMarT's Road to Positive EBITDA by 2032 Requires Government and Institutional Support

The financial trajectory of IOCE-SMarT underscores the prolonged challenge of achieving profitability, with EBITDA remaining negative for the first eight years and turning positive only in 2033. The center's revenue grows steadily from ₹60 million in 2026 to ₹126.3 million in 2034; however, the persistent rise in operating expenses—from ₹69.9 million in 2026 to ₹126.1 million in 2034—hampers early financial stability. Despite this revenue growth, the EBITDA margin remains negative until 2032, emphasizing the substantial funding gap that must be addressed through external support. Given these financial constraints, government grants, institutional contributions, and strategic collaborations will be critical in sustaining IOCE-SMarT's operations. Aligning with initiatives like the Sagarmala Program, Green Ports Policy, and Maritime India Vision 2030 will enhance funding opportunities, particularly for research and digital infrastructure development.

Additionally, partnerships with public sector undertakings such as Cochin Shipyard Limited and the Shipping Corporation of India, along with CSR contributions from private maritime players, will be crucial in bridging the early financial shortfall. While the center's EBITDA turns positive in 2032, net profitability remains elusive due to ongoing depreciation costs, reinforcing the necessity for long-term funding mechanisms, international collaborations, and strategic alliances with global maritime institutions to ensure financial sustainability.

Figure 15: Funding support crucial to early-stage financial stability

10. Implementation Roadmap

IOCE-SMarT Detailed Timeline for Full-Scale Implementation

2025

Finalize the Detailed Project Report (DPR) in collaboration with Lloyd's Register.

Release of DPR

- DPR to incorporate:
  - **Governance structures** and organizational objectives.
  - **Financial frameworks** for the project's long-term viability.
  - **Technical inputs** and feasibility assessments.
- Prepare the BMSMarTC concept note as a separate vertical under IOCE-SMarT
- **Submit DPR to stakeholders**, including the Ministry of Ports, Shipping, and Waterways (MoPSW), Ministry of External Affairs (MEA), and the Shipping Corporation of India Logistics and Allied Limited (SCILAL).

Stakeholder discussion and approval

- Organize **stakeholder consultation** meetings to review and finalize the DPR.
- Secure **formal approvals** from: MoPSW, MEA, and SCILAL Board of Directors.
- Obtain **Cabinet approval** and make a formal announcement of BMSMarTC at the BIMSTEC Ministerial Meeting.
- Establish a **Project Management Unit (PMU)** with professional domain expertise for managing and overseeing project phases.

Preliminary Phase

- Execute **Memoranda of Understanding (MoUs)** with key stakeholders, including BIMSTEC member nations and IMO.
- Submit a **detailed proposal to IMO** for technical collaboration and funding.
- Establish **Governance and Advisory Boards** to oversee IOCE-SMarT operations.
- Develop policies for:
  - Operational procedures.
  - Recruitment frameworks for key roles.
- **Initiate operations** utilizing existing Maritime Training Institute (MTI) facilities.
- Build partnerships with local and global organizations for capacity building.

June – December

2026

Infrastructure Development Phase

- **Renovate and upgrade MTI facilities** to align with IOCE-SMarT's operational and sustainability goals.
- Establish **fully operational offices** and departments for:
  - Administration.
  - Research and Development.
  - Training and Capacity Building.
- **Recruit a CEO and key department heads** with expertise in green shipping, maritime technology, and global sustainability practices.
- **Begin installation of IT infrastructure**, simulators, and other necessary equipment

January – December

2027

Operational Readiness Phase

- Develop **specialized training programs** focusing on:
  - Green shipping technologies.
  - Energy-efficient vessel operations.
  - Environmental compliance.
- **Launch pilot training programs** and evaluate their effectiveness.
- **Test and validate all operational workflows**, systems, and facilities to ensure readiness for full-scale implementation

January – June

Full Scale Implementation Phase

- **Conduct the official inauguration** of the IOCE-SMarT Centre.
- **Commence full-scale operations**, including:
  - Capacity-building programs.
  - Research initiatives on green shipping and alternative fuels.
  - Collaboration with BIMSTEC nations and IMO.
- Establish mechanisms for regular **stakeholder engagement** and feedback.

2028 - 2030

Expansion and Sustainability Phase

- **Expand global partnerships** to strengthen IOCE-SMarT's position as a regional leader.
- **Develop new verticals** such as:
    - DigiSMarT: Leveraging digital technologies for maritime efficiency.
    - FinSMarT: Financial models for sustainable shipping operations.
- Build **additional infrastructure** and adopt renewable energy solutions to ensure sustainability.
- Establish **long-term revenue streams** through:
    - Training programs.
    - Consultancy services.
    - Collaborative research projects.

- Monitor, evaluate, and refine operational frameworks to align with global standards.

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