Prospects of the blue economy in India: emerging policy challenges and the way forward

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'Blue economy' is becoming a buzzword for high economic growth with environmental sustainability, which is a reflection of the experiences of both developed and developing countries. A growing 'blue voice' emanates from a wide spectrum of countries about the efficacy of development strategies. Empirical evidence indicates that there is no 'stylized fact' about the contribution of blue economy to a country's GDP. As a satellite account, the blue economy contributed 4.1% of India's GDP in 2016. Accounting of the sector is important to identify priority sectors for policy planning in areas such as investment, employment, technology and other aspects of financial decisions. The blue economy value added in India is not only growing faster than the overall GDP, but is also becoming resilient to withstand adverse effects of the global exogenous shocks. Blue trade is becoming robust and is growing faster than the overall trade of a large number of littoral states. In India, blue trade shared more than 10% of the overall trade and openness of the sector was more than 100% during 2011–16. In blue trade, merchandise and services trade registered a favourable trade balance during 2008–22. The blue economy is likely to drive the Indian economy on a high-growth path after effective implementation of the National Blue Economy Advisory Council.

Keywords: Blue trade, development strategies, economic growth, environmental sustainability, marine services.

Introduction

BLUE economy is spreading across countries as a new development paradigm in the growth framework with sustainable development[1]. In the post-war period, the neoclassical growth models considered labour and capital as scarce factors of production, while raw materials as abundant in their models[2–4]. These development models undermined the sustainable consumption and production approach in the modern theory of economic development which threatened the sustainable use of materials and conservation for future generations. This aspect of development was highlighted by the Club of Rome, Switzerland, in 1972, by focusing on the issue of sustainability for the first time and presenting a report on 'limit to growth'. It was argued in the report that high economic growth indicates greater environmental concerns and therefore, consumption has to be restrained with the intervention of technology[5]. The Rio Earth Summit in 2012 was a watershed in development thinking, where 'blue economy' as a development paradigm was acknowledged and the ecosystem's productivity was considered inseparably linked with ocean health. The blue economy as a development strategy is embraced by both developed and developing countries. The experiences of a diverse set of economics, regarding the blue economy, reveal that it is generally highly growth-oriented and technology-intensive for emerging ocean sectors with a focus on conservation of marine resources.

Blue economy discusses harvesting of ocean resources without pollution and environmental degradation while maintaining an optimum level of consumption. It not only considers economic activities streaming from the sector, but also takes into account the damage to marine resources through over-exploration as well as pollution, thereby considering the net gain of activities from the sector as a contribution of the blue economy to a country's gross value added (GVA)[6]. In the ocean sector, there are enormous opportunities to harness existing resource deposits, which seem much higher than the land-based stock of resources. An example of over-exploitation of the marine sector is the wild catch of fish. It was observed that fish catch is substantially higher in the potential fishing zones than in the other zones, enhancing fish landing significantly[7]. Placer minerals are central to the fourth Industrial Revolution (Industry 4.0). Despite large deposits of such minerals in the coastal region of India, this sector is yet to kick-start due to the underdeveloped value-chain industry.

There are multiple sources of renewable and non-renewable marine energy available, and each of them can meet the energy requirements of a country for several decades. The drivers of growth and employment in the blue economy sector are marine manufacturing and services. Additionally, blue trade is likely to steer the external sector performance in India and several other countries. A large number of micro, small and medium enterprises in the blue economy sector are emerging in countries like the US, Germany, France, Japan and many others, and these units are potentially endowed to generate employment. India has evolved

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its blue economy Policy which is presently under the consideration of the Government. Realizing the relevance of estimating the size of its blue economy in the absence of 'stylized facts' about the sector, India has done so[8]. Other countries need to harness the existing potential of their blue economy by strengthening their blue economy accounting system.

