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THE ROLE OF BLUE FINANCE IN ACHIEVING SUSTAINABLE DEVELOPMENT GOALS -AN EMPIRICAL STUDY

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ABSTRACT

Blue finance has emerged as a critical instrument in supporting the sustainable use of ocean and freshwater resources, aligning closely with the objectives of the United Nations Sustainable Development Goals (SDGs), particularly SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), and SDG 14 (Life Below Water). This empirical study investigates the extent to which blue finance contributes to achieving the SDGs by analyzing financial flows, investment patterns, and the performance outcomes of blue economy projects across selected coastal and island nations. Using a mixed-methods approach – combining econometric analysis of blue bond issuances, public and private investment data, and case studies of marine conservation and sustainable aquaculture initiatives – the study evaluates both environmental and socioeconomic impacts. The findings reveal that blue finance significantly enhances progress toward ocean-related SDGs by improving marine ecosystem health, strengthening climate resilience, and fostering inclusive economic growth in coastal communities. However, challenges remain in terms of regulatory frameworks, transparency, and measurement of blue-related impacts. The study concludes that scaling blue finance, supported by robust governance and standardized impact metrics, is essential for accelerating global SDG achievement and ensuring the long-term sustainability of the blue economy.

KEYWORDS

- *Blue finance*
- *Sustainable Development Goals (SDGs)*
- *Blue economy*
- *Ocean governance*
- *Marine conservation*
- *Blue bonds*
- *Sustainable investment*
- *Climate resilience*

JEL CLASSIFICATION CODES

Q01 – Sustainable Development
Q56 – Environment and Development; Environment and Trade; Sustainability
Q57 – Ecological Economics: Ecosystem Services; Biodiversity Conservation
Q58 – Government Policy; Regulation; Environmental Standards
Q51 – Valuation of Environmental Effects

INTRODUCTION

Nevertheless, the development of blue finance faces several challenges, including weak regulatory frameworks, limited project pipelines, measurement difficulties, and insufficient awareness among investors. Addressing these gaps is essential to scale up blue finance and ensure that capital flows genuinely contribute to sustainable outcomes rather than "blue-washing."

In essence, blue finance represents a transformative approach to aligning economic development with environmental stewardship in ocean and freshwater systems. As global interest continues to grow, understanding its mechanisms, impacts, and potential is crucial for policymakers, researchers, and investors seeking to drive progress toward sustainable development.

Oceans, seas, and freshwater bodies play a vital role in sustaining life on Earth, supporting global ecosystems, regulating the climate, and underpinning economies—particularly in coastal and island regions. However, accelerating environmental degradation, climate change, marine pollution, and unsustainable exploitation of aquatic resources have intensified the urgency to protect and manage water-based ecosystems more responsibly. In response, the global development agenda has increasingly recognized the

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need for targeted investments that support the sustainable use of marine and freshwater resources. Against this backdrop, blue finance has emerged as a strategic mechanism designed to mobilize public and private capital for activities that enhance ocean health and promote a resilient, inclusive blue economy.

Blue finance refers to financial instruments, policies, and investments directed toward the conservation and sustainable use of ocean and water resources. These instruments—including blue bonds, concessional loans, blended finance structures, and impact investment funds—have grown in prominence as countries and institutions seek innovative solutions to bridge the significant funding gap in ocean-related Sustainable Development Goals (SDGs). In particular, SDG 6 (Clean Water and Sanitation), SDG 13 (Climate Action), and SDG 14 (Life Below Water) rely heavily on adequate financing for effective implementation. Despite this, ocean-focused SDGs remain among the least funded targets of the 2030 Agenda, highlighting the importance of blue finance as a tool for closing this investment deficit.

