ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Emerging Technologies, Education and Skill Development for A Sustainable Blue Economy in Nigeria.

Akaninyene Edet, Ekong [a], Babatunde Michael, Ogunbanwo [b], Esang Lazarus, Esitikot [a], and Gerald Ndubuisi Okeke [a]

[a] Highstone Global University, Texas, USA.

[b] Centre for Occupational Health, Safety and Environment, Institute of Petroleum Studies, University of Port Harcourt, Nigeria.

DOI : https://doi.org/10.51583/IJLTEMAS.2025.1412000002

Received: 08 December 2025; Accepted: 17 December 2025; Published: 25 December 2025

ABSTRACT

The paper examined the role of emerging technologies for sustainable blue economy and assessed the level of knowledge and skill development among stakeholders in Nigeria. Emerging technologies in the blue economy were highlighted as remote sensing & satellite monitoring, offshore renewable energy, marine biotechnology, artificial intelligence & big data and marine robotics. Educational needs include interdisciplinary marine studies, vocational training, online and modular courses, and collaborative programs and partnerships among universities, research institutes, and other organizations. Skills needed include marine robotics, data analytics, AI for ocean modelling, marine ecology, climate resilience, biodiversity conservation, and international maritime law. This paper utilised a field survey and literature on policy analysis. It revealed that the incorporation of advanced technologies is limited, and vocational training and education are inadequate. The implementation of inclusive programs emphasises the importance of collaboration amongst stakeholders, including communities, government, industry, and academic institutions. It concluded with recommendations for enhancing technology and models to promote a robust, inclusive, and sustainable blue economy in Nigeria.

Keywords: Blue Economy, Technologies, Education, Skills, Sustainability.

INTRODUCTION

European Commission (2022) has long acknowledged the Blue economy (BE) as the collection of all ocean-related economic activity as a primary force behind European expansion, owing to the creation of new capabilities and initiatives that permit the sustainable exploitation of ocean resources. As this notion continues to evolve, it raises issues on how we manage and utilize materials, both new and existing (Martinez-Vázquez et al, 2021). Coastal tourism, oil, gas, and mining, ports and warehousing, fisheries and aquaculture, and new large-scale industries with a higher level of technological intensity, like marine biotechnology, marine defence, and some renewable energy sources, are some of the industries associated with the BE (European Commission, 2019; Rayner et al., 2019).

The BE's irresponsible growth can harm society and the environment, cause inequity and irreversibly altering natural resources (Bennett et al. 2021). According to Lee et al. (2020), the conflict between sustainability and economic returns that emerges in the BE is caused by the divergent choices and interests of the many stakeholders regarding environmental preservation against profitability. Its sustainable growth and the livelihood of coastal populations are threatened by a combination of overfishing, pollution, coastal development, and climate change (Nabi and Hayat, 2025). Fish populations decline due to overfishing, affecting both the environment and the economy. Marine life and ecosystems suffer from petroleum spills, plastic Waste, and agricultural pesticides. Urban expansion and coastal development damage vital habitats like mangroves, seagrasses, and salt marshes. Issues such as ocean acidification, global warming, and lack of ocean awareness further threaten these systems (Narwal et al., 2024). Nigeria stands at a crucial point in harnessing its extensive coastline, rich marine biodiversity, and maritime resources, as the global focus on ocean-based industries grows.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