For discussing the contours of the blue economy, with special reference to India, this article is organized as follows: First we evaluate the contribution of blue economy in the world and discuss the possibility of arriving at some stylized facts about the size of the sector. Next, we focus on the accounting framework in India and the key role of blue trade in the country. Thereafter, we present the linkages between blue technology and sustainable development in the context of blue economy. This is followed by an overview of India's blue economy strategy. The last section sheds light on the main findings of the study.

Contribution of the blue economy: experiences of the global economy

Over decades of discussions and evolving policy strategies, there have been strong 'blue voices' emerging globally, across a wide spectrum of countries, about the relevance of blue economy as the driver of economic growth[9]. In the absence of global consensus about the definition of blue economy[10], the driving factors of the sector are rather unclear. A common definition can suggest a set of uniform sectors for evolving prudent development strategies for numerous areas, including investment, output target, employment policy and sector-specific strategies depending upon the competitive sectors. In the absence of a common definition, different countries have adopted heterogeneous forms of blue economy, such as ocean economy, coastal economy, marine economy, etc. for the estimation of their economic activities. These terminologies are different variants of the blue economy, but by definition they are not the same. In that case, the contribution of the blue economy under a different nomenclature may neither be comparable nor help in formulating a common framework for the development of sectors across countries. Policy actions are needed to prioritize sectors for investment, socio-economic programmes and developing strategies for gaining economic benefits from the blue economy.

With definitional heterogeneity, the size of the blue economy may vary significantly for a country[1], but there could be some comparison between countries to provide a broad sense of the sector. Several countries have evolved separate approaches to estimate the size of their blue economies depending upon the importance of different subsectors in the marine ecosystem[11–16]. We have collected information for a group of four dozen countries, particularly about the contribution of blue economy to their GDP (Figure 1). Due to the complexities involved in the estima-

tion of blue economy, they are mostly estimated for a specific year, except for a few countries, namely the US, the European Union and China.

The results show that there are no stylized facts to support guesstimating the relative size of the blue economy to the GDP of a country. We have taken reported estimates of the blue economy from developed, developing, emerging, island, least developed countries (LDCs), littoral and landlocked countries for analysis. Variables such as length of the coastline, size of the GDP, per capita income, coverage of land and coastline-to-land ratio were chosen for each country to understand the determinants of the size of the blue economy. We have listed 48 countries drawn from various studies to understand their nature that can maintain a high contribution from the blue economy to the GDP. At least in 10 countries, blue economy has contributed more than 10% to the GDP in recent years.

Voyer et al.[15] estimated the contribution of the blue economy of Timor-Leste to its GDP, which was estimated at 87% in 2015. No other country has reported such a large blue economy sector in the world so far. Among the known countries, the estimated size of their blue economies ranged between 87% (Timor-Leste) and 0.01% (Austria). Then what factors determine the size of the blue economy in a country? To address this question, we have taken various criteria to examine the possibility of identifying stylized facts about blue economy. The 48 nations that have already estimated the size of their blue economy, are from different stages of economic development (They are from developed countries (Iceland (26%) and Canada (9%)), developing countries (Tanzania (11.9%) and Mauritius (10.8%)), emerging countries (Thailand (29.6%), Malaysia (23%) and Vietnam (20.8%)), island nations (Seychelles (41.9%)) and LDCs (Timor-Leste and Cambodia (16%)).) The presence of a longer coastline does not ensure high contribution of blue economy to the overall GDP. For example, countries like Japan, USA, New Zealand and India, which have longer coastlines have less than 5% blue economy share to their economy. Moreover, countries with a high GDP do not show any consistency in terms of their contribution to the blue economy, whereas countries like Canada and China show a high contribution to the sector; others like the US, Japan, Germany, France and South Korea experience lesser share of the blue economy in their GDP.