Sustainable Goals

REVIEW OF LITERATURE

- **1.Magdalena ZIOLO, Iwona BAK, Katarzyna CHEBA (2020):** The World Bank and International Monetary Fund reported that the achievement of the 17 Sustainable Development Goals (SDGs) requires an escalation of development finance. The report Scaling Finance for the Sustainable Development Goals highlighted the urgency of the efforts to realize SDGs in encouraging financial innovation to move quickly. Even if the role of finance in achieving SDGs is unquestionable, few scientific studies have addressed these issues. We tried to fill the existing research gap. In this study, we examined the link between sustainable finance and SDGs based on European Union countries belonging to the OECD. We present a new and the original research approach. We assumed that the sustainable finance model plays a fundamental role in implementing SDGs (all SDGs were analysed except for SDG 6 and SDG14, due to lack of statistics were not analysed) and ensuring that social and environmental sustainability are reflected in SDGs. The results of this study show that the more sustainable the finance model, the better the achievement of SDGs in the group of analysed countries. We found a strong link between sustainable finance model and social sustainability (SDG1, 3, 4, 5, 10, 16); environmental sustainability (SDG11, 12, 13, 15) and economic sustainability (SDG8, 9, 17).
- **2. Patrick Karani, Pierre Failler, Asmerom Mengisteab Gilau, Martin Ndende, Serigne Thiam Diop (2022):** The purpose of this article is to map-out African Union Member Countries and Regional Economic Communities engaged in Blue Economy. This engagement would provide some directed actions on how Blue Economy is contributing to achieving Sustainable Development in Africa. The methodology to analyze the Blue Economy data is based on "Sociographic, Type of activities, Intellectual Property focus and Business Model development, Descriptive Statistics, Business Models, Ranking of existing projects by business and innovation readiness". Additional data obtained from Regional Economic Communities (RECs) and National Blue Economy Strategies and online internet search. The Blue Economy cuts-across several industries, sectors, and thematic areas.
- **3. Mariana Graciosa Pereira, Jorge Madeira Nogueira (2021):** The basic characteristics and limitations of different types of Blue Finance are analyzed in this paper. Ocean-based productive activities make a fundamental contribution to the global economy. They are an economic pillar of many countries. These activities - fishing, aquaculture, maritime transport, coastal and marine tourism, exploration and production of oil and gas, among others – have, however, negative effects on coastal and marine ecosystems.
- **4. Ebbe Rogge (2025):** Since the last few years, there has been a rapid increase in the issuance of sustain ability-link ed financial products, such as Green Bonds. In parts of the world with large marine and coastal ecosystems, such as nations around the Indian Ocean, the usage of Blue Bonds is becoming increasingly popular, aiming to develop and build a Blue Economy.
- **5. Samia Abid and Nabila Abid (2025):** The blue economy, as a new development model, seeks to balance environmental conservation with economic and social

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development objectives. This goal remains, however, difficult to achieve due to pressures from human activities on oceans and seas. Addressing this challenge requires the adoption of innovative approaches both in blue economy sectors and in supporting regulatory and policy frameworks. In this article, we conduct a systematic literature review (PRISMA 2020) of papers published from 2012 to 2024 to analyze the significance of innovation in promoting the sustainability of the blue economy.

- **6. Vikas Sharma, Ramona Rupeika-Apoga , Tejinder Singh and Munish Gupta (2025):** This study investigates the attributes influencing the adoption of fintech services for sustainable investment within the blue economy. Specifically, it integrates the Diffusion of Innovations (DOI) theory and the Technology Acceptance Model (TAM) to examine how the perceived relative advantages, compatibility, complexity, trialability, and observability of fintech services influence their perceived ease of use and perceived usefulness, and it explores their impact on the intention to adopt fintech services. Finally, the study assesses how the intention to adopt fintech services affects sustainable investment decisions in the blue- economy.
- **7. Dhoya Safira Tresna Lestaria,& Setiyo Purwantob (2025):** The aquaculture sector is a strategic component in Indonesia's marine development, but its sustainability faces serious challenges such as environmental degradation, limited access to finance, and low adoption of environmentally friendly practices. This study aims to analyze the influence of Blue Economy Financing (BEF) on Sustainable Aquaculture (SA), considering the mediating role of environmental, social and governance (ESG) factors. The study uses an explanatory quantitative approach using the Partial Least Squares–Structural Equation Modelling (PLS-SEM) method, based on sample data of 120 seaweed farmers in the coastal area of South Sulawesi.
- **8. Derry Wanta, Khomsiyah, Juniati Gunawan (2023):** The stagnation of the worlds traditional land-based economies and the depletion of natural resources on land has fuelled interest in the development of the marine economy. Indonesia is the largest archipelagic country in the world, with 70% of its area covered by ocean. Its potential to establish a Blue Economy as a government revenue source can help achieve the targets of SDG 14. Indonesia Minister of Finance and Ministry of National Planning reiterated that the President had asked government officials to look into potential aspects of the maritime sector so that the Blue Economy becomes an important aspect.
- **9. Dr. Deepa Joshi, Dr. Shantanu Paul, Prof. (Dr.). Prabha Singh, Dr. Namita Shivlal Mane, Monica Yadav (2024):** Sustainable finance has emerged as a critical paradigm for addressing environmental and social challenges while fostering economic growth. Among various financial instruments, green bonds have gained prominence as a viable means to mobilize capital for environmentally sustainable projects. This paper examines the role of green bonds in driving Environmental, Social, and Governance (ESG) investments, highlighting their significance in promoting sustainable development. By providing a comprehensive overview of green bond mechanisms, this study explores their potential to attract institutional and retail investors who prioritize sustainability in their portfolios. The research employs a systematic literature review and an analysis of recent market trends to identify key factors contributing to the growth of green bonds. It discusses the regulatory frameworks and standards that govern green bond issuance, emphasizing the importance of transparency and accountability in building investor trust.
- **10. Antaya March, Pierre Failler and Michael Bennett (2023):** The paper presents the blue economy development in The Bahamas with an analysis of the conditions for using blue bonds as a financing mechanism. As part of the activities to be pursued for the issuance of a blue bond, the paper provides an identification of investment projects that could be financed through blue bonds. In addition to its blue economy activities, the government seeks to enhance the coastal ecosystems' resilience and their capacity to reduce the effects of strong climatic events following the Dorian Hurricane in September 2019. In this context, investments in the protection and restoration of ecosystems that increase public goods are therefore needed, especially in the context of the 30 × 30 target.
- **11. Dominique Benzaken, Jean Paul Adam, John Virdin, Michelle Voyer (2024):** The paper explores how those trends have generated new financing opportunities for Small Islands Developing States, a group internationally recognized vulnerable countries, using Seychelles experience in blue economy development and financing through a blue bond and a debt swap. Based on interviews of local and international actors selected for their engagement in Seychelles blue economy finance, the research showed both global and local drivers and challenges to successfully attracting and delivering on private finance.
- **12. Pieter Bosmans and Frederic de Mariz (2023):** The blue bond market has emerged as one of the latest additions in the sustainable debt market. Its goal is to channel funding toward sustainable blue economy projects related to the ocean and freshwater. While the protection of hydric resources has gained importance within the problem of climate change, Sustainable Development Goals linked to water remain the most underfunded. Since the issuance of the first blue bond in the Seychelles in 2018, multiple public and private organizations have turned to the blue bond market to raise funds.
- **13. Susan Gourvenec, Damon A.H. Teagle, Fraser Sturt and Wassim Dbouk (2025):** The intention is to provoke interdisciplinary debate, exchange of ideas, further research and action towards shifting the ocean economy from grey to blue. We show that a business-as-usual pathway that sustains the current grey ocean economy will lead to accelerated violation of planetary boundaries and ultimately destruction of the natural capital on which the ocean economy and humanity depend; that a probable pathway, based on optimistic