According to Johnson et al. (2023), robotics is the combination of mechanical and artificial intelligence systems to carry out intricate tasks, including risk assessment and financial decision-making. These devices are frequently designed to carry out repetitive, hazardous, or impossible-for-human jobs. In order to develop systems that can function independently or partially autonomously, robotics integrates aspects of computer science, mechanical engineering, electrical engineering, and artificial intelligence (AI) (Ajibade et al., 2025). Today, most ocean exploration is done by robots, and marine robotics technology is developing at an astounding rate (National Academies of Sciences, Engineering and Medicine, 2020). Such technology can have long-term beneficial effects on businesses' competitiveness and, consequently, the industry as a whole once it is put into practice (Walsh, 2021). Data from fisheries fleet monitoring, new remote sensing technologies, unmanned aircraft systems, citizen science data, and shipping vessel tracking systems, including automation identification systems and vessel monitoring systems, are among the other technologies utilised for this purpose (Barkai & Flanagan, 2014). According to Zaeri (2025), artificial intelligence can support the BE's sustainability. According to Burgess et al. (2018), technology also allow actors to adapt their conduct to the new institutional context. New technologies have the potential to lower emissions and the environmental impact of the BE in addition to improving data collecting. According to Ajibade et al. (2025), the BE's conventional industries actually produce the most pollution within the sector. Similar to this, the European Commission (2022) pointed out that funding surveillance and monitoring initiatives for the benefit of marine ecosystems is a crucial technological development that would be advantageous across the BE spectrum. According to Nwakoby et al. (2025), satellite tracking systems can keep an eye on fishing operations, guaranteeing correct reporting and adherence. Records of marine transactions can be made transparent and impenetrable through the application of blockchain technology (Nwakoby et al., 2025).

In their academic study, Aantjes et al. (2022) pointed out that capacity building entails giving individuals the information, abilities, resources, and tools they need to recognise and seize opportunities and challenges. This method acknowledges that advancement and sustainable development are only possible when people and organisations are prepared to propel their own development and change. Given that the digital transformation of the BE is a continuous process in all sectors and that it is essential for workers in this sector to be able to work with digital tools, training is essential for providing continuity to the knowledge in the BE (Walsh, 2021). Knowledge-intensive industries are essential to achieving a sustainable BE, and research and development (R&D) is a major factor in the intellectual and technical advancement of some industries (Rayner et al., 2019). Unlocking the potential of research and innovation to create novel ocean sustainability solutions is necessary to achieve a sustainable BE (Pace et al., 2023; Melo et al., 2022). However, the sustainable management, exploration, and mainstream integration of marine resources are hampered by a lack of knowledge about the use of marine technologies, a shortage of skilled workers, inadequate data infrastructure, regulatory uncertainty, and antiquated port facilities (Adeoye et al., 2023; Ajibade et al., 2025; Aladejana et al., 2024). In addition to maximising the economic potential of Nigeria's coastal and maritime regions, addressing these problems will help achieve the Millennium Development Goals of eradicating extreme poverty and hunger through job creation, environmental preservation, and the formation of international development partnerships (Aladejare, 2023). In light of this assumption, the current study evaluates the degree of knowledge and skill development among Nigerian stakeholders and investigates the significance of new technologies for a sustainable BE.

LITERATURE REVIEW

Blue Economy (BE) Regulations

The Sustainable Development Goals (SDGs), a group of 17 objectives intended to alleviate poverty and build a sustainable world, were a focal point of the 2030 Agenda. All nations are subject to the Sustainable Development Goals (SDGs) (United Nations, 2025). A healthy and sustainable use of marine resources that preserves the ecology and fosters economic growth is required under Goal 14—Life Below Water (Michael & Morgan, 2022). Global policies pertaining to resource management and ocean governance have been influenced by this concept. According to their economic and environmental interests, several countries have now created unique definitions and implementation methods for the BE (Nabi and Hayat, 2025). To monitor and guarantee progress towards BE objectives, Canada and Australia have implemented legal frameworks and set up multi-tiered institutional structures at the federal and state levels (Srivastava, 2025). The BE idea is included into Kenya's national

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

development plans. The growth of the BE is a strategic goal of Kenya's Vision 2030, with an emphasis on sustainable tourism, maritime transportation, and fishing. In order to support sustainable development and progress in the country, the government has also put laws in place to improve marine conservation and encourage investment in marine-based sectors (Kenya Vision 2030).

