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REVEALING THE TRAJECTORY OF SUSTAINABLE ECONOMIC DEVELOPMENT: MANEUVERING OPPORTUNITIES AND CHALLENGES IN THE BLUE ECONOMY

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Abstract: Indian Blue economy offers immense business prospects if ocean resources are used wisely and responsibly. This paper evaluates the economic viability of Indian marine sectors and need of utilizing maritime resources strategically. This study also explores job creation prospects vis-à-vis economic growth and environment friendly usage of marine means in areas like Marine fishing, Aquatic Ergonomics, Marine and Deep Ocean Mining, Aquatic Tourism, Maritime Transport, Port Operations, and Logistics, Coastal and Marine Infrastructure Development, Marine Renewable Energy (MRE), Marine Manufacturing. This article also analyzes challenges for India to maximize its business potential in the Blue Economy, ensuring both long-term economic and ecological benefits.

Keywords: Blue economy, economic opportunities, maritime resources, Responsible Development, India.

I. INTRODUCTION

The Indian marine economy is a bouquet full of diverse activities of ocean based industries. But to make it economically viable all the assets, goods and services offered by marine ecosystem should be used strategically. Blue economy is a concept that aims economic development through responsible usage of ocean resources. To achieve economic development through blue economy improvement in livelihood is utmost important and therefore multiple job creation based on marine based resources are necessity. Economic development through blue economy does not justify irresponsible usage of resources. Often Maritime, Marine, and Ocean Economy are interchangeably used for the term blue economy, This research paper has also used these terms interchangeably, but essence remain same. and that is upgradation of from

the traditional “ocean economy” to a “blue economy” by integrating corporate sustainability principles and ensuring that economic growth can occur without causing environmental harm. Marine products are intermediate products for many industries and therefore deregulated and haphazard growth of these sectors can affect marine ecosystem too.

External environment has become too dynamic and world is moving towards speedy transformation. Marine sector is also not an exception to this trend. Shipping and port sectors have already adopted automation in its operation. With the help of artificial intelligence coastal aquaculture is also incorporating science and technology intensive activities. Satellite monitoring systems, and growth in cruise tourism to new destinations is no more a new phenomenon. Cruise industry has already started exploration of new destinations like the Arctic and Antarctica.

Global leaders have started to notice if nations want to achieve goals like holistic growth by creating job opportunities for all and eradication of poverty, preservation of natural resources are must. It is definitely a positive move that global leaders are acknowledging that economic well being cannot be achieved at the cost of social well being. This has led to the cautious and responsible use of marine resources at global level. Equilibrium between social and economic well being is prerequisite for welfare of people and planet both. This dual goal is to ensure the healthy functioning of Earth's ecosystems.

Promising prospects of the aquaculture, renewable energy, and biotechnology fields are capable enough to offer economic expansion, advancement of environmental stewardship and social fairness—provided they are properly capitalized via waste and by-products management. In recent times, the blue economy has emerged as a pivotal approach for fostering Responsible Development. Notably,

the European Union has crafted a blue growth strategy, advocating for the responsible exploitation of marine resources. Conversely, the African Union has initiated its Blue Economy Strategy, aiming to foster sustainable economic expansion, ensure food security, and create employment opportunities through the enhancement of marine resources.

Research Methodology

Purpose of the Article

1. To study the current status and potential growth opportunities within the blue economy sectors.
2. To identify the key challenges and barriers hindering environment friendly growth of Marine economy
3. To analyze the socioeconomic and environmental benefits of promoting the blue economy, including job creation, economic growth, and resource management.

Data Gathering

Secondary data, from various local, national and international publications as well as government agencies have been used. Data is also collected from academic journals in the fields of marine science, environmental economics, maritime law, and Responsible Development.

Business Prospects in India

The Blue Economy holds considerable scope of yielding income and producing employment opportunities, and boosting exports. However, realizing these advantages require intentional efforts in context of planned investments and strategic allocation of resources to ensure the organic growth of the maritime. To invigorate specific sectors, it is crucial to identify priority areas within the various segments of the marine life, considering their potential and feasibility in terms of country like India. Total 8 sectors have been identified which offer business prospects in Indian blue economy and their detail analysis has been done.