Countries with high per capita income also demonstrate mixed responses regarding the contribution of their blue economy to the GDP, and most of them are developed economies. Some countries with high per capita income and low contribution to the blue economy are Luxembourg, Sweden, USA, Austria and Finland, and those with high contribution are Singapore, Canada and Iceland. The contribution of the blue economy to GDP is again unclear among littoral countries with a large land mass. Countries having large land mass with a low contribution to the economy are the US, France and Spain, and those with high contribution are Indonesia, Thailand, Tanzania and Canada. We have
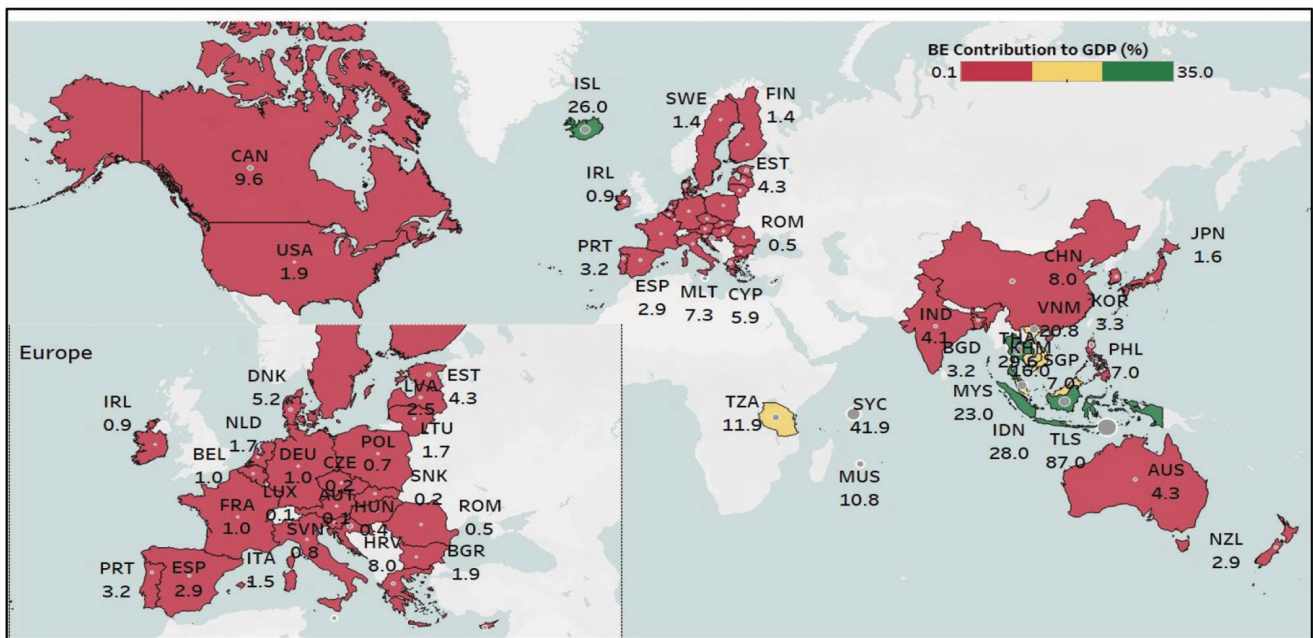
Figure 1. Global experience of contribution of blue economy to GDP. Map drawn based on various published material reports, etc.[11–16].

examined littoral countries having long coastlines along with large land masses to provide some lead to understanding the size of the blue economy in them. With the dual criteria, we considered the top littoral economies and found that the contribution of the blue economy to the GDP was large for some countries (Indonesia, Canada, China and Thailand) and small for others (USA, France, India and Spain). By taking various forms of economics and marine macroeconomic variables, we have examined the factors explaining the large size of the blue economy sector relative to its economy in littoral and landlocked countries. We could not trace any criteria to guesstimate the contribution of the blue economy to GDP. Therefore, we conclude that each country should estimate its blue economy, which is critical for long-term policy planning and action strategy, for its key sectors in the areas of investment, employment planning, technology development and acquisition.