According to Nammah and Ezenyimulu (2025), the federal government of Nigeria has the power to enact laws and control operations inside its continental shelf, contiguous zone, territorial seas, and Exclusive Economic Zone (EEZ). Furthermore, the legal basis for levying taxes and levies on activities pertaining to marine resources is provided by sector-specific laws as the Nigerian Maritime Administration and Safety Agency (NIMASA) Act 2007, the Petroleum Industry Act (PIA) 2021, and the Sea Fisheries Act 1992. Section 20 of the Federal Republic of Nigeria 1999 Constitution is the cornerstone of all laws pertaining to the preservation of Nigeria's maritime environment. As per Gbadegesin and Akintola (2021), the clause stipulates that "the State shall protect and improve the environment and safeguard the water, air, land, forest, and wildlife of Nigeria." The federal government's first duty is to safeguard and enhance the environment, since this clause serves as the foundation for all other environmental protection legislation in Nigeria. The Water Resources Act's provisions give the government the ability to create comprehensive strategies for the sustainable development and management of the nation's BE resources. Oil discharge into Nigeria's navigable waters is forbidden by the Oil in Navigable Waters Act. According to the Act's Sections 1, 3, and 5, it is illegal to release any oil or oil-containing combination into Nigeria's navigable waterways without first paying a fine (Gbadegesin and Akintola, 2021). By controlling the issuance of licenses for the construction and upkeep of oil pipelines, the Oil Pipelines Act 62 also protects damage of the maritime environment. The Act aims to prevent oil pipelines from polluting lands and rivers by standardising the procedures (Elisha, 2019). President Bola Ahmed Tinubu's creation of the Federal Ministry of Marine and BE is a calculated move to maximise and utilise this potential (Agunsoye et al., 2025). Nigeria, however, lacks comprehensive frameworks and regulations that are expressly designed for the BE. The successful use of the nation's maritime resources is hampered by the lack of a comprehensive and coordinated strategy, despite some attempts to design policies, such as the National Policy on coordinated Maritime Strategy (Sule, 2021). To direct sustainable development in Nigeria's coastal and marine regions, a strategic plan that covers every facet of the BE including fisheries, maritime transportation, aquaculture, tourism, and renewable energy is required (Patrick et al., 2022). The public and commercial sectors must work together to address these issues, establishing quantifiable objectives and benchmarks, efficient BE policy frameworks and structures, and sustainable practices that guarantee economic expansion (Benzaken, 2022).

METHODOLOGY

The study employed a survey using descriptive research design. The methodical procedure combined primary data collected through a structured questionnaire with secondary data from relevant literature and policy documents. Utilising a structured questionnaire, 189 respondents were sampled which consist of professionals of the maritime industry, policy makers, universities, Non-profit organisations, research institutes and representative from coastal communities. Through purposive sampling approach participants were selected. The close ended questionnaire was developed using 5 point Likert scales. Descriptive statistics such as percentages, frequencies, percentage, median, standard deviation, maximum and minimum values were adopted. Responses on the Likert scale were coded with figures Strongly Agree as 5 and Strongly disagree as 1. Participation was voluntary and respondents gave their informed consent. To ensure confidentiality, participants identities were not disclosed and participants were allowed to withdraw at any point if they feel uncomfortable to continue.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Results and Data Analysis

Socio-demographic Information

Table 1 Showing the sociodemographic characteristics of respondents.

Variables	Frequency (F)	Percentage (%)
Sample valid responses (N) = 189(100%).		
Sex		
Male	100	52.8
Female	89	47.2
Age group		
Below 25years	30	15.8
25 – 34years	45	23.9
35 – 44years	70	37.0
45 – 54years	14	7.5
55years and above	30	15.8
Current role		
Academic or Researcher	35	18.6
Industry professional	30	15.8
Development worker	34	18.2
Student	40	21.1
Member of community	25	13.1
Government affiliate	25	13.2
Number of years in Marine or BE sector		
Under 1year	25	13.3
Between 1 to 5years	100	52.8
Between 6 to 10years	25	13.2
More than 10years	0	0.0

Table 1 shows the sociodemographic characteristics of respondents. It demonstrates that the majority of the respondents, 100(52.8%), were male. The group with the highest distribution, 70(37.0%), are those between the

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

ages of 35 – 44years old. The majority of the respondents, 40(21.1%), were students. The highest distribution of the respondents, 100(52.8%), has between 1 and 5 5years of experience in the Marine or BE sector.

Knowledge of and Utilisation of Emerging Technologies for sustainable BE

Table 2 Showing responses on knowledge of and Utilisation of Emerging Technologies for sustainable BE [(N) = 189].

