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Factors affecting marine economic development: evidence from central coastal provinces, Vietnam

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A B S T R A C T

The Central Coast of Vietnam, spanning from Thanh Hoa province to Binh Thuan province, holds a highly significant political and economic position, with the marine economy making substantial contributions to the existence and development of the region. This study aims to identify the factors influencing marine economic development (MED), evaluate the extent of influence of each factor, and determine whether security and coastal defense (SCD) plays an intermediary role in the development of the marine economy in the Central Coast provinces of Vietnam. The research conducted a typical survey of 268 fishermen engaged in marine economic activities, including aquaculture and the exploitation of aquatic resources, across the coastal provinces of the Central Coast of Vietnam. The collected data was analyzed using the structural equation modeling method through PLS-SEM software. The results of the study indicate that six factors have a direct and positive impact on MED. These factors, ranked by decreasing levels of influence, are: SCD ($\beta = 0.412$), Policy and Management (PM) ($\beta = 0.329$), Human Resources (HR) and Marine Infrastructure (MI) (both $\beta = 0.268$), Marine Resources (MR) ($\beta = 0.204$), and the lowest, Technology and Protection of Marine Environment (TPME) ($\beta = 0.152$). Additionally, the findings reveal that the three factors are HR, PM, and MI positively influence the SCD variable, with the levels of influence ranked as follows: HR ($\beta = 0.272$), PM ($\beta = 0.224$), and MI ($\beta = 0.166$). Moreover, at a significance level of 5%, all independent variables (HR, PM, and MI) exhibit statistically significant indirect relationships with MED through the SCD variable, confirming that SCD serves as an intermediary in the relationship with MED. Based on these findings, the study proposes managerial implications to support the development of the marine economy in the Central Coast provinces of Vietnam.

1. Introduction

In the 21st century, seas and oceans have become the focal point of global attention. Many coastal nations around the world are focusing on marine biodiversity conservation to strike a balance between preservation and marine economic development, thereby enhancing their national economic strength. Recent studies, such as Truong (2009), Tran (2014), Huynh (2018), Truong (2021), He and Mai (2021), Cheng et al. (2023), Zou et al. (2023), etc., indicate that research on marine economic development, marine environmental protection, sustainable use of marine resources, and maritime security has become a new trend in promoting sustainable marine economic growth. In Vietnam, the government places great importance on the marine economy, recognizing it as a critical link in achieving the country's sustainable development and prosperity goals. The Vietnamese government has enacted several key policies to promote marine economic development, including the *Strategy for Sustainable Development of Vietnam's Marine Economy to 2030 with a Vision to 2045* (Politburo, 2018) and the *Socio-Economic Development and National Defense and Security Plan for the North Central and Central Coastal Regions to 2030 with a Vision to 2045* (Politburo, 2022). These policies provide important legal and strategic foundations for the development of the marine economy in the Central Coast provinces of Vietnam.

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The Central Coast of Vietnam stretches from Thanh Hoa to Binh Thuan provinces, encompassing coastal provinces and cities with a coastline of nearly 2,000 km, accounting for over 55% of the country's total coastline (3,260 km). This region is endowed with stunning beaches, seas, islands, valuable natural resources, and diverse ecosystems, providing favorable conditions for marine economic development, tourism, transportation, and significant potential for developing major seaports. It is home to important coastal economic zones such as Nghi Son, Vung Ang, Chu Lai, Dung Quat, and Nhon Hoi, as well as deep-water seaports like Chan May, Lien Chieu, Tien Sa, Ky Ha, Chu Lai, Dung Quat, and Quy Nhon. The geographic location of the Central Coast offers strategic advantages for connecting Vietnam's maritime areas with international waters, serving as a crucial hub for aquaculture and large-scale fishing activities. This highlights the Central Coast as a strategic area of political, economic, cultural, social, defense, and security significance for Vietnam. However, to effectively harness this potential, it is essential to understand the factors influencing marine economic development, such as marine resources, marine infrastructure, human resources in aquaculture and fishing, maritime management policies, and especially the role of coastal security and defense. These factors not only affect the efficiency of resource exploitation and utilization but also determine the sustainability of development. Marine economic activities in the Central Coast are significantly impacted by natural and environmental factors. The region frequently faces natural disasters such as storms, floods, and rising sea levels, which severely disrupt marine economic activities, particularly fishing, aquaculture, and marine tourism. Additionally, overexploitation of marine resources and marine pollution pose challenges that must be managed to ensure long-term sustainability.