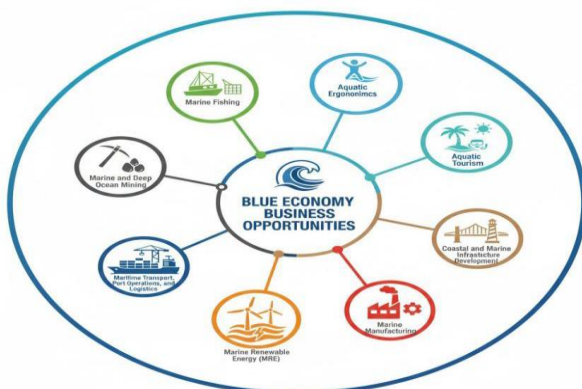


Figure: 1 Sectors offering Business Prospects in Indian Blue Economy

Marine Fishing

Due to concrete share in different economic events such as increasing national income and business, creating employment, providing food and nutritional security, and generating alternative forms of economic stability, fishing sector has always been remained as a vital part of the maritime resources. It is certainly one of the important sectors of Indian Blue economy, which offers abundant business prospects is fishing. Out of total GDP growth rate according to the National Fisheries Development Board (2023), the fishing industry contributes about 1% to India's GDP and supports more than 28 million livelihoods. India ranks third globally in fish production, accounting for roughly 8% of total output (National Fisheries Development Board [NFDB], 2023). As one of the developing nations of world, India is a prominent player in the global fisheries sector, India's share is more than 8% in global fish intake, and generating a more than 15 million metric tons (MMT) of fish during every year. Approximately 12.00 MMT of fish is derived from inland and around 3 MMT fish is derived from other marine sectors. India being one of the high ranked exporters of seafood globally, Indian fishing sector is very good source of foreign exchange also. Even though India's share of capture fishing is declining, the share of aquaculture is on the rise, creating substantial opportunities and boosting domestic production. Globalization is another pivotal factor, expanding the demand for Indian fisheries globally. After India has equipped herself with satellite launching and optimal and strategic use of satellite system in Indian Ocean Rim Association area, India's involvement in marine activities has also increased. It is now not restricted up to fishing only but it has reached to meteorology and safety operations also. Not only that but due to its significance in fisheries, India has established itself as a net exporting nation in this sector.

Aquatic Ergonomics

Aquatic Ergonomics which is popularly known as Marine biotechnology also is another fastest growing, and technology driven area within Blue economy. This sector is identified as highly advanced sector and mainly utilized in pharma, esthetic, nutrient supplements, chemicals, agrochemical, bio fuels, and bio informatics. Market experts value Marine Biotechnology market at global level to be around 2.4 billion US\$ with 10% CAGR (OECD, 2023). Front runner of marine biotechnology which uses marine organisms are agriculture, pharma and cosmetic industries. This sector is mainly categorized into four: White, Red, Green and Blue. White is used in Industrial biotechnology, Red in pharma, Green in agricultural and Blue is used as bio fuel and Bio informatics.

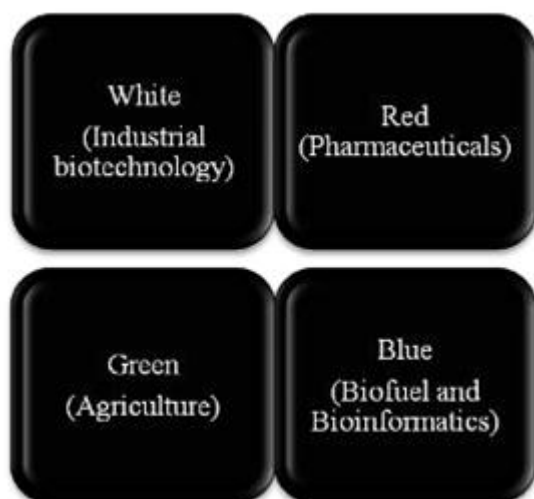


Figure: 2 Categories of Marine biotechnology

At one side capture fishing is declining and on other side need for fisheries products is rising and therefore environmentally sustainable fish production have become more crucial. Agricultural biotechnology is pivotal in enhancing the supply of high-quality food on a sustained basis, focusing on optimal food and feeding, healthy cultured organisms, and disease resistance. Blue biotechnology, being commercially sensitive, involves detailed micro-level information that is typically reserved by companies, public research centers and patent databases. Bio fuels and informatics, two key components of blue biotechnology, present lucrative business opportunities. In the United States, companies in the micro and macro sectors are involved in substantial bio fuel businesses, while companies located in Southeast Asia predominantly focus on Bio-informatics. Addressing regulatory concerns is essential for fostering a favorable environment for innovation, investment, and responsible development within the blue biotechnology sector. This requires handling of complex legal procedure and environmental standards, and promoting responsible practices to balance economic opportunities with ecological preservation.