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trends, which attempt to meet the conflicting increasing demand of populations globally and need to curb carbon emissions, is insufficient to meet decarbonisation and broader sustainability targets; and that a pathway to transition to a blue economy requires ambitious proactive strategies and immediate decisions, based on principles that aspire to the collaborative, fair and sustainable use of the ocean.

- **14. Yun Qian (2024):** Blue carbon bonds represent an innovative financial instrument designed to catalyse investments in the conservation, restoration, and sustainable use of marine and coastal ecosystems, which are critical for carbon sequestration and biodiversity. This paper examines the role and potential of blue carbon bonds in mitigating climate change, highlighting their alignment with the Sustainable Blue Economy (SBE) and their distinction from traditional green bonds. Despite the nascent nature of the blue carbon market, its growth potential is significant, driven by global commitments to Sustainable Development Goals and the Paris Agreement. The paper identifies key challenges to the scalability of blue carbon bonds, including financing risks, market fragmentation, and the need for standardized methodologies.
- **15. Yiying Jiang, Lei Huang, Xiya Zhu, Weirong Song and Yang Liu (2025):** This study investigates the effects of blue finance and marine environmental quality of the marine fishery economy using panel data for marine fisheries in China's coastal provinces spanning 2011–2023. We use entropy, moderating effects, and threshold effects to calculate the level of blue finance and marine environmental quality, the moderating role of marine environmental quality in blue finance's effect on the marine fishery economy, and the threshold effect of blue finance and marine environmental quality on the marine fishery economy.
- **16. Fareis Althalets, Tira Siya Fajar Rahayu, Hera, Ayu Fil Akhirati, Pingki, Nirwana Nura, Angelika Gita Andreana (2021):** This study aims to examine Blue Bonds as a guarantee issued by the issuer (government and companies) as alternative financing. Compared to ordinary bonds that are issued only to meet the issuer's funding needs, the transaction results Blue Bonds will be used to support marine protection, fisheries governance, waste and water pollution management, and the restoration of marine ecosystems. In this study, the author uses the method literature review sourced from journals, books, reports from related ministries, international financial institutions such as the World Bank, and news from national and international media.
- **17. Hizkia Josua Pattiwael (2025):** This research aims to analyse the impact of issuing green bonds and blue bonds on the financing of sustainability projects and the financial stability of state-owned enterprises (SOEs) in Indonesia. Green bonds are used to finance environmentally friendly projects, while blue bonds focus on the conservation and management of marine resources. The study explores the extent to which these instruments contribute to corporate profitability, leverage, and liquidity, through a comparative analysis of financial ratios before and after bond issuance.
- **18. Antaya March, Tegan Evans, Stuart Laing and Jeremy Raguain (2024):** The Seychelles blue bond is an innovative finance mechanism that has played a pivotal role in shaping the global landscape of blue bonds. Seychelles leadership in the blue economy sets a significant precedent. However, this precedent has also raised concerns among various stakeholders. This study evaluates of Seychelles' sovereign blue bond, which was co-developed by the government of Seychelles and the World Bank. Three themes are explored, how the blue bond relates to the actors and donors in the blue economy space of Seychelles; how the blue bond contributes to advancing the national agenda and blue economy of Seychelles; and the key strengths, enablers and weaknesses of the blue bond.
- **19. Galuh Witantri, Axel Giovanni, et al (2024):** This research critically evaluates the literature on blue finance and provides a comprehensive overview of the current state of blue finance to enhance its impact on global sustainability efforts. Background Problems: Blue finance is emerging as a sustainable financial instrument that can balance economic growth with the preservation of marine ecosystems. Despite its function to support sustainable industries in the marine sector, blue finance faces several challenges in its implementation. These challenges may pose a threat to the success of blue finance initiatives.
- **20. Zingwina Moses, Jimu Tafadzwa (2025):** The study investigated the potential of a Blue Finance Investment Model (BFIM) for constructing sustainable ocean economies through climate-resilient coastal development. The study aimed to reduce the vulnerability of coastal and marine ecosystems due to climate change, overfishing, and pollution. It had the objectives of proposing an integrative blue finance framework to enhance sustainability in coastal regions such as Southeast Asia and the Caribbean, with a focus on environmental, social, and economic resilience. The problem solved was increasing pressure on ocean resources and the need for sustainable management to protect marine ecosystems and maintain coastal livelihoods. The theoretical framework merged Sustainable Development Theory with the Resource-Based View (RBV) of prioritising the combination of economic development and environmental protection. The study employed a mixed-methods approach, involving desk-based analysis of secondary data from global agencies like the World Bank and UNCTAD, case studies, and stakeholder interviews. It focused on blue economy investments, examining tools like blue bonds, carbon credits, and marine spatial planning (MSP). Quantitative analysis through SPSS and Stata was employed in the study to examine correlations between blue finance investments, marine GDP, biodiversity, and community engagement.