To address these challenges, coastal security and defense play a vital role, not only in protecting the environment and resources but also in supporting mechanisms for disaster prevention and mitigation. Coastal defense structures such as dikes, seawalls, and early warning systems safeguard local populations and coastal economic infrastructure. Furthermore, coastal security and defense are closely linked to protecting territorial sovereignty and national security, preventing violations of territorial waters, illegal resource exploitation, and smuggling activities. Coastal defense forces, through patrolling, monitoring, and law enforcement, ensure stability and create favorable conditions for marine economic activities. Therefore, integrating marine economic development with coastal security and defense ensures not only economic value but also enhances the quality of life for Central Coast residents. Thus, we believe that researching the factors influencing marine economic development and verifying the intermediary role of coastal security and defense in the Central Coast provinces of Vietnam is essential. Such research provides a scientific basis for proposing strategic solutions to ensure harmonious marine economic development alongside environmental protection, security stability, and national sovereignty.

This study contributes significantly to the empirical research on marine economic development in Vietnam, offering additional scientific evidence on factors affecting marine economic growth. It seeks to address three key research questions:

1. What factors influence marine economic development in the Central Coast provinces of Vietnam, and what is the extent of their impact?
2. Is there an intermediary role of coastal security and defense in marine economic development in the Central Coast provinces of Vietnam?
3. What are the suitable solutions for promoting marine economic development in the Central Coast provinces of Vietnam?

2. Literature Review

An overview of the studies shows that there are quite a few studies related to the development of the marine economy. Depending on the viewpoint and perspective on the development of the marine economy in the direction of exploiting aquatic resources from the sea or aquaculture or exploiting and developing marine and island tourism or exploiting oil and gas minerals from exclusive economic zones on the sea, etc., there are different views and assessments, typically the following typical studies:

Yeung and Chu (2000) have generalized the economic development process in the coastal area of Fujian (China) in terms of agriculture, business development and direct and indirect foreign investment in this area. The study also emphasized that marine resources play a key role in the economic development of coastal areas. In the same research direction, Ho and Ho (2006) believe that investment in seaport infrastructure at Jurong Port - Singapore will manage risks and increase port exploitation capacity, developing the economy in the long term. Or the study by Çağlak et al. (2011) assessed the impact of port development investment on both direct and indirect aspects on regional economic development, using the specific example of Cadarli port in Turkey and argued that port system investment will enhance competitive advantage.

From another perspective, Ahlhorn (2009) analyzed the factors affecting the lives of coastal people and showed that human resources to exploit marine resources play an important role in sustainable marine economic development. Beatley (2012) also showed that developing production and business activities and the lives of coastal people will help preserve the sea and the livelihoods of coastal people. Meanwhile, Burroughs (2011) pointed out the factors related to management for the development of coastal economy such as oil exploitation, fishing, bay management, wastewater management, waste in coastal areas affecting coastal economic development.

Recently, with the trend of developing the marine economy associated with environmental protection, energy and marine security. Fang (2017) stated that China is one of the countries severely affected by coastal and marine disasters due to its geographical distribution and affecting the development of the marine economy, the study proposed solutions to protect the marine environment and the livelihoods of coastal fishermen. Similarly, Smith et al. (2021) also stated that the development of marine ecosystems and the conservation of marine biodiversity will contribute to the sustainable development of the marine economy. Or Cheng et al. (2023) stated that the Chinese government has attached great importance to the marine economy, the study focused on the relationship between marine economic development and energy efficiency in the Zhoushan Islands and showed that there is an impact relationship between marine economic development and energy efficiency. The study also confirmed that the construction of the Zhoushan New Marine Economic Zone has a statistically significant impact on energy efficiency. At the same time, Zou et al. (2023) in the study measured the performance of the blue economy and showed the operating characteristics of the blue economy at different stages, which can assist policymakers in optimizing the development model of the marine economy.

In Vietnam, many recent studies have also shown that the development of the marine economy is influenced by many factors such as marine economic development policies (Truong, 2009; Tran, 2014) or marine resources (Truong, 2021; Vu & Nguyen, 2021), as well as coastal security and defense, marine infrastructure, and marine exploitation human resources (Huynh, 2018; Truong, 2021). He and Mai (2021) show that the circular economic model has a positive impact on people's living conditions, supporting sustainable development at the local level. However, technological progress and people's awareness are barriers to coastal economic development, because the process of mechanical modernization and technological application is still limited in coastal areas. The study also suggests that the establishment and expansion of local government policies is an indispensable part of coastal economic development to limit the negative impacts of natural resource abuse and facilitate businesses and families in coastal areas to strive towards the integration of economic development with social and environmental responsibility. The above research overview shows that there are many factors affecting the development of the marine economy, depending on the marine economic development policies of the government or local coastal authorities, including natural and environmental factors. This is an important basis for the research team to identify factors affecting the development of the marine economy in the central coastal provinces of Vietnam.