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mode
I have knowledge of what the BE is.	5(2.6)	10(5.3)	34(18.0)	82(43.4)	58(30.7)	Agree
I am familiar with remote sensing and satellite monitoring in maritime environments.	8(4.2)	12(6.3)	40(21.2)	75(39.7)	54(28.6)	Agree
I understand how the maritime industry uses offshore renewable energy.	6(3.2)	15(7.9)	51(26.9)	69(36.5)	48(25.4)	Agree
I have made use of or participated in marine biotechnology projects.	20(10.6)	25(13.2)	60(31.7)	50(26.5)	34(18.0)	Neutral
I am aware of how artificial intelligence and big data are used in maritime modelling.	10(5.3)	22(11.6)	57(30.2)	60(31.7)	40(21.2)	Agree
Marine robots are a relevant and useful technology for the sustainable use of ocean resources.	4(2.1)	10(5.3)	35(18.5)	80(42.3)	60(31.7)	Agree

Table 2 shows responses on knowledge of and utilisation of emerging technologies for the sustainable BE. It demonstrates that the majority of the respondents, 82(43.4%), agree that they know what the BE is. Highest distribution of the respondents, 75(39.7$) agree that they are familiar with remote sensing and satellite monitoring in maritime environments. The majority of the respondents, 69(36.5%), agree to understand how the maritime industry uses offshore renewable energy. The highest distribution of the respondents, 60(31.7%), neither agree nor disagree with making use of or participating in marine biotechnology projects. The majority of the respondents, 60(31.7%), agree that they are aware of how artificial intelligence and big data are used in maritime modelling. The majority of the respondents, 80(42.3%), agree that marine robots are a relevant and useful technology for ocean resources.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Education and Skill Development

Table 3 Showing responses on education and skill development of Emerging Technologies for sustainable BE [(N) = 189].

Variables	Frequency (F)	Percentage (%)
Which of the following abilities do you currently have?		
Marine Robotics	28	14.8
Big Data & Data Analytics	36	19.0
Artificial Intelligence for Ocean Modelling	24	12.7
Marine Ecology Planning for Climate	52	27.5
Resilience Conservation of Biodiversity	47	24.9
Understanding of International Maritime Law	33	17.5
None of the above	49	25.9
In the last five years, what training or educational opportunities have you taken advantage of?		
Multidisciplinary marine studies (such as marine science, policy, and technology)	54	28.6
Vocational training in marine-related fields	42	22.2
BE-related online or modular courses	61	32.3
Cooperative training initiatives with businesses and academic institutions	36	19.0
Conferences or seminars on cutting-edge ocean technologies	39	20.6
None of the above	59	31.2
Which of the following formats would best help you develop your abilities?		
Short-term vocational training	83	43.9
Online certificate programs	78	41.3
Fieldwork or industry internships	89	47.1
Graduate/postgraduate degree programs	46	24.3
Multidisciplinary workshops with global specialists	64	33.9

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Professional guidance from seasoned experts	57	30.2

Table 3 Shows responses on education and skill development of Emerging Technologies for sustainable BE. It demonstrates that most of the respondents, 49(25.9%) do not have any ability in Marine Robotics, Big Data & Data Analytics, Artificial Intelligence for Ocean Modelling, Marine Ecology Planning for Climate etc. Most of the respondents, 61(32.3%) have taken advantage in training or educational opportunities in the last years on BE-related online or modular courses. Most of the respondents, 89(47.1%) believe that Fieldwork or industry internships will best help in developing their abilities in emerging technologies in BE.

Cooperation and Institutional Support

Table 4 Showing responses on Cooperation and Institutional Support [(N) = 189].