Marine and Deep Ocean Mining

Seaside mining stands out as a crucial sector within the global Blue Economy. Marine mining primarily focuses on extracting aggregates such as sand, gravels, salt, sulfur, magnesium, oil, gas, tin, and valuable heavy metals. With the rapid pace of industrialization and urbanization, there is increasing pressure to commercialize aggregates and placers. This involves not only generation and extraction but processing of non-living resources such as minerals and metals from seawater and marine aggregates like limestone, sand, and gravel. It also includes searching of natural gas and oil.

Having a knowledge about availability of abundant ocean resources is not a new phenomenon but extraction of the same is definitely in an inception stage. The prime reason behind this is difference in exploration costs between land and marine resources. Persistent demand of metals such as copper and zinc have fueled curiosity in mining of sea resources. India is one of the front leaders in reserving of minerals like Limonite, Sillimanite, and Kyanite. These minerals find applications in various industries. Offshore placers, like Limonite originating from fossil shells, are particularly valuable and in high demand by heavy manufacturing sectors.

Even though deep sea resources offer so many advantages, they are not free from negative externalizations as it has negative effect on aquatic environment. In India, mainly state agencies are into the commercial extraction of resources; even state agencies also face challenges in meeting current target as it requires huge investment in extraction and processing of the same, although Public Private Partnership model has been suggested to speed up the process.

Aquatic Tourism

Marine tourism offers lots of opportunity for travelers in the form of sunbathing, pleasure boating, snorkelling, scuba diving, sea walking, whale and dolphin watching. In connection with Blue Economy, coastal or marine tourism holds significant importance, and is extended beyond conventional tourism. Coastal nations have already started promotion of aquatic tourism with emphasis on cruise shipping and lighthouse tourism. It has not boosted only Indian tourism sector but also playing an active role in generating employment in other sectors like hotel, restaurants, housing and residential housing too.

However, impacting on the coastal environment, contributing to issues such as urban sprawl, urbanization, waste production, and alterations in the social environment. Bringing balance between responsible development and aquatic tourism is utmost important.

Maritime Transport, Port Operations, and Logistics

Indian maritime transport has been the backbone of Indian trade since ages and with the passage of time it has witnessed only growth. To leverage India's 7515 KM long coastline, 14,500 KM of navigable waterways and tactic locational advantage of international sea routes, the Government of India with the aim of promoting port-led development has launched the Sagarmala Project. Reduced logistic costs for internal and international trade with minimum investment in infrastructure investment is the vision of Sagarmala Project.

Government is committed to invest \$123 billion across 415 projects in port modernization and new port development, port-linked industrialization, port connectivity

enhancement, and coastal community development (Ministry of Ports, Shipping & Waterways, 2023). A substantial portion of India's international trade, approximately 95 percent by volume and 68 percent by value, is facilitated through maritime transport.

Table 1: Projects Under Sagarmala Programme

Projects under Sagarmala Programme	Number	Investment (Rs.)
Total number of projects	802	5.40 lakh crore
Completed projects	220	1.12 lakh crore
Projects under implementation	231	2.21 lakh crore
Water transportation & shipping	27	7.14 lakh crore

Source: Indian Ports Association, Ministry of Shipping Annual Report(22–23).

Coastal and Marine Infrastructure Development

Construction in the marine and offshore environment presents significant opportunities for innovation, making it one of the most exciting fields of engineering practice. Marine construction encompasses a range of activities, including construction, diving, dredging, hydraulic engineering, underwater works such as cabling, and the development of ports and offshore bridges.

Recent government policies in India have successfully attracted the participation of foreign investors in the port development sector. The new Foreign Direct Investment (FDI) policy has introduced automatic approval for up to 100 percent FDI for the construction and maintenance of ports and harbors. These policies aim at fostering infrastructure development and attracting investments to enhance the efficiency and capacity of maritime facilities in India.