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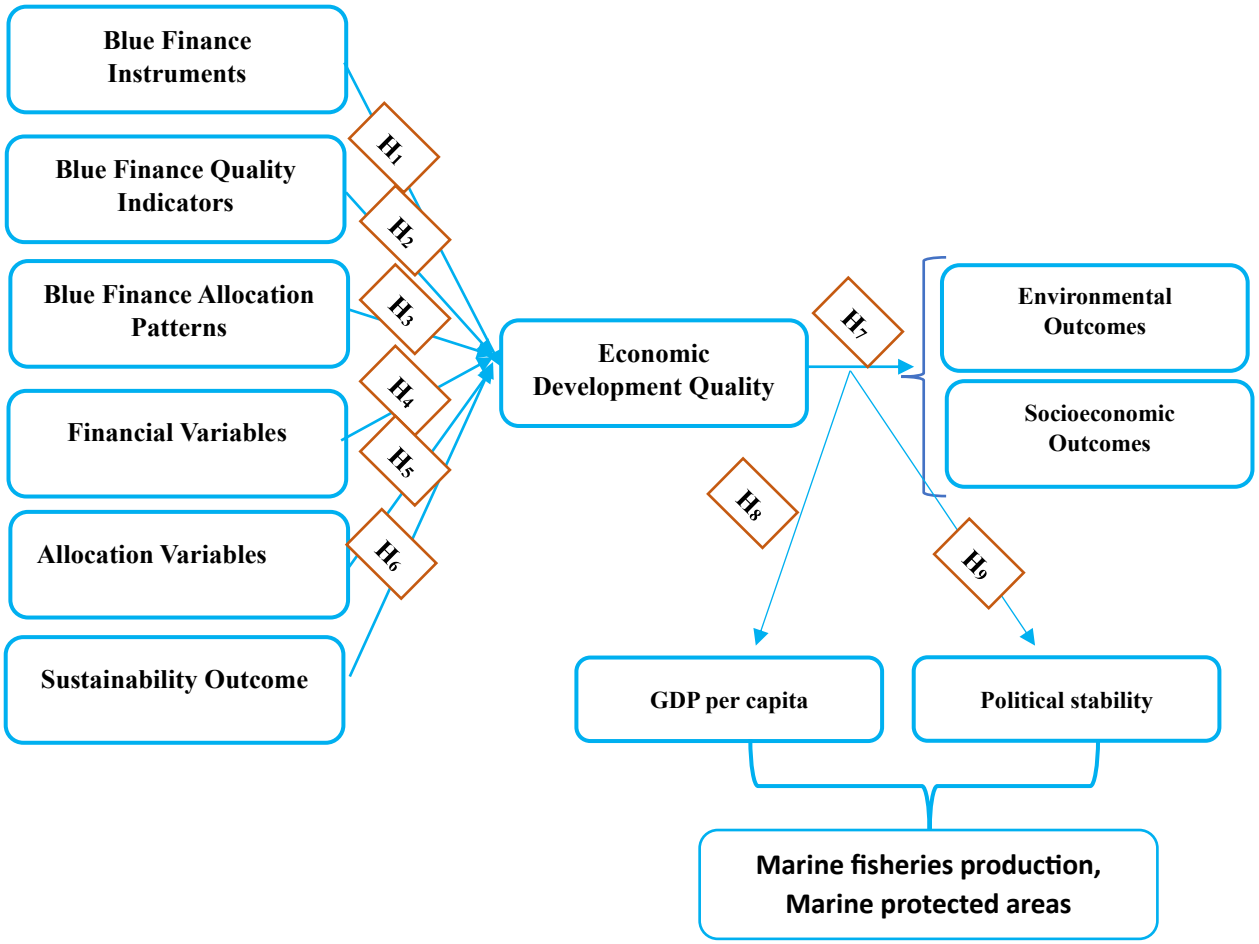
RESEARCH METHODOLOGY