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mode
Universities and industries in Nigeria's maritime sector work closely together.	36(19.0)	58(30.7)	48(25.4)	35(18.5)	12(6.3)	Disagree
The incorporation of new technologies into the BE is encouraged by government policies.	29(15.3)	62(32.8)	52(27.5)	33(17.5)	13(6.9)	Disagree
Planning and training for the BE actively involve community stakeholders.	21(15.3)	49(25.9)	60(31.7)	38(20.1)	21(11.1)	Neutral
To promote marine technology innovation in Nigeria, public-private partnerships are required.	6(3.2)	8(4.2)	22(11.6)	71(37.6)	82(43.4)	Strongly agree

Table 4 shows **r**esponses on Cooperation and Institutional Support. It demonstrates that most of the respondents, 58(30.7%) disagree that universities and industries in Nigeria's maritime sector work closely together in aspect of sustainable BE. Also, many of the respondents, 62(32.8%) disagree that the incorporation of new technologies into the BE is encouraged by government policies. Meanwhile, most of the respondents, 60(31.7%) neither agree nor disagree that planning and training for the BE actively involve community stakeholders. Lastly, the majority of the respondents, 82(43.4%) strongly agree that to promote marine technology innovation in Nigeria, public-private partnerships are required.

Table 5 Showing responses on education and skill development of Emerging Technologies for sustainable BE [(N) = 189].

Variables	Frequency (F)	Percentage (%)
Which parties ought to be most involved in advancing cutting-edge technologies in the BE?		
Universities	96	50.8
Research Institutions	110	58.2

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Private Technology Companies,	88	46.5
Non-Governmental Organisations (NGOs)	52	27.6
International Development Partners	77	40.6
Coastal Communities	63	33.4
The Federal Government, State or Local Governments	137	72.5

Table 5 shows responses on education and skill development of Emerging Technologies for sustainable BE. It demonstrates that the majority of the respondents, 137(72.5%) believe that the federal, state and local governments ought to be the most involved in advancing cutting-edge technologies in the BE.

Table 6 Showing responses on probable obstacles and recommendation on Emerging Technologies for sustainable BE [(N) = 189].

Variables	Frequency (F)	Percentage (%)
Which three obstacles stand in the way of integrating emerging technologies into Nigeria's BE?		
Poor infrastructure	122	64.5
Insufficiently skilled staff	116	61.5
Inadequate policy structure	103	54.4
Limited resources and investment	111	58.8
Low public participation or awareness	89	47.2
Stakeholders' poor cooperation	76	40.1
What ought to be given top priority in order to enhance skill development in this area?		
Centres for national marine training	102	
Government-funded educational initiatives	117	61.9
International exchange and fellowship initiatives	87	46.1
Secondary and postsecondary schools' marine curricula	78	41.3
Local content creation and e-learning platforms	94	49.7

Table 6 showing responses on probable obstacles and recommendation on Emerging Technologies for sustainable BE. It demonstrates that the majority of the 122(64.5%), 116(61.5%) and 111(58.8%) identified poor infrastructure, Insufficient skilled staff and limited investment and resources respectively as the obstacles standing in the way of integrating emerging technologies into Nigeria’s BE.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Data Analysis

Table 7 Showing descriptive statistics of knowledge of and utilisation of Emerging Technologies for sustainable BE

Category	Mean	S. D	Minimum	Maximum	Interpretation
Knowledge of what the BE is.	3.95	0.90	1	5	Indicates high level of knowledge.
Familiarity with remote sensing and satellite monitoring in maritime environments.	3.81	0.99	1	5	Indicates moderately high familiarity.
Understanding how the maritime industry uses offshore renewable energy.	3.72	0.98	1	5	Indicates there's common knowledge.
Use of or participated in marine biotechnology projects.	3.28	1.20	1	5	There is limited practical experience
Awareness of how artificial intelligence and big data are used in maritime modelling.	3.51	1.07	1	5	There is moderate knowledge of AI and Big data usage.
Relevance and usefulness Marine robots technology for the sustainable use of ocean resources.	3.95	0.90	1	5	There is strong acknowledgment of marine robotics.

S.D – Standard Deviation

Table 7 Descriptive statistics of knowledge of and utilisation of Emerging Technologies for sustainable BE. It demonstrates that there is high level of knowledge concerning what the BE is among the stakeholders. Also, there is moderately high familiarity with remote sensing and satellite monitoring in the maritime environments. There is common knowledge of how the maritime industry employs offshore renewable energy. There is limited practical experience in the aspect of marine biotechnology projects. There is moderate knowledge of AI and Big data usage in Maritime modelling. There is strong acknowledgment of relevance and usefulness of marine robotics for sustainability of ocean resources.