3. Theoretical basis and research model

3.1 Theoretical basis

Currently, there are many different views on the definition of marine economic development. In this study, we focus on the marine economy and the role of coastal security and defense in marine economic development activities. Therefore, we only focus on clarifying the theory of marine economy and the theory of coastal security and defense, specifically:

Huynh (2002) defines "Marine economy is the combination of economic activities at sea with economic activities on land, in which the sea mainly plays a role in exploiting raw materials, for transportation activities, tourism activities at sea, while most of the activities of organizing production, processing, logistics and services for marine exploitation are located on land". Similarly, according to Bui (2007), He and Mai (2021) also believe that the concept of marine economy is still a concept that has not been unified. Due to the specific nature of the marine environment, all marine economic activities are closely related and determined from the mainland, so it is impossible to talk about the marine economy without taking into account economic activities related to the sea in coastal areas. However, the author also believes that in a narrow sense, the marine economy can be understood as all activities taking place at sea such as maritime transport and barrier services, fishing and aquaculture, shipbuilding and repair, oil and gas processing industry, etc. According to Article 43 of the 2012 Law of the Sea of Vietnam, the marine economy includes the following sectors: (i) Searching, exploring, exploiting, processing oil, gas and other marine resources and minerals; (ii) Maritime transport, seaports, building and repairing ships, seagoing vehicles and other maritime services; (iii) Marine tourism and island economy; (iv) Exploitation, aquaculture, seafood processing; (v) Development, research, application and transfer of science and technology on exploitation and development of marine economy; (vi) Building and developing marine human resources. Therefore, marine economy according to the approach of this study is understood in the most general way to include all economic activities related to the sea taking place at sea and economic activities taking place along the coast.

Concurrently, coastal security and defense are two important concepts, closely linked to ensuring stability, sustainable development of the sea and protecting the sovereignty of a country. Coastal security refers to a state of stability and safety in economic, social and marine environmental activities, including controlling threats such as territorial waters encroachment, smuggling, illegal exploitation of resources and environmental pollution (Vu, 2021). This is a core factor to maintain a favorable environment for marine economic development and improve the quality of life for coastal residents. Coastal defense has strategic significance in protecting the territory and national security. It includes activities such as building defense systems, patrolling, monitoring and deploying naval and border forces to deal with military threats, natural disasters and environmental crises (Politburo, 2007; Vu, 2021). Accordingly, coastal defense not only ensures territorial waters safety but is also the foundation for protecting economic, ecological and social interests at sea.

3.2 Research model

To answer the research questions, the authors define the research model as follows:

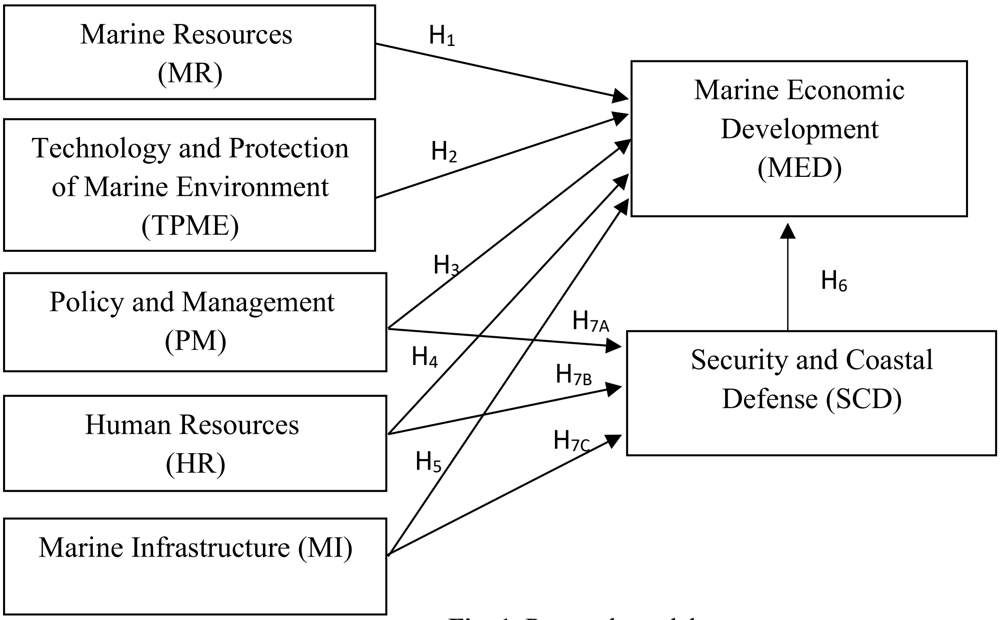

Fig. 1. Research model

Interpretation of the symbols of the research model:

- For the dependent variable which is the development of the marine economy in the provinces of the Central Coast, Vietnam:

MED: Marine Economic Development

- For the independent variables which are the factors affecting the development of the marine economy in the provinces of the Central Coast, Vietnam:

MR: Marine Resources;
TPME: Technology and Protection of Marine Environment;
PM: Policy and Management;
HR: Human Resources;
MI: Marine Infrastructure;
SCD: Security and Coastal Defense.