Blue economy accounting framework for India

There has been a debate in India on the relevance of the blue economy during the last decade, but progress regarding the estimation of this satellite sector was not much due to the lack of an accounting framework to measure sectoral contribution to the country's GDP. India has been using the classification of the National Accounts System (NAS) based on the United Nations (UN) classification, the System of National Accounts-1993, to estimate its GDP. The same accounting system has been restructured for the estimation of the blue economy in India[8]. The value-added national income estimation uses the National Industrial

Classification-1998 (NIC-1998), which is based on the International Standard Industrial Classification (ISIC, revision 4) of the UN. For the identification of ocean and marine activities in India, industries are identified at a more disaggregated level of five digits, which is the basis for the estimation of GVA for ocean and marine sector industries. The value added generated by each identified micro-level industry contributes either partially or fully to the accounting of blue economy. Those industries contributing partially are given specific weights which are generally drawn from various surveys/studies.

In income accounting methodology, the wage share or labour share is often used to isolate the specific contribution of a micro-level industry from others when the aggregate value added is given for a group of industries[17,18]. A similar approach was used to separate the contribution of specific industries at a five-digit level from a group of industries in India for the period 2011/12–2016/17 (ref. 8). The present use of industry weights from secondary sources may be replaced by results from time-to-time country-wide benchmark surveys. A similar approach may be considered for both goods and services in the blue economy sector. Special efforts are being made to access GVA for established and emerging sub-sectors in each sector separately. NSS Employment Unemployment Survey and Annual Survey of Industries databases are used for estimating labour coefficients in both organized and unorganized manufacturing sectors. In this regard, 159 industries have been identified at a five-digit level for the goods and services sectors, where 54 of them are fully and 105 of them are partially contributing to the blue economy in India[19]. For the presentation of the blue economy in India, we have used

Table 1. Blue economy in India: sectoral contribution estimated based on the PMEAC Report[8] (US$ billion)

Sector	2011	2012	2013	2014	2015	2016
Agriculture, forestry and fishing	14.6	15.0	16.8	19.1	20.7	23.0
Mining and quarrying	22.4	21.4	20.2	20.2	18.8	19.8
Manufacturing	5.1	4.9	4.6	5.0	5.5	5.8
Electricity, gas, water supply, etc.	5.1	5.2	5.9	6.9	7.6	9.4
Construction	2.5	2.4	2.4	2.4	2.3	2.3
Trade, repair, hotels and restaurants	2.0	2.0	2.0	2.1	2.2	2.3
Transport, storage, communication, etc.	5.0	4.8	4.5	5.1	5.0	5.4
Financial services	6.8	6.6	6.7	7.1	7.4	7.3
Real estate, storage, communication, etc.	4.2	4.4	4.7	5.2	5.6	5.9
Public administration and defence	3.0	2.9	2.9	3.1	3.2	3.6
Other services	0.2	0.2	0.2	0.2	0.3	0.3
Overall gross value added	70.8	69.7	70.9	76.5	78.6	85.2

the NAS classification, where Table 1 shows the contribution of 12 broad sectors. The results show that contributions of several sub-sectors are either marginal or insignificant, which necessitates the need for a benchmark survey or selected sample survey for arriving at credible statistics for industries in specific blue economy sectors.

India's blue economy GDP was estimated at US$ 85.19 billion in 2016, which increased from US$ 70.82 billion in 2011. In terms of local currency units (LCUs), it touched INR 5724.3 billion in 2016 from INR 3305.4 billion in 2011 in current prices. During 2011–16, exchange rate fluctuation was at its peak, particularly growing at the rate of over 8.8% per annum, causing a downsizing of the sectoral performance of the blue economy in US dollars terms compared to INR. In terms of LCUs in current prices, the GDP grew in double digits on a year-on-year basis, except for 2015–16, where it was at 8.0% per annum.

At the very outset, it may be admitted that the blue economy sector has been underestimated due to the lack of appropriate estimates for different segments of the blue economy by different studies/surveys. For example, the contribution of sectors like connecting ports and hinterlands, the use of seaplanes, cruise and hovercrafts[20], satellite services for fishermen in the deep sea for navigation and locating fish clusters in the deep sea, and early warning system for weather forecast and tsunamis, several minor and major port services (tugging, reception services, etc.), valuation of non-tangible questions services (using contingent valuation approach) is not known.