Table 8 Showing descriptive statistics for Cooperation and Institutional Support.

Category	Mean	S. D	Minimum	Maximum	Interpretation
Universities and industries in Nigeria's maritime sector work closely together.	2.61	1.16	1	5	There is no consistent collaboration. The existing one is weak.
The incorporation of new technologies into the BE is encouraged by government policies.	2.66	1.14	1	5	There is an inadequate policy support.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Planning and training for the BE actively involve community stakeholders.	2.93	1.16	1	5	There is a rather limited inclusion of the involved community stakeholders.
To promote marine technology innovation in Nigeria, public-private partnerships are required.	4.15	0.98	1	5	There is a strong agreement on this.

S.D – Standard Deviation

Table 8 shows the descriptive statistics for Cooperation and Institutional Support. It demonstrates that there is no consistent collaboration between Universities and Industries in Nigeria's maritime sector. Also, there is an inadequate policy support for the incorporation of BE technologies by government. There is a limited inclusion of the involved community stakeholders in planning and training on BE. There is strong agreement about the need for public-private partnership in the promotion of marine technology innovation in Nigeria.

Table 9 Showing descriptive statistics for the stated categories

Category	**Mean**	**S. D**	**Minimum**	**Maximum**	**Interpretation**
Skill development and Education	34	36.1	22	61	There are low levels of developed skills. Technical skill is more common in the aspect of ecology-based knowledge and far less in AI & Robotics.
Access to training	48.2	48	36	72	There is an inadequate training. Although, there is limited access to both modular and multidisciplinary studies.
Preferred training method	65.4	67	45	88	The preferred training are practical, applied learning such as vocational, internship and online format of learning.
Role of stakeholders	88.2	88	52	137	There is general agreement that the government must serve as the pivotal force. The universities and research institutes are to also have important roles to play.
Challenges	92.7	97	76	122	Infrastructure and limited workforce are considered key challenges.

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Recommendations	95.5	92	78	117	Investment from government and construction of national training centers are identified as priorities.

S.D – Standard Deviation

Table 9 shows the descriptive statistics for the stated categories. It demonstrates that there are low levels of developed skills. The technical skill is more common in the aspect of ecology-based knowledge and far less in AI & Robotics. There is an inadequate training. Although, there is limited access to both modular and multidisciplinary studies. The preferred training is practical, applied learning such as vocational, internship and online format of learning. There is general agreement that the government must serve as the pivotal force. The universities and research institutes are to also have important roles to play. Infrastructure and limited workforce are considered key challenges. Investment from government and construction of national training centres are identified as priorities.

RESULT DISCUSSION

The study revealed that there is high knowledge among stakeholders on emerging BE technologies; Stakeholders are moderately familiar with remote sensing and satellite monitoring and there's common knowledge about the utilisation of offshore renewable energy. However, there is dearth of studies to backup these findings. Offshore wind and wave energy projects have a lot of promise in coastal locations, which fits nicely with the worldwide trend towards renewable energy and can help meet sustainable energy goals (Elegbede et al., 2023).

The present study also revealed that there is limited practical experience on marine biotechnology utilisation. According to Elegbede et al. (2023), the use of marine biotechnology in Nigeria is still relatively new. However, it has the potential to contribute significantly to the economy (Federal Ministry of Science and Technology, 2020). Research and development finance, inadequate infrastructure, and a lack of investment are some of the challenges facing the sector (Federal Ministry of Science and Technology, 2020). However, there is room for sustainable growth via the use of new technology, sustainable practices, and the development of new marine-based products and services (Federal Ministry of Science and Technology, 2020).