3.3 The hypothesis development and research model

Marine Resources (MR)

Marine resources are understood as all natural resources and economic, ecological, and cultural values in the sea and ocean. These are resources that humans can exploit and use to serve the needs of economic development, life, and environmental protection. Marine resources are divided into three main groups including (i) Biological resources, which are resources related to living organisms in the marine environment such as aquatic species, marine organisms and plants, etc.; (ii) Non-biological resources, which are resources not related to life such as minerals, energy, etc.; and (iii) Marine ecosystem services, which are services that provide intangible values such as maritime transport, marine tourism, etc. Studies by Fang (2017), Truong (2021), Vu & Nguyen (2021), Smith et al. (2021), Zou et al. (2023), etc., all show that marine resources have an impact on marine economic development.

Hypothesis H_1: *Marine resources have a positive impact on marine economic development in the central coastal provinces of Vietnam.*

Technology and Protection of Marine Environment (TPME)

Marine exploitation technology and marine environmental protection are two parallel fields, aiming at sustainable use of marine resources and protecting marine ecosystems from negative impacts. Marine exploitation technology includes advanced methods and equipment to exploit marine resources effectively, safely and sustainably such as smart fishing gear, clean aquaculture, exploitation of renewable energy from the sea, etc. Marine environmental protection includes activities, technologies and policies to minimize negative impacts on marine ecosystems, maintain ocean sustainability such as marine monitoring systems, policies on wastewater treatment into the sea, etc. Studies by Yeung and Chu (2000), Ho and Ho (2006), Çağlak et al. (2011), Cheng et al. (2023) all show that marine exploitation technology and marine environmental protection have an impact on marine economic development.

Hypothesis H2: *Technology and protection of marine environment have a positive impact on marine economic development in the central coastal provinces of Vietnam.*

Policy and Management (PM)

Marine policy and management is a set of regulations, strategies and actions of governments, international organizations and communities to manage, protect and sustainably develop marine resources and environment, including resource exploitation, ecosystem conservation, response to challenges such as climate change and marine pollution, while ensuring economic, social and environmental benefits. Marine policy will guide the development of activities at sea, often based on international law and regional agreements such as marine resource management policies, exploitation and conservation of marine biological resources, etc. Marine management is the process of implementing policies, regulations and measures to ensure the sustainable and orderly use of marine resources and the marine environment, such as marine spatial development planning, zoning of marine areas for marine tourism development, etc. Studies by Truong (2009), Tran (2014), Burroughs (2011), Zou et al. (2023) all show that marine policies and marine management have an impact on marine economic development.

Hypothesis H3: *Policy and management have a positive impact on marine economic development in the central coastal provinces of Vietnam.*

Human Resources (HR)

Marine human resources are understood as the workforce with expertise, skills and knowledge related to the exploitation, management, protection and development of marine economic sectors, as well as protection of the marine environment. This is a core factor for the sustainable development of the marine economy, ensuring security and effective exploitation of marine resources. Studies by Ahlhorn (2009), Beatley (2012), Huynh (2018), Truong (2021) all show that marine human resources have an impact on marine economic development.

Hypothesis H4: *Human resources have a positive impact on marine economic development in the central coastal provinces of Vietnam.*

Marine Infrastructure (MI)

Marine Infrastructure is a system of facilities, works and equipment built, installed or used in marine-related activities. This is a fundamental factor in developing marine economic sectors, resource management, environmental protection and ensuring marine security such as infrastructure for marine transport, infrastructure for marine resource exploitation, infrastructure for marine environmental protection, infrastructure for marine research and management, and infrastructure for marine tourism. Studies by Tran (2014), Huynh (2018), Truong (2021), He and Mai (2021) all show that marine infrastructure has an impact on marine economic development.

Hypothesis H_5: *Marine infrastructure has a positive impact on marine economic development in the central coastal provinces of Vietnam.*

Security and Coastal Defense (SCD)

Security and coastal defense are activities, strategies, and systems established to protect the sea, coastal areas, and national territories from security, environmental, and economic threats. In particular, maritime security focuses on maintaining safety, stability, and order at sea, especially protecting the exclusive economic zone and the country's sea such as protecting territorial sovereignty at sea, ensuring maritime safety, and preventing crimes at sea. Coastal defense focuses on protecting coastal areas, islands and near-shore territorial waters such as building and deploying coastal military bases, enhancing maritime patrol and surveillance capabilities, etc. Studies by Bui (2007), Huynh (2018), Vu (2021), He and Mai (2021) all show that security and coastal defense have an impact on marine economic development.