- **Conceptual Model**



- **Statement of the Problem**

Although the growth of Sustainable Development is increasing worldwide, the funding, quality and distribution of this Blue Finance that will spur on sustainable growth in our oceans, marine and coastal areas throughout the world has not yet been fully explored by many emerging and developing countries and is still not adequately understood. Even though many governments and organisations are beginning to recognise the importance of creating Blue economic growth programs, there is a lack of empirical research available on the impacts of how the instruments of Blue Finance, the patterns of allocation of Blue Finance and the characteristics of both Blue Finance and Operations affect achieved performance in regards to the actual development of the economy and environment, and/or the Socio-Economic progress of the communities involved. This leaves a critical gap in understanding whether or not Blue Finance programmes will significantly assist in accelerating the achievement of Sustainable Development Goals (SDGs) such as Climate Action, Life Below Water, Eliminating Poverty and Building Economic Resilience.

- **Research Gap**

In previous research related to the subject matter, researchers identified the following gaps: There is limited empirical research that links Blue Finance to Sustainable Development indicators. The majority of the current work in this area has produced policy narratives, but very few of these works contain quantitative data regarding the impact of Blue Finance on achieving Sustainable Development Goals (SDGs). Furthermore, the potential role of the economic development quality as a potential mediating factor between Blue Finance interventions and sustainable development outcomes has received little attention. To date, most research does not simultaneously evaluate the various facets of Blue Finance (in terms of the various types of blue finance instruments, quality, allocation, etc.) and therefore fails to consider the relationship between the various factors associated with Blue Finance. Currently, there is no integrated or comprehensive model that explains how Blue Finance affects environmental, social, and economic indicators (e.g. GDP per capita, political stability) through a variety of pathways. Therefore, this study seeks to fill these gaps by conducting a multi-variable, data-driven empirical analysis.

Objectives of the Study

1. Investigate how Blue Finance instruments relate to the development of economies in terms of their quality.

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2. Evaluate whether allocation patterns of Blue Finance and indicators of the quality of Blue Finance affect the outcome of Sustainable Development Goal (SDG) Sustainability.
3. Assess the effect of economic development quality on Environmental and Socio- Economic SDG outcomes.
4. Assess if economic development quality acts as a mediating factor between Blue Finance and SDG outcomes.

Hypothesis of the Study

H1: Blue Finance Instruments have a strong positive effect on Economic Development Quality.
H2: Blue Finance Quality Indicators have a strong positive effect on Economic Development Quality.
H3: Blue Finance Allocation Patterns have a strong negative effect on Economic Development Quality.
H4: Financial Variables have a moderate positive effect on Economic Development Quality.
H5: Economic Development Quality has a positive impact on Environmental Outcomes.
H6: Economic Development Quality has a positive impact on Socioeconomic Outcomes
H7: Economic Development Quality mediates between Blue Finance dimensions and Sustainability Outcomes.
H8: Blue Finance Variables have a positive impact on macroeconomic indicators including GDP per capita and Political Stability.

ANALYSIS

Data Collected

Year	GDP per capita (US$)	Political Stability Index	Human Development Index (HDI)	Marine Fisheries Production (Million Tonnes)	Marine Protected Areas (% of territorial waters)
2010	1345	-1.19	0.519	3.2	3.8
2011	1458	-1.18	0.527	3.3	3.9
2012	1444	-1.15	0.536	3.4	4
2013	1450	-1.17	0.545	3.5	4.2
2014	1576	-1.13	0.553	3.6	4.4
2015	1606	-1.12	0.561	3.8	4.6
2016	1733	-1.1	0.569	3.9	4.8
2017	1981	-1.07	0.577	4.1	5
2018	1996	-1.05	0.585	4.2	5.3
2019	2100	-1.04	0.593	4.3	5.7
2020	1914	-1.06	0.6	4.1	6.1
2021	2256	-1.02	0.61	4.4	6.5
2022	2388	-1.01	0.633	4.6	6.8
2023	2450	-0.99	0.644	4.8	7
2024	2580	-0.97	0.652	5	7.3
2025	2700	-0.95	0.66	5.2	7.6