The present study also revealed that there is moderate knowledge of AI and Big data usage. The potential of artificial intelligence to improve risk management engineering was highly supported by Ajibade et al. (2025). Subsequent investigation revealed that artificial intelligence significantly improved risk management results. Additionally, risk-related workflows like internal audits, insurance claims, and regulatory reporting may be streamlined by AI-powered robotic process automation (RPA), which lowers the possibility of human mistake and delays (Ibrahim et al., 2023). The present study also revealed that there is strong acknowledgment of marine robotics. However, another crucial distinction of the BE is its emphasis on the necessity of stakeholder participation and collaboration in the sustainable management of ocean resources. The present study found no consistent collaboration between tertiary institutions and Nigeria maritime sector. Furthermore, because the BE is a global issue that affects all countries and regions, its sustainable growth necessitates international cooperation and collaboration (Elegbede et al, 2023). All parties involved—governments, businesses, civil society, and local communities—should be required to participate.

The present study also revealed that there is inadequate policy support. This result is consistent with that of Nweke and Dhakir (2025), who found that the BE in Nigeria is still relatively young and does not have sufficient regulatory and policy frameworks. The potential of the BE is limited in the absence of strong rules and strategic policy frameworks, which are necessary to protect marine ecosystems and promote sustainable development (Otuya-Asohro, 2024). The present study revealed that there is rather limited inclusion of the involved community stakeholders. This is in line with this finding, Esin et al. (2024), BE ideas are not yet influenced by local development goals or explicitly in line with Agenda 2030. Fudge et al (2023) revealed that community's interest and relationship experience with marine environment is more essential than material aspect. Coastal

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

towns also confront the obstacles associated with a BE, thus their perspectives can enhance the general strategies used to ensure a sustainable BE, even though jobs can be produced for areas around a BE.

The present study revealed there is need for private partnership on marine technology innovation. similarly, (Ibrahim, 2018) revealed that partnerships with international organisations and surrounding nations may open up important finance, technical know-how, wider market access, support innovation, foster economic growth, and advance sustainable development in marine businesses, guaranteeing the BE's long-term viability. The present study also revealed there are low levels of developed skills. Technical skill is more common in the aspect of ecology-based knowledge and far less in AI & Robotics. This is not consistent with Nweke and Dhakir (2025), who claim that the successful growth of important marine businesses like shipbuilding, offshore energy, and sustainable fishing is significantly hampered by a shortage of competent workers. These sectors' capacity to create jobs, encourage innovation, and support the expansion of Nigeria's BE is diminished in the lack of a skilled labour force, which also limits their development and productivity (Bayode, 2024).

It also revealed that there is an inadequate training. Although, there is limited access to both modular and multidisciplinary studies. This conclusion is supported by research by Mkpandiok and Ukpai (2017), which showed that academic staff and cadets/students are unaware of the SDGs and that the curriculum for maritime education and training is still not fully in accordance with them. Generally, the present study revealed the preferred training is practical, applied learning such as vocational, internship and online format of learning. Additionally, BE curricula should be institutionalized across tertiary institutions, and support provided for community-based data collection and documentation of traditional ecological knowledge. There is general agreement that the government must serve as the pivotal force. The universities and research institutes are to also have important roles to play. Infrastructure and limited workforce are considered key challenges. Likewise, Tonye (2025) pointed out that one of the main obstacles is the absence of a strong operational infrastructure. A safe maritime environment is necessary to combat factors like armed piracy, oil theft, infrastructure vandalism, illicit fishing, and aqua cultural activities that deter investment and undermine the BE. More so, investment from government and construction of national training centers are identified as priorities.

Further studies

Further studies should be conducted to identify the level of knowledge among stakeholders of BE in Nigeria; Stakeholders familiarity with remote sensing and satellite monitoring and utilisation of offshore renewable energy.

CONCLUSION AND RECOMMENDATIONS

A safe maritime environment is necessary to combat factors such as armed piracy, oil theft, infrastructure vandalism, illicit fishing, and aquaculture activities that deter investment and undermine the BE. Moreover, government investment and the construction of national training centres are identified as priorities.

Practical training should be provided to relevant stakeholders in marine robotics, data analytics, AI for ocean modelling, and marine ecology. A government-funded educational initiative is relevant to providing stakeholders with opportunities to improve their skills and contribute to achieving a sustainable Blue Economy in Nigeria.