Hypothesis H_6: *Security and coastal defense have a positive impact on marine economic development in the central coastal provinces of Vietnam.*

At the same time, the Politburo (2007), Vu (2021) also said that to ensure coastal security and defense, it is necessary to perfect and synchronize institutional and policy issues in marine management and development, raise awareness and quality of marine exploitation human resources, improve the marine exploitation infrastructure system, etc. Therefore, the study proposes the following hypothesis H7:

Hypothesis H_7: *H7a (Policy and Management), H7b (Human Resources) and H7c (Marine Infrastructure) have an impact on security and coastal defense in the central coastal provinces of Vietnam.*

4. Research methods

4.1. Methods used for the study

The study uses a mixed research method (including both qualitative and quantitative research methods) to collect data, analyze, verify, discuss and propose managerial implications, specifically:

Qualitative research method: Used for theoretical research, collecting secondary data sources, primary data sources, surveying and interviewing fishermen engaged in marine economy (including aquaculture and exploitation) in the provinces of the Central Coast, Vietnam.

Quantitative research method: The study uses analytical tools including descriptive statistical analysis, assessing internal consistency reliability through Composite Reliability (CR) and Cronbach's Alpha (CA), assessing convergent validity through Average Variance Extracted (AVE), assessing discriminant validity through Fornell-Larcker coefficient, cross loading factor and using structural model for analysis through PLS-SEM software to verify and analyze analysis of research objectives.

4.2. Sample for conducting the study

According to Hair et al. (2017), the ratio of observations to an analysis variable is 5:1 or 10:1, the survey of the study has 29 questions using a five level likert scale (corresponding to 29 observed variables belonging to different factors), these 29 questions are used for analysis in one EFA. Applying the ratio of 5:1, the minimum sample size required for this study will be 29 × 5 = 145 samples. However, to ensure the representativeness of the research sample, the authors proactively distributed the survey to 300 fishermen and collected 268 valid questionnaires, reaching a rate of 89.33%. Valid questionnaires are determined according to the following criteria: (i) Fully answering the information of the survey; (ii) Must be a fisherman with the main source of income from marine exploitation; (iii) Diversify the forms of marine economic development, including exploitation of marine resources or aquaculture and exploitation of marine resources. Regarding the method of sample collection, the authors conducted the survey using a random and convenient sampling method through the Google Form tool. The links of the data collection form after being designed on Google Form will be sent to fishermen via email or social networking tools such as Zalo, Facebook for fishermen to answer the survey.

5. Research results

5.1. About the demographics of the survey sample

Table 1

Demographics of the survey sample

Order	Criteria	Scale	Number	Percentage
1	Genders	Male	203	75.74%
		Female	65	24.26%
		Others	0	0.00%
		Total	***268***	***100.00%***
2	Age groups	≤ 20 years	6	2.24%
		21- 30 years	88	32.83%
		31 – 40 years	146	54.48%
		41 – 50 years	20	7.46%
		> 50 years	8	2.99%
		Total	***268***	***100.00%***
3	Educational levels	High school graduate	151	56.34%
		Secondary school, College	72	26.86%
		Bachelors	14	5,22%
		Over Bachelors	0	0.00%
		Others	31	11.58%
		Total	***268***	***100.00%***
4	Marine economic activities	Exploiting resources from marine life	120	44.77%
		Aquaculture and exploitation of marine resources	148	55.23%
		Others	0	0.00%
		Total	***268***	***100.00%***

From the statistical results in Table 1, it is shown that the majority of the survey are male, aged between 21 and 40, with a high school graduate in education or secondary school, college, working mainly as aquaculture and exploitation of marine resources. This shows that the fisherman in the survey are quite suitable for the purpose of the study.

5.2. Assessment of scale reliability and scale convergent validity

Regarding the reliability of the scales, Table 2 shows that the composite reliability (CR) of the research variables ranges from 0.879 to 0.916 and is higher than the minimum threshold of 0.70. The Cronbach's Alpha (CA) coefficients of the research variables are also greater than the minimum threshold of 0.70 (ranging from 0.794 to 0.886), demonstrating that the scales have high reliability (Hair et al., 2017).
At the same time, the average variance extracted (AVE) values are all from 0.637 or higher, higher than the minimum threshold of 0.50 (Chin, 2010; Hair et al., 2017). Therefore, it can be concluded that the scales for the research variables have full convergent validity.