The average contribution of the blue economy in India was 4.1% during 2011–16, and annual growth performance ranged between 1.7% and 8.3% during this period. Interestingly, growth performance of the sector remained buoyant in the second phase of the global recession, particularly between 2013–14 and 2016–17. Barring a few sub-sectors within the blue economy, others have performed consistently well over the years. In terms of constant and current prices in LCU, the contribution of the blue economy to the GDP was hovering around 4%. It was 4.1% in 2011–12 and remained at the same level in 2016–17. In US dollar terms, the contribution of the blue economy to the GDP remained almost unchanged from 4.1% in 2011–12 to 4.0% in 2013–14 and further to 4.1% in 2016–17. However, the driver of India's Blue Economy has been the blue trade, which is conceptually different from marine trade, where the volume of blue trade is not likely to be altered by changing the mode of transport.

India's blue trade as a driver of blue growth

Blue trade will be the growth driver of the Indian economy which is expected to grow faster than the overall GDP, blue economy GDP and overall trade of the country. What is blue trade if it is not the same as maritime trade? Blue trade is the trade of a bundle of products which have special characteristics to qualify as blue products. Blue products are embedded with inputs which are either coming or going into the ocean. We have identified a variety of products and resources which are used as inputs for domestic production like fish, seagrass, placers, sand and gravel, offshore renewable and non-renewable energy, water, marine biodiversity, etc. We also produce several products like ships, boats, fishing nets and equipment, and several other goods and services which are meant to go into the ocean to generate economic activities. The entire range of such products and services falls under the broad classification of tradeable blue products.

In the blue economy literature, identification of sectors to industries and further to the level of activities has been a critical researchable area during the past half a century, but further expansion from activities to products is a new research area. A study identified products of goods and services under the blue trade and estimated the time-series blue merchandise trade for 169 countries as well as for the world economy during the period 2002–20 (ref. 21). Table 2 presents the goods and services trade in the ocean sector estimated for India. It is estimated that the global blue trade increased rapidly from US$ 770 billion in 2002 to US$ 3.2 trillion in 2015, and declined to US$ 2 trillion in 2020 (ref. 22). The world economy witnessed a highly turbulent phase for blue trade during the second phase of

Table 2. Blue trade performance in India estimated based on Mohanty and Gaur[22] (US$ billion)

Year	Trade in goods			Trade in services			Overall blue trade
	Exports	Imports	Trade balance	Exports	Imports	Trade balance	
2003	6.4	6	0.4	3.1	5.4	−2.4	20.8
2004	10.4	8.7	1.7	4.3	7.6	−3.3	31.0
2005	17.6	12.4	5.2	5.8	11.7	−6.0	47.5
2006	23.3	18.5	4.9	7.6	14.2	−6.5	63.6
2007	27.9	22.4	5.5	9.3	17.7	−8.4	77.2
2008	38.0	35.5	2.5	11.8	8.4	3.4	93.7
2009	32.5	24.3	8.2	10.7	6.6	4.1	74.0
2010	43.6	33.0	10.7	12.4	8.5	3.9	97.5
2011	61.5	43.3	18.2	15.6	9.0	6.6	129.3
2012	52.8	48.7	4.1	16.0	9.2	6.7	126.8
2013	69.7	49.4	20.3	16.1	8.3	7.8	143.6
2014	63.4	46.4	17.0	17.3	9.7	7.6	136.6
2015	36.5	31	5.6	15.1	9.1	6.0	91.7
2016	35.1	28.8	6.3	15.6	8.5	7.1	88.0
2017	45.0	37.2	7.8	16.8	9.9	6.9	108.9
2018	54.1	56.4	−2.3	18.5	12.1	6.4	141.1
2019	53.5	41.0	12.5	20.6	14.6	6.0	129.7
2020	37.4	31.8	5.6	20.9	12.5	8.4	102.5
2021	60.9	47.7	13.2	27.5	18.6	8.9	154.8
2022	91.7	71.3	20.5	34.4	26.1	8.3	223.6

the global recession. The rebound was visible for the global economy in blue trade in 2017, but downturn in the sector reappeared in 2019 and continued with the deepening of trade with the onset of the COVID-19 pandemic in 2020. The blue trade in India will continue to become the growth driver of the country if the present trend continues in future.