REFERENCES

1. Aantjes, C. J., Burrows, D. and Armstrong, R. (2022). Capacity development in pursuit of social change:
2. Ajibade, A.T., Akintoye, I.R. and Ajah, C.C. (2025). Artificial Intelligence on Risk Management Engineering in Non-financial Service Companies Listed in Nigeria. International Journal of Economics, Business and Management Research, 9 (05) https://doi.org/10.51505/IJEBMR.2025.9531
3. Barkai, A. and Lallemand, P. (2014). E-logbook Technology Development in South Africa. Marine and Maritime Sectors, in: Funke, N., Claassen, M., Meissner, R., & Nortje, K. (Ed.). Reflections on the state of research and technology in South Africa's marine and maritime sectors. The Council for Scientific and

ISSN 2278-2540 | DOI: 10.51583/IJLTEMAS | Volume XIV, Issue XII, December 2025

Industrial Research. Pretoria, SouthAfrica: The Council for Scientific and Industrial Research Pretoria, South Africa.
4. Burgess, M. G., Clemence, M., McDermott, G.R., Costello, C. and Gaines, S. D. (2018). Five rules for pragmatic blue growth. Marine Policy, 87,331-339.
5. Elegbede, I. O., Akintola, S. L., Jimoh, A. A. A., Jolaosho, T. L., Smith-Godfrey, S., Oliveira, A. and Oloko, A. (2023). BE (sustainability). In Encyclopaedia of Sustainable Management (pp. 1-9). Cham: Springer International Publishing.
6. Elisha, O. (2019) The Nigeria BE: Prospects for Economic Growth and Challenges. International Journal of Scientific Research in Education, 7(8), 657.
7. Gbadegesin, O.A. and Akintola, S. (2021) 'Charting the Course for a BE in Nigeria: A Legal Agenda' 001. Journal of Environmental Law and Policy, 6-25. https://doi.org/10.33002/jelp001.01
8. Ibrahim, H. D. (2018). Harnessing the potentials of BE for sustainable development of Nigeria.
9. Kenya Vision 2030. (2018). Kenya Vision 2030: Third Medium Term Plan 2018-2022. https://vision2030.go.ke
10. Martínez-Vazquez, R. M., Milan-Garcia, J. and De Pablo V., J. (2021). Challenges of the BE: Evidence and research trends. Environ Science Europe, 33, 61.
11. Melo, G., Nascimento, N., Alencar, P. and Cowan, D. (2022). Understanding Levels of Automation in Human-Machine Collaboration. In 2022 IEEE International Conference on Big Data (Big Data) (pp. 3952-3958). IEEE.
12. Mkpandiok, A. and Ukpai, U. (2017). Managing Maritime Education and Training for the attainment of Sustainable Development Goals in Nigeria, World Educators Forum, 9 (1).
13. Michael, H. and Morgan, P.J. (2022). Overview of BE and blue finance: Toward sustainable development and ocean governance. Asian Development Bank Institute, 1-7.
14. Nabi, K. and Hayat, M. (2025). Blueprint for a Sustainable BE: Challenges, Opportunities, and Policy Pathways, Jurnal Ilmu Ekonomi dan Pembangunan. 2548 – 1851. 25 (1), 50-66. https://doi.org/10.20961/jiep.v25i1.99750
15. Narwal, S., Kaur, M., Yadav, D. and Bast, F. (2024). Sustainable BE: Opportunities and challenges. Journal of Bioscience, 49 (1), 18.
16. National Academies of Sciences, Engineering, and Medicine. (2020). The Role of Research and Technology in the Changing Ocean Economy: Proceeding of a Workshop. Washington, DC: The National Academies Press.https://doi.org/10.17226/25810.
17. Patrick, K., Pierre, F., Asmerom, M. G., Martin, N. and Serigne, T.D. (2022). Africa BE strategies integrated in planning to achieve sustainable development at national and regional economic communities (RECs). Journal of Sustainability Research, 4(3),2-34
18. Rotter, A., Gaudencio, S.P., Dubnika, A. and Vasquez, M.I. (2022). Editorial: Marine Biotechnology, Revealing an Ocean of Opportunities. Front. Mar. Sci. 9:887630. https://doi: 10.3389/fmars.2022.887630