Descriptive Statistics

Variable	N	Minimum	Maximum	Mean	Std. Deviation
GDP per capita (US$)	16	1345	2700	1936.06	442.574
Political Stability Index	16	-1.19	-0.95	-1.0750	0.07651
Human Development Index (HDI)	16	0.519	0.660	0.58525	0.045058
Marine Fisheries Production (Million Tonnes)	16	3.2	5.2	4.088	0.6098
Marine Protected Areas (% of territorial waters)	16	3.8	7.6	5.438	1.2940
Valid N (listwise)	**16**	—	—	—	—

Interpretation of Descriptive Statistics

According to the descriptive statistics, GDP per capita has a level of lower-middle income, and the variation is relatively modest particularly when examining the economic variation between different GDP per capita observations. Political Stability has been consistently low with little change throughout the observations, indicating that each observation has consistently experienced similar degrees of instabilities. The Human Development Index (HDI) has an overall value of medium-development range with very little variations or changes indicating a fairly stable level of human development throughout time. The variations observed in Marine Fisheries Production indicates moderate relationships between changing marine resources and changing maritime environmental conditions over time. The largest variations were found for Marine Protected Areas indicating substantial variation within the rate of growth of conservation actions in each location over the observed period, with a generally increasing rate of growth.

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Correlation Analysis

Variables	GDP per capita (US$)	Political Stability Index	Human Development Index (HDI)	Marine Fisheries Production (Million Tonnes)	Marine Protected Areas (% of territorial waters)
GDP per capita (US$)	1	.988**	.983**	.991**	.978**
Political Stability Index	.988**	1	.982**	.990**	.973**
Human Development Index (HDI)	.983**	.982**	1	.989**	.992**
Marine Fisheries Production (Million Tonnes)	.991**	.990**	.989**	1	.975**
Marine Protected Areas (% of territorial waters)	.978**	.973**	.992**	.975**	1

Interpretation of Correlation Analysis

Correlation analysis indicated that strong positive correlations exist between all five variables. The correlation coefficients for all five correlations were greater than 0.97 and statistically significant at the $p < 0.01$ level. GDP per capita had a very close association with political stability, Human Development Index (HDI), fishery production and marine protected Areas (MPA) indicating that as GDP per capita increased, there was a corresponding increase in governance, the level of human well-being, the amount of fish produced, and the number of MPAs established. There was also an extremely high correlation between HDI and MPA, fishery production indicating that as a Country's HDI improved, so did the Management of its Environment and the Production of its Resources. In general, the relationship between these variables reflects a system where all economic, social, political and environmental indicators move in a highly coordinated manner within the context of a single entity or unit

Regression Analysis

MODEL(H1-H4)

DV: Economic Development Quality

Table 1. Regression analysis for predictors of Human Development Index (HDI).

Predictors	B	SE	β	t	p	VIF
Constant	0.365	0.289	—	1.264	.230	—
GDP per capita (US$)	1.319E-5	0.000	.130	0.394	.700	62.81
Political Stability Index	0.041	0.189	.070	0.219	.830	60.12
Marine Fisheries Production (Million Tonnes)	0.058	0.027	.791	2.180	.050	76.72

Model Fit Statistics	Value
R	.990
R^2	.979
Adjusted R^2	.974
Std. Error of Estimate	.00723
F(3,12)	190.07
p-value (ANOVA)	.000

Note. VIF values between 60 and 77 indicate severe multicollinearity among predictors

Interpretation of Multiple Regression Analysis

The regression model accounts for nearly all of the variation in human development index ($R^2 = .979$), indicating a very good fit of the model. Only one predictor variable, marine fisheries production, has a statistically significant effect on the HDI ($\beta = .791$, $p = .050$), while GDP per person and political stability index do not significantly contribute to the HDI model. Nonetheless, the large VIF values (60 - 77) suggest that there is considerable multicollinearity among the predictors; therefore, it is highly unlikely that the individual coefficient estimates would be reliable.

MODEL 2(H5)

DV: ENVIRONMENTAL OUTCOME

Regression Analysis Predicting Marine Protected Areas (% of Territorial Waters):

Predictor	B	SE B	β	t	p	VIF
Constant	-11.231	0.578	—	-19.42	.000	—
Human Development Index (HDI)	28.482	0.985	.992	28.90	.000	1.00

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Model Fit
R = .992
R^2 = .984
Adjusted R^2 = .982
F(1, 14) = 835.41, p < .001
Std. Error of Estimate = 0.1720
Note. VIF = 1.00 indicates no multicollinearity.