Table 2
Results of reliability and convergent validity assessment of the scale

Scale	CA	CR	AVE
Independent variable			
1. Marine Resources (MR)	0.849	0.898	0.688
2. Technology and Protection of Marine Environment (TPME)	0.886	0.913	0.637
3. Policy and Management (PM)	0.878	0.916	0.732
4. Human Resources (HR)	0.794	0.879	0.708
5. Marine Infrastructure (MI)	0.834	0.888	0.665
6. Security and Coastal Defense (SCD)	0.825	0.884	0.655
Dependent variable			
7. Marine Economic Development (MED)	0.840	0.893	0.677

5.3. Assessment of discriminant validity of scales

The authors assessed the discriminant validity of the scales using the Fornell-Larcker coefficient and cross-loading coefficient criteria, with the following results:

(1) Fornell-Lacker

Table 3
Results of discriminant validity assessment using the Fornell-Lacker criterion

Variable	HR	MED	MI	MR	PM	SCD	TPME
HR	**0.841**						
MED	0.345	**0.823**					
MI	-0.015	0.329	**0.816**				
MR	0.263	0.624	-0.003	**0.830**			
PM	-0.032	0.339	0.129	-0.070	**0.856**		
SCD	0.262	0.803	0.191	0.745	0.237	**0.809**	
TPME	0.249	0.621	0.152	0.582	-0.008	0.685	**0.798**

From the results of Table 3, we can see that the average extracted variance square root $\sqrt{AVE}$ (numbers on the diagonal, in bold) of the variables are all from 0.798 or higher and are larger than the correlation coefficients of the variables (corresponding numbers not in bold are on the same column of the variables). Thus, the scales satisfy the Fornell-Lacker criteria to obtain discriminant validity.

(2) Cross-loading coefficients

Table 4 shows that the cross-loading coefficient of an observed variable is always larger than all of its loading coefficients on the remaining observed variables (Hair et al., 2017). Therefore, the measurement model achieves discriminant validity.

Table 4
Results of assessing discriminant validity of scales using cross-loading coefficients

Variable	HR	MED	MI	MR	PM	SCD	TPME
HR1	**0.842**	0.304	0.048	0.199	-0.016	0.253	0.220
HR2	**0.829**	0.302	-0.046	0.247	-0.034	0.201	0.236
HR3	**0.854**	0.260	-0.051	0.220	-0.033	0.201	0.167
MED1	0.276	**0.865**	0.283	0.497	0.344	0.702	0.522
MED2	0.289	**0.838**	0.265	0.551	0.282	0.676	0.503
MED3	0.287	**0.831**	0.289	0.505	0.247	0.679	0.537
MED4	0.284	**0.753**	0.244	0.502	0.239	0.582	0.483

Table 4
Results of assessing discriminant validity of scales using cross-loading coefficients (Continued)

Variable	HR	MED	MI	MR	PM	SCD	TPME
MI1	-0.069	0.310	**0.842**	0.008	0.144	0.176	0.154
MI2	-0.003	0.287	**0.834**	0.004	0.126	0.211	0.129
MI3	-0.011	0.231	**0.806**	-0.050	0.077	0.114	0.078
MI4	0.055	0.224	**0.778**	0.024	0.051	0.092	0.125
MR1	0.211	0.499	-0.007	**0.801**	-0.103	0.590	0.473
MR2	0.234	0.547	0.001	**0.852**	0.001	0.621	0.473
MR3	0.194	0.439	-0.044	**0.799**	-0.073	0.586	0.413
MR4	0.230	0.569	0.031	**0.864**	-0.064	0.670	0.558
PM1	-0.037	0.262	0.117	-0.018	**0.802**	0.188	-0.014
PM2	0.007	0.332	0.183	-0.070	**0.848**	0.236	0.024
PM3	-0.018	0.239	0.051	-0.112	**0.836**	0.142	-0.029
PM4	-0.062	0.309	0.073	-0.047	**0.932**	0.226	-0.017
SCD1	0.118	0.604	0.143	0.588	0.193	**0.818**	0.520
SCD2	0.215	0.643	0.065	0.656	0.227	**0.804**	0.573
SCD3	0.185	0.616	0.126	0.596	0.226	**0.817**	0.544
SCD4	0.306	0.720	0.264	0.573	0.132	**0.798**	0.574
TPME1	0.240	0.511	0.149	0.489	0.018	0.608	**0.844**
TPME2	0.217	0.520	0.101	0.538	0.018	0.613	**0.812**
TPME3	0.169	0.489	0.089	0.466	0.007	0.565	**0.784**
TPME5	0.176	0.509	0.144	0.430	-0.015	0.518	**0.760**
TPME6	0.204	0.455	0.113	0.439	-0.066	0.485	**0.772**
TPMR4	0.186	0.485	0.134	0.417	-0.004	0.484	**0.816**

5.4. Results of structural model analysis

In this study, the authors tested two models:

Model 1: Factors influence marine economic development in the Central Coast provinces of Vietnam, and what is the extent of their impact, accordingly:

Independent variables include HR, MI, MR, PM, SCD, TPME;
Dependent variable is MED.

Model 2: Is there an intermediary role of coastal security and defense in marine economic development in the Central Coast provinces of Vietnam, accordingly:

Independent variables include HR, MI, PM;
Intermediate variable is SCD;
Dependent variable is MED.

5.4.1. Assessment of multicollinearity

The authors used the variance inflation factor (VIF) to assess multicollinearity between independent variables in the two models.