India's total blue trade was estimated at US$ 223.6 billion, where goods trade stood at US$ 163 billion and services trade at US$ 60.6 billion in 2022. During 2003–22, India's blue exports, imports and total blue trade registered a 12-fold increase in the goods sector. Numerous studies have shown that trade has been the driver of growth in the Indian economy[23–25]. As a resilient sector, the blue economy contributes around 4% of India's GDP, but blue trade shares more than 10% of the country's overall trade. Share of blue exports in goods and services increased from 10.4% in 2003 to 13% in 2021. The share of blue imports in goods and services was robust, and was in double digits and reached the peak of 14.2% of total imports in 2006. During 2003–22, the share of blue exports was higher than the share of blue imports, thus, allowing the share of overall blue trade to remain at double digits in the trade.

Another important feature of the blue trade is that its trade openness has been much higher than the overall trade openness (i.e. trade to GDP ratio) of India. After the COVID-19 pandemic, overall trade openness was much slower to recover than blue trade in the immediate post-recovery period. It is important to note that the openness of blue trade has been much higher than the overall trade, thus indicating that the growth of blue trade can take India on a high growth path in the coming years. Like overall trade openness, blue trade openness was reported at 182.6% in 2011, but declined gradually to 103.3% in 2016. Blue

trade openness was over three times higher than overall trade openness in 2011, but the gap declined to two and a half times in 2016.

From the total blue trade surplus of US$ 28.8 billion, the goods sector contributed US$ 20.5 billion and the services sector US$ 8.3 billion in 2022. India continued to enjoy blue trade surplus in the goods sector during 2003–22, except for 2018. In the blue services sector, trade balance was adverse for 2003–07, but a new trade regime began with a sizable trade surplus in 2008 and the trend continued without interruption until 2022. During the global recession, particularly in the period 2008–22, trade balance of the blue services sector was at its peak, having an annual trade balance of over US$ 8 billion. India maintained a trade surplus in the blue services trade in 2022, like earlier years since 2009. It is important to note that the country maintained a trade surplus in blue goods and services sector separately, but this was not the case for the overall merchandise trade sector of India.

Blue technology and sustainable development

Technology has been the bedrock of the blue economy, especially for its emerging sectors where technology development has been in a nascent state. Technology creation has been the most critical aspect of policy intervention for a country, which is irrespective of its stages of economic development, to spur economic activities in the marine sector. In this context, Industry 4.0 is important. It is driven by advanced digital technologies and automation, which embrace several elements of technological advancement, including AI, internet of things (IoT), big data, 3D printing, cloud computing, robots, digital twins, etc. These technologies are

collectively responsible for the transformation of traditional industries in the framework of new business models based on productivity, quality and efficiency[26]. Global efforts have been made to reduce inequality and disparity among different communities with effective implementation of SDGs. In this regard, Industry 4.0 could be a catalyst to make qualitative improvements in the initiatives to reduce the global deprivation gap through technological interventions.

Considering the strong interface between technology and SDGs, particularly in the blue economy sector, the UN Decade of Ocean Science for Sustainable Development (2021–30) will support global efforts on SDG-14 through the use of appropriate technology with different national governments. Apart from specific requirements of SDGs, technology interventions are required in the blue economy since the imprints of the sector can be traced in every broad economic activity. Apart from established sectors in the blue economy, emerging sectors also co-exist. The modern emerging sectors have a high potential to augment economic activities and require disrupting technologies to flourish under Industry 4.0.