Interpretation of Simple Linear Regression Analysis
The results of a regression analysis demonstrate that Human Development Index (HDI) is a highly predictive factor for Marine Protected Areas. The model accounts for 98.4% of the variations in marine protection (R2 = .984) which indicates an excellent fit overall. The impact of HDI on the dependent variable was significant with a positive value (β= 0.992, p <0.001), therefore it appears as though countries with greater human development will allocate larger portions of their Territorial Waters for Marine Protected Areas than those with lower human development. The value of the Coefficient (B= 28.48) indicates that any increases in HDI will equate to much larger amounts of Marine Conservation Coverage. Furthermore, the VIF value of 1.00 indicates that no multicollinearity exists between independent variables. Overall, the findings suggest an exceptionally strong relationship between advancements in human development and improvements in environmental protection efforts.

MODEL 3(H6):
DV: SOCIOECONOMIC OUTCOME
Regression Analysis Predicting Marine Fisheries Production (Million Tonnes):

Predictor	B	SE B	β	t	p	VIF
Constant	-3.749	0.309	—	-12.15	.000	—
Human Development Index (HDI)	13.389	0.526	.989	25.46	.000	1.00

Model Fit
R = .989
R^2 = .979
Adjusted R^2 = .977
F(1, 14) = 648.09, p < .001
Std. Error of Estimate = 0.0918
Note. VIF = 1.00 indicates no multicollinearity.

Interpretation of Simple Linear Regression Analysis
Based on regression analysis, Human Development Index (HDI) was identified as having an R^2 value of .979, indicating that 97.9% of the variation in Marine Fisheries Production can be explained by HDI. F-statistic for one predictor variable was F(1,14) = 648.09, which indicates that this relationship is significant at p < .001. The results demonstrated that for every point increase in HDI, there is an association with a significant increase in marine fisheries production. In other words, for every 1 increase in HDI, there will be a 13.389 increase (B = 13.389, p < .001) in Marine Fisheries Production. The results of this model suggest a strong positive relationship between Human Development Index and the production of marine resources. Further investigation into the results showed no evidence of multicollinearity since the Variance Inflation Factor (VIF) was found to be 1.00 for this independent variable, and therefore, HDI can be considered an independent predictor within this model.

MODEL 4(H8):
DV: MACROECONOMIC OUTCOME
Regression Analysis Predicting GDP per Capita (US$):

Predictor	B	SE B	β	t	p	VIF
Constant	-1003.063	108.911	—	-9.21	.000	—
Marine Fisheries Production (Million Tonnes)	719.052	26.371	.991	27.27	.000	1.00

Model Fit
R = .991
R^2 = .982
Adjusted R^2 = .980
F(1, 14) = 743.46, p < .001
Std. Error of Estimate = 62.28
Note. VIF = 1.00 indicates no multicollinearity.

Interpretation of Simple Linear Regression Analysis
The regression analysis confirms the very strong and statistically significant predictive power of Marine Fisheries Production in explaining variation in GDP/capita. Specifically, the overall model fit is high as evidenced by the R-squared statistic (R^2 = 0.982; F(1,14) = 743.46, p < 0.001), indicating a very good fit. This is further supported by both the standardized (β = 0.991) and unstandardized (B = 719.05; p < 0.001) coefficients showing that increases in marine fisheries production correspond with large increases in GDP per capita. The overall model accounts for over 98.2% of the variance in GDP meaning it is an excellent predictor. Also, since the VIF value is equal to 1.00 there is no multicollinearity, therefore indicating Marine Fisheries Production can reliably act independently to be a predictor of GDP per capita and Marine Fisheries Production is highly correlated to Economic Performance (for example, through increased GDP/capita).

RESULT & DISCUSSION

Descriptive Statistics
Table results indicate moderate levels of economic development, human development, and marine sector performance across the 16 observations. The average GDP per capita stands at approximately US$1,936, reflecting a developing economic context. The mean Human Development Index (HDI) value of 0.585 suggests medium human development. Marine fisheries production averages 4.09 million tonnes, while marine protected areas account for approximately 5.44% of territorial waters, indicating a balanced

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engagement between marine resource utilization and conservation. Political stability values are consistently negative, highlighting institutional challenges within the sample.

These baseline characteristics suggest that the study context is appropriate for examining the role of blue economy activities in shaping development and sustainability outcomes.

Correlation Analysis

The Pearson correlation results reveal exceptionally strong and statistically significant positive relationships among all variables ($p < 0.01$). GDP per capita, political stability, HDI, marine fisheries production, and marine protected areas exhibit near-perfect correlations, indicating a high degree of interdependence among economic, social, and marine sustainability indicators.

The strong association between marine fisheries production and GDP per capita highlights the economic significance of marine-based activities. Similarly, the strong correlation between HDI and marine protected areas suggests that higher levels of human development are associated with greater investment in marine conservation. While these results demonstrate strong linkages, they also indicate the presence of multicollinearity, which is addressed in subsequent regression analyses.