The Sagarmala Project stands as a significant initiative by the Indian Government. The project is designed to address the challenge of under-utilized ports by focusing on port modernization, efficient evacuation, and coastal economic development. Under the Sagarmala Programme, 17 projects with a total investment of Rs. 10,300 crore were completed in the calendar year 2022. These include 8 projects focusing on port modernization, 7 projects on port connectivity, 1 project on RORO Passenger Jetty at JNPA, and one project under the Sagarmala scheme.

These opportunities highlight the development, modernization, and green initiatives within the port sector, contributing to the overall growth of maritime infrastructure in India.

Marine Renewable Energy (MRE)

“Energy Triangulate Issue”—which focuses on energy resilience, social equity, and responsible development—can be overcome via enhanced usage of renewable energy. In the global energy mix, regenerative energy accounts for more than 22 percent and yields considerable return on investment (International Energy Agency, 2022).



Figure 3 Different Forms of Marine Renewable Energy

Harnessing energy from these different sources varies; solar and wind are particularly crucial sources of Marine Renewable Energy in India. Among these sources, deep sea and energy via wind are the most mature and effortlessly surpassing the growth of other forms of marine energy. The world's exploitable offshore wind resource is estimated to be around 30 times higher than the global average electricity generation. Wave energy is also emerging as a viable and environmentally friendly energy source, providing substantial energy with minimal environmental impact.

Although tidal energy holds immense potential, its full-scale growth due to environmental concern is yet to be achieved. Technology advancement and addressing environmental considerations are key factors influencing the commercial viability and widespread adoption of marine renewable energy sources.

Despite India's cumulative investment amounting to US\$10.2 billion, financing remains a significant constraint in the renewable energy sector in India. Addressing this constraint is crucial, especially while a country has a long coastline spanning 7,500 km, including island territories. India is equipped enough and strategically well positioned to tap into multiple sources of marine renewable energy. Constant technological advancement and progressive



policies support the development of marine renewable energy. India has the competitive advantage of harnessing the vast pool of resources available along its coastline for sustainable and clean energy generation.

Marine Manufacturing

Marine manufacturing is a dynamic global sector and a significant component of Maritime Economy. India has the ability to become a new global leader in ship manufacturing. During last decade, India has already showcased remarkable growth in this direction.

Marine manufacturing encompasses the construction, repair, and maintenance of various vessels, including boats, ships, fishing vessels, cargo vessels, submarines, yachts, and other floating structures. It also involves evolution of innovative technology such as navigation equipment, which makes marine manufacturing smooth and easy. The ship dismantling industry, often referred to as ship breaking or ship recycling, is another growing sector that extracts value from materials and equipment from end-of-life ships.

India possesses a large shipbuilding base that requires modernization. Currently, the country has 23 shipyards, with 7 under central government control, 2 under state governments, and the rest in the private sector. The Indian shipping industry, with a marginal share of 0.1 percent of the global shipbuilding market in 2002, has experienced substantial growth, accounting for 1 percent of the world shipbuilding industry over the past decade.

The global shipbuilding industry presents formidable entry barriers and high-risk factors, but India benefits from a cost-effective skilled labor force and the availability of ancillaries, positioning it competitively in this sector. Similar to emerging global players, India has the potential to compete with the United States and the European Union, capturing a share of the global market.

Challenges

The biggest challenge posed before Indian Blue Economy is inadequacy of dedicated policy. This is an autonomous sector and it should have a dedicated policy. Even though Indian Blue Economy consists of multiple sectors most of them are fragmented with no unified national framework. Second challenge is insufficient human and financial resource. Result is shortage of long-term funding to sustain policy implementation, this leads to non-compliance with existing regulations.

Another biggest challenge is less involvement of local communities. It is mainly because of absence of secure and long-term investment for initiatives involving local communities, and this is leaving stakeholders frustrated. Absence of systematic approach, continuity in data, and restricted access to data held by various institutions also pose challenges of monitoring of projects. Protected areas

currently lack monitoring programs and necessary indicators to track their impact and effectiveness.

II. CONCLUSION

Indian government is focusing on advancing maritime economy for economic development. India has tactfully positioned itself as significant force in marine and sea squad and development affairs. But at the same time Indian maritime economy is in urgent need of regulatory reforms so that strategic innovations can be initialized for capacity building. Marine resources should be used responsibly which can facilitate socio-economic growth via job creation. India is also emerging as start up hub and marine economy certainly offers ample opportunities for knowledge-driven start-ups and businesses, ensuring alignment of India's commitment to responsible and environment-friendly development.

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