Table 5
Variance inflation factor

Variance	Model 1	Model 2
	MED	SCD
HR	1.099	1.001
MI	1.099	1.017
MR	2.764	
PM	1.295	1.018
SCD	3.849	
TPME	2.031	

According to the results in Table 5, it shows that the VIF values are all less than 5.0. The largest VIF value of model 1 is 3.849 and the smallest is 1.099; while the largest VIF value of model 2 is 1.018 and the smallest is 1.001, so both models satisfy the condition of being less than 5.0 (Hair et al., 2017). Therefore, the research models are appropriate and are not affected by the problem of multicollinearity between independent variables.

5.4.2. Evaluation of adjusted coefficient of determination

The results of data analysis in Table 6 show that the adjusted R^2 value of model 1 is 0.747 and model 2 is 0.462, so both are greater than 0.1. Therefore, models 1 and 2 are suitable.

Table 6
Adjusted coefficient of determination

	Dependent variable	
Criteria	**Model 1**	**Model 2**
	MED	**SCD**
R^2	0.752	0.561
The adjusted R^2	0.747	0.462

5.4.3. Evaluation of the impact coefficient f2

In addition to the adjusted R^2 coefficient value, the authors also consider the impact coefficient f^2 value to evaluate the contribution of exogenous variables to the R^2 value of endogenous latent variables.

Table 7.
Impact coefficient f^2

	Model	
Variable	**Model 1**	**Model 2**
	MED	**SCD**
HR	0.089	0.087
MI	0.146	0.032
MR	0.061	
PM	0.174	0.059
SCD	0.178	
TPME	0.046	

The analysis results of model 1 show that: the variables SCD, PM, MI have a high impact on MED (corresponding to f^2 values of 0.178, 0.174 and 0.146, respectively, all greater than 0.15); the variables HR, MR, TPME have a small impact on MED (the f^2 values of 0.089, 0.061, 0.046, respectively, are all greater than 0.02 but less than 0.15). Model 2 shows that the variables HR, PM, MI all have an impact on SCD because the f^2 values are 0.087, 0.059, 0.032, respectively (higher than 0.02).

5.5. Results of testing hypotheses about the relationship

5.5.1. Results of testing hypotheses on direct relationships

The results of testing model 1 in Table 8 show that all six independent variables HR, MI, MR, PM, SCD and TPME have a direct and positive impact on MED (because the p-value of the t-test of the variables is less than 0.05). In which, the order of decreasing impact of the variables on MED is as follows: SCD ($\beta = 0.412$), PM ($\beta = 0.329$), HR and MI (both $\beta = 0.268$), MR ($\beta = 0.204$), and the lowest is TPME ($\beta = 0.152$).

Table 8
Results of testing model 1

Influence relationship	**Model 1**	
	β coefficient	**p - value**
HR → MED	0.268	0.000
MI → MED	0.268	0.000
MR → MED	0.204	0.000
PM → MED	0.329	0.000
SCD → MED	0.412	0.000
TPME → MED	0.152	0.003

Similarly, Table 9 shows that all three variables HR, PM and MI have a positive and positive impact on the SCD variable with the strongest impact on SCD being HR ($\beta = 0.272$), followed by PM ($\beta = 0.224$) and finally MI ($\beta = 0.166$).

Table 9
Results of testing model 2

Influence relationship	**Model 2**	
	β coefficient	**p - value**
HR → SCD	0.272	0.000
MI → SCD	0.166	0.000
PM → SCD	0.224	0.000

5.5.2. Test results on indirect relationship

Next, the authors tested the hypothesis on the mediating role of SCD to MED, with a significance level of 5%, all independent variables HR, PM, MI have an indirect relationship with the MED variable through the SCD variable in a statistically significant way (because all p-values < 0.05). Thus, the SCD variable plays a mediating role in this relationship.

Table 10.
Test results on the mediating role of SCD

Influence relationship	β coefficient	p - value
HR → SCD → MED	0.112	0.001
MI → SCD → MED	0.068	0.000
PM → SCD → MED	0.092	0.006

At the same time, the PLS Algorithm with Bootstrap 5,000 results are as follows:

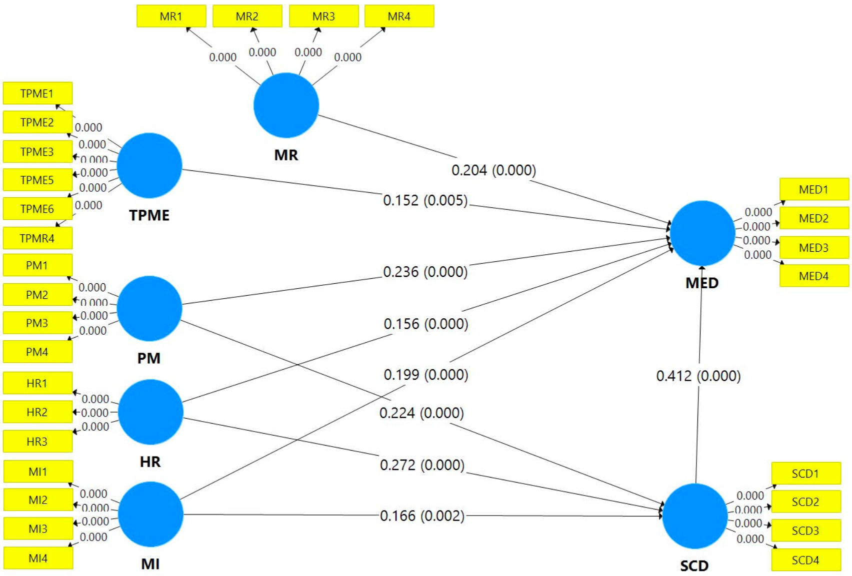

Fig. 2. PLS Algorithm with Bootstrap 5,000

5.6. Discussion and managerial implications

The results of model 1 show that all six independent variables HR, MI, MR, PM, SCD and TPME have direct and positive impacts on MED with the order of decreasing impact of the variables on MED being SCD (β = 0.412), PM (β = 0.329), HR and MI (both 0.268), MR (β = 0.204), and the lowest is TPME (β = 0.152). The results of this study show that there are some variables that are somewhat similar in impact to some previous research results such as Fang (2017), Smith et al. (2021), Vu and Nguyen (2021), Cheng et al. (2022), Zou et al. (2023). However, the impact level is different in the context of the provinces in the Central Coast of Vietnam. At the same time, the results of model 2 also show that all three variables HR, PM and MI have a positive and similar effect on the SCD variable with HR (β = 0.272), PM (β = 0.224) and MI (β = 0.166). This is a new finding of this study compared to previous studies, because the studies. In addition, with a significance level of 5%, all independent variables HR, PM, MI have an indirect relationship with the MED variable through the SCD variable in a statistically significant way, thereby affirming that the SCD variable plays an intermediary role in the relationship with MED.

From the above research results, the authors believe that MED is one of the important strategic goals for countries or localities with marine potential. However, to implement effectively, it is necessary to analyze and closely manage the main influencing factors, including MR, TPME, PM, HR, MI and SCD. Therefore, the authors propose the following management implications:

Firstly, for SCD: Coastal security and defense are prerequisites for protecting national maritime interests, so it is necessary to combine marine economic development with strengthening national defense, security and international cooperation. This helps maintain stability, prevent threats such as territorial conflicts, maritime crimes and natural disasters.

Secondly, for MR: MR is the foundation of MED, including aquatic resources, minerals, renewable energy and marine landscapes. MR management requires a balance between exploitation and conservation, so it is necessary to develop sustainable resource exploitation plans, apply modern technology to minimize negative impacts on the ecosystem and promote research to accurately assess resource potential.

Third, for PM: The policy framework is a decisive factor for the effectiveness of MED, so it is necessary to develop synchronous, flexible policies that are suitable for the characteristics of the marine economy in each country and locality, such as in the provinces of the Central Coast of Vietnam, such as investment incentive mechanisms, regulations on resource exploitation and international cooperation in marine management. In addition, it is necessary to strengthen the capacity of management, supervision and handling of violations, etc.

Fourth, for HR: Human resources are a key factor to realize MED goals, so it is necessary to build a specialized training system and develop a highly skilled workforce in areas such as marine exploitation. In addition, it is necessary to encourage the participation of coastal communities in resource protection and economic development.

Fifth, for MI: Infrastructure is the foundation for MED, including seaports, logistics systems, and coastal energy projects, so it is necessary to invest in and upgrade infrastructure in a modern direction, while ensuring connectivity and compatibility with international standards.

Sixth, for TPME: Technology is the driving force behind MED, while marine environmental protection is a factor to ensure sustainability, so it is necessary to invest in research and application of advanced technology, such as marine environmental monitoring technology, non-harmful exploitation technology and marine waste treatment, etc. At the same time, environmental protection policies need to be closely integrated into the marine economic development strategy.

6. Conclusion

The research results show that all six independent variables HR, MI, MR, PM, SCD and TPME have direct and positive effects on MED. At the same time, all three variables HR, PM and MI have positive and positive effects on SCD, and at the 5% significance level, all independent variables HR, PM, MI have an indirect relationship with MED through SCD. Therefore, MED wants to manage and implement SCD and MR, TPME, PM, HR, MI well. However, effective management of these factors requires close coordination among stakeholders, from government, businesses, communities to international organizations. MED is not only an economic strategy, but also a commitment to protect resources, environment and maritime sovereignty of each country.

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