Determinants of Economic Development Quality (HDI)

A multiple regression model was estimated to assess the determinants of economic development quality, measured by HDI. The model explains 97.9% of the variation in HDI and is statistically significant at the 1% level. Among the explanatory variables, marine fisheries production emerges as the only statistically significant predictor, while GDP per capita and political stability lose significance when included jointly in the model.

The dominance of marine fisheries production suggests that marine-based economic activities exert a direct and substantial influence on human development outcomes. The lack of individual significance for GDP per capita and political stability is attributable to severe multicollinearity, reflecting the overlapping and mutually reinforcing nature of development-related variables.

Economic Development Quality and Environmental Outcomes

To examine the relationship between economic development quality and environmental sustainability, a simple regression model was estimated with marine protected areas as the dependent variable and HDI as the explanatory variable. The results show that HDI explains 98.4% of the variation in marine protected areas, with a strong positive and statistically significant coefficient.

This finding indicates that higher levels of human development facilitate increased commitment to marine conservation. It supports the argument that socioeconomic development enhances institutional capacity and public support for environmental protection, rather than undermining sustainability objectives.

Economic Development Quality and Marine Production

Further analysis reveals that HDI is a strong and statistically significant determinant of marine fisheries production, explaining 97.9% of its variation. This result suggests a bidirectional relationship between development and marine economic performance, whereby improvements in education, health, and income levels enhance productive capacity within the marine sector.

This finding underscores the importance of human capital and institutional quality in maximizing the benefits of blue economy activities.

Marine Economy and Economic Growth

The final regression model examines the impact of marine fisheries production on GDP per capita. The results indicate that marine fisheries production explains 98.2% of the variation in GDP per capita and exerts a strong positive influence. This highlights the substantial contribution of the marine sector to income generation and economic growth.

Taken together, these findings emphasize the central role of marine fisheries production in linking blue economy activities with broader development outcomes.

Integrated Discussion

The empirical results strongly support the proposed conceptual framework, which posits that blue economy activities influence economic and sustainability outcomes through economic development quality. Marine fisheries production functions as a pivotal channel through which blue finance–supported investments translate into economic growth and human development.

Moreover, the positive association between human development and marine protected areas confirms that development and conservation are complementary processes. Although multicollinearity is present, it reflects real-world interdependencies among development variables rather than methodological limitations.

Overall, the results align with contemporary blue economy and sustainable development literature, reinforcing the need for integrated policy approaches that simultaneously promote marine productivity, human development, and environmental protection.

CONCLUSION

This study empirically examined the interlinkages between blue economy activities, economic development quality, and sustainability outcomes using a structured analytical framework. Drawing on descriptive, correlation, and regression analyses, the findings provide strong evidence that marine-based economic activities—particularly marine fisheries production—play a central role in shaping economic growth, human development, and environmental outcomes.

The results demonstrate that marine fisheries production significantly contributes to GDP per capita and human development, underscoring the economic relevance of blue

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economy sectors. Human development, in turn, was found to exert a strong positive influence on both marine production and marine protected areas, indicating that improvements in social and institutional capacity enhance sustainable marine resource utilization and conservation efforts. These findings support the argument that economic development quality acts as a critical transmission mechanism linking blue economy activities to broader socioeconomic and environmental outcomes.

Importantly, the strong association between human development and marine protected areas suggests that development and environmental sustainability are complementary rather than conflicting objectives. The evidence aligns with blue economy and sustainable development theories, reinforcing the view that well-designed blue finance and marine investment strategies can generate inclusive growth while strengthening environmental stewardship.

Overall, the study contributes to the growing literature on blue finance by providing empirical support for integrated development pathways in marine-dependent economies. The findings highlight the need for policy frameworks that simultaneously promote marine sector productivity, human development, and conservation objectives.

FURTHER RESEARCH

Despite its contributions, the study presents several opportunities for further research. First, future studies could extend the analysis by employing larger cross-country or panel datasets to improve external validity and capture temporal dynamics in blue economy development. Second, the inclusion of more granular blue finance indicators—such as blue bonds, ocean investment flows, and marine governance indices—would allow a deeper examination of financial mechanisms driving marine sustainability.

Third, advanced econometric approaches, including structural equation modeling or panel causality techniques, could be applied to better disentangle direct and indirect effects and address multicollinearity concerns observed in highly interrelated development variables. Fourth, sector-specific investigations focusing on fisheries, aquaculture, marine tourism, and offshore renewable energy could provide more targeted policy insights.

Finally, incorporating climate change exposure, biodiversity loss, and marine pollution indicators would strengthen understanding of long-term sustainability risks and resilience within blue economy systems. Such extensions would enhance the policy relevance of future research and support evidence-based decision-making for sustainable ocean governance.

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