Fishery is the largest sector in several littoral economies, and is crucial for the food and livelihood security of millions of people. India is the third largest producer of fish and the second largest producer of aquaculture in the world, but is grossly below its potential in fish landing. Strategies are needed to modernize traditional techniques in areas like fishing gears, fish nets, mesh size, motorized boats, etc.[27]. Small-sized bottom trawlers mainly operate on the Indian coast, but need to be replaced by second-generation trawlers to improve the efficiency of fish production[28]. Focus on future innovation should be on high-efficiency, motorized, fish-catching boats, modern techniques in aquaculture, setting norms for responsible fishing, and sustainable production and consumption.

Coastal placer minerals and deep-sea mining are important for Industry 4.0, and India has achieved the status of a 'pioneer investor' according to the International Seabed Authority. Deep-sea exploration for biological materials is also important for promoting pharmaceutical, food supplement, cosmetics and biofuel industries, but technological breakthroughs are necessary to explore biological materials from the deep sea without destabilizing the ecological balance. Processing of placers from the coast and polymetallic nodules/polymetallic sulphide from the deep sea, designing and indigenous production of equipment for isolation of minerals from sand and the use of rare earth elements in industrial production require considerable level of domestic innovation. Towards the reduction of global warming, new technologies in various sectors need to be evolved to achieve 'net zero' at the firm and country levels.

With the ongoing industrialization in developing countries, growing energy requirements have been a major challenge. To keep a check on global warming, there is a global consensus to reduce dependence on fossil fuels and other energy sources to mitigate carbon footprints. There is a continuous process of switching energy sources from non-renewable to renewable, and the blue economy can be a major provider of energy for both. The ocean sector has large reserves of renewable and non-renewable sources of energy. However, technologies are immature for these energy sources globally, except for solar and wind energy. Global shipping sector has been a major source of environmental pollution due to the use of high-emitting bunkers. Technologies in India are in the process of approaching their maturity stage in areas like processing of placer minerals, developing early warning systems for managing natural disasters, satellite fabrication for various ocean-related applications, manned submersible and underwater robotics for deep-sea mining, etc.

Several industries fall within the purview of the blue manufacturing sector where proliferation of technology has been fast in the ship-building industry across the globe. In the ship-building sector, demand for a variety of vessels, such as container ships, oil tankers, LNG carriers, etc. is seen in the global market. Depending upon the specialization and development of technology in the domestic sector, specific countries in the East Asian region, including Japan, China and Korea have maintained their monopolies in these blue sectors. IoT is used in the sector for sharing, monitoring and tracing ship movement at sea[29]. Automation of port and shipping is gaining importance because of the reduction of operational costs and rising productivity[30], easier movement of goods and standardizing customs clearance in ports[31]. Besides, there have been significant innovations in the areas of marine cyber security, containerization and 3D printing in the port and shipping sector[32]. The governance structure needs to be evolved along with institutional development to provide leadership in indigenous technology development.

Evolving blue economy policies in India

Governance of blue economy is a major challenge faced by countries across the globe because ocean activities are spread in most of the economic areas. It is a cross-cutting sector that encompasses the activities of several ministries, which are directly associated with specific activities of the blue economy. Taking several ministries at the federal level, provincial governments and related autonomous agencies concerning the ocean sector, governance of activities is a complex matter for a single authority. In certain industrial economies like the US and Canada, the blue economy administration is mostly headed by the President or Prime Minister of the country. Many of them have evolved National Blue Economy Policies to drive futuristic policy planning. The practice of having a federal budgetary system is also in place for some countries to promote activities in the ocean sector. In this regard, Canada and Australia have established hierarchical institutions which are placed at the federal and provincial levels to implement

targets set for the blue economy. India is working for the establishment of a National Policy on Blue Economy under the stewardship of the Ministry of Earth Sciences (MoES), Government of India, to undertake comprehensive activities in the maritime domain. The activities in the sector are likely to be governed by the National Blue Economy Advisory Council (NBEAC) which is to be represented by secretaries from relevant ministries as members, official representation from the coastal states and representatives from various industries[33]. Besides, representations from other maritime autonomous institutions are likely to be part of this new set-up.

For the coastal development under the blue economy initiative, India has undertaken several programmes in multiple directions. The 'Sagarmala' programme is an initiative to construct and upgrade basic ports and related infrastructure to support coastal states and Union Territories in harnessing their potential existing in the blue economy with an investment of US$ 120 billion in 600 projects. To develop coastal economic zones, an investment of US$ 150 million has been year marked for each location. Another Government initiative has been 'SAGAR–Security and Growth for All in the Region' to foster bilateral and multilateral cooperation in the blue economy sector in projects like port development and coastal community development. India and Japan took the initiative to develop quality infrastructure in Africa, particularly in the blue economy sector[34]. 'Sagar Manthan' is a digital platform operating through the dashboard to integrate data systems to support projects in the shipping, ports and inland waterways sectors. To reduce friction between coastal communities with the ocean, Marine Spatial Planning is being implemented in the coastal sector and is linked with the Integrated Coastal Zone Management to conserve resources and provide livelihood security for the local communities. For the coastal region development, many action plans were undertaken such as coastal restoration through Mangroves for Future, initiating a comprehensive National Fisheries Policy, 2020, providing early warning against ocean disasters under the O-SMART initiative, effective policies for coastal placers, etc. These policies were effective in improving the quality of life of local communities in the coastal region.

In 2018, India launched the 'Deep Ocean Mission', a five-year initiative with multiple objectives to implement several programmes. The Mission is mandated to develop underwater submersibles and robotics, build technology for conservation and sustainable use of bio-resources, promote technologies for renewable energy, initiate programmes for extracting minerals from the ocean bed, develop offshore desalination techniques for freshwater, etc. A study has discussed the strategic role of Indian institutions in evolving technologies for the exploration of living and non-living economic resources without affecting the marine ecosystem[35]. India is also developing a manned ocean submersible – Samudrayan rated to dive up to 6000 m deep to explore the non-living resources such as polymetallic manganese nodules, gas hydrates, hydrothermal sulphides, cobalt crusts, etc. A recent study has presented an overview of India's prowess in ocean technology development[36]. To maintain the country's pioneering status in ocean technology, it needs to engage in the creation of technology in multifarious areas. To meet this end, MoES, GoI, should secure financial autonomy and establish its commercial arm to disseminate its ocean technology along with mobilizing resources for promoting its indigenous technology development programmes.

Conclusion

The blue economy has emerged as a new development paradigm to embark on a high growth path with sustainability. Experiences of four dozen countries share a similar understanding of accomplishing high growth with large employment opportunities in this sector. It offers economic opportunities in almost all sectors, but challenges are many to seize these sectoral opportunities. To take advantage of low-hanging sectors with plentiful opportunities, hard decisions must be taken in critical areas such as investment, technology, manpower, etc. Accuracy in the estimation of the blue economy has been a prerequisite for evolving pragmatic policy planning. Since there are no stylized facts available for the contribution of the blue economy in specific sectors, the estimation should not be based on guesstimates.

India's blue economy GDP was estimated at US$ 85.2 billion in 2016, which increased from US$ 70.8 billion in 2011. The contribution of the blue economy to the total GDP of the country was 4.1% in 2016, where the primary sector shared more than half of the total value added by the blue economy. Blue trade emerged as the growth driver for the world economy and India. While the blue economy contributed around 4% of India's GDP, blue trade shared over 10% of the total trade, which was irrespective of the global trade regimes. It maintained a trade surplus in both merchandise trade and services trade. India's trade openness in blue trade ranged between 103% and 189%, whereas the country's overall trade openness remained below 50% of its GDP during 2011–16. Blue trade in the services sector continued to show a trade surplus during 2008–21, where the sector mostly relied on transport and communication, and the ICT sub-sectors.

The governance structure for blue economy is in the formative stage and final approval of the Government is awaited for launching NBEAC to implement the Blue Economy policies. Several policies have been initiated in the past, including the Deep Sea Mission in recent years. Launching of NBEAC would open up a new era in India's development history in institutionalizing Blue Economy policies in the country.

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