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Development of an Innovative Blue Economy Model with a Quadruple Helix Approach: Integration of AD-AS Dynamics in Bone Regency

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Abstract

This study formulates an innovative model for blue economy development in Bone Regency by integrating aggregate demand (AD) and aggregate supply (AS) dynamics within a quadruple helix collaboration framework. Quantitative data were obtained from a survey of 100 respondents including fishermen, fish farmers, fishery product processors, and local consumers; qualitative data were collected through in-depth interviews with 12 key informants from the local government, academics, business actors, and coastal communities. Descriptive and thematic analyses indicate that AD is primarily driven by high domestic consumption, but weak in investment, logistics infrastructure, and export market access. On the AS side, marine resource availability is relatively adequate, but productivity, post-harvest quality, and distribution efficiency are constrained by low technology adoption, seasonal production capacity, and long supply chains. Key findings confirm that aligning AD AS requires interventions in product, technology, distribution, and market innovation facilitated by the government through regulations, infrastructure, financing, and human resource development, and strengthened by the roles of academics, industry, and the community. The resulting conceptual model provides a measurable framework for accelerating the development of an inclusive and sustainable blue economy in Bone Regency. This model positions the government as an enabler, academics as providers of research and mentoring, industry as offtakers and investors, and the community as guardians of socio-ecological compliance so that the innovation process runs consistently.

Keywords: Blue Economy, Quadruple Helix, Aggregate Demand, Aggregate Supply

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1. Introduction

The blue economy emphasizes the simultaneous use of marine resources for economic growth, improved welfare, and ecosystem preservation (World Bank, 2017). Bone Regency, South Sulawesi, boasts a coastline and potential for capture fisheries, seaweed cultivation, and marine tourism, which can serve as the basis for the economic transformation of coastal areas.

However, the development of the blue economy in Bone still faces three key issues: (1) a lack of synchronization between the demand side (aggregate demand/AD) and the supply side (aggregate supply/AS); (2) low investment, post-harvest technology, and logistics efficiency; and (3) inconsistent collaboration between stakeholders. Therefore, this article combines AD-AS analysis with the Quadruple Helix collaboration framework (government–academia–industry–community) to ensure that policy interventions are non-sectoral and more contextual.

The formulation of the research problem is:

1) How do AD conditions (consumption, investment, government spending, exports) affect the development of the blue economy in Bone Regency?

2) How does US capacity (resources, technology, production, distribution) contribute to strengthening the blue economy sector?

3) How can the Quadruple Helix collaboration connect AD-AS dynamics to create a sustainable blue economy in Bone Regency?

The purpose of this article is to map the AD-AS gap and formulate an innovative model for developing a blue economy based on Quadruple Helix collaboration in Bone Regency.

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2. Literature Review

2.1. Konsep Blue Economy

The Blue Economy focuses development on the sustainable use of marine resources by balancing economic, social, and environmental objectives, and contributing to the SDGs 14 agenda (Bhuyan et al., 2021; Sardan et al., 2023).

Implementing a blue economy requires coherent governance across sectors because marine activities fisheries, tourism, energy, and logistics directly interact with ecosystem carrying capacity (Carver, 2022; de Ycaza et al., 2024). Without policy integration, increased economic activity risks driving social exclusion and ecological stress, particularly in vulnerable coastal communities (Clark & Cisneros‐Montemayor, 2024; Das, 2023).

In addition to governance, the adoption of innovations and sustainable practices (e.g., post-harvest technology, energy efficiency, and product diversification) is a prerequisite for increasing the added value and economic resilience of coastal areas (Karuppiah et al., 2025; Loureiro et al., 2022).

2.2. Quadruple Helix Approach

The Quadruple Helix approach expands the Triple Helix by adding the role of civil society as an innovation actor, so that the policy development and innovation process becomes more inclusive and oriented towards local needs (Kuntariningsih et al., 2023).

In the context of regional development, the Quadruple Helix helps bring together resources: the government provides regulations and infrastructure; academia provides research and mentoring; industry provides investment, technology, and market access; and communities ensure social legitimacy, compliance, and the integration of local knowledge (Khouroh et al., 2021; Siswanto & Rosdaniah, 2023).

Implementation challenges primarily relate to role allocation, coordination mechanisms, and conflict of interest management; therefore, a collaborative platform and mutually agreed-upon performance indicators are required (Kunwar & Ulak, 2024; Saepuloh, 2022).

2.3. AD-AS Framework in the Context of the Blue Economy

The AD-AS framework maps how aggregate demand (consumption, investment, government spending, exports) and aggregate supply (production capacity, technology, distribution efficiency, input availability) mutually influence output and prices at the macro level. In the context of the blue economy, increasing demand for sustainable seafood products needs to be balanced by increasing efficient supply capacity to prevent economic benefits from being lost due to post-harvest losses, logistics costs, and inconsistent quality (Vrontisi et al., 2022; Wuri et al., 2024).

AD-AS interactions in the marine sector are also influenced by governance and stakeholder collaboration, particularly to ensure that production practices do not damage ecosystems and that benefit distribution is more equitable (Tsiouvalas et al., 2022; Wuwung et al., 2022).

Therefore, integrating AD-AS with the Quadruple Helix enables the design of interventions that simultaneously close market, technology, and governance gaps.

3. Research Method and Materials

This study employed a mixed-methods explanatory sequential design. The quantitative phase involved a survey of 100 respondents, including fishermen, fish farmers, fishery product processors, small business owners, and local consumers in Bone Regency. The survey mapped the condition of AD components (consumption, investment, government spending, exports) and AS factors (resource availability, technology, production capacity, distribution).

The qualitative stage was conducted through in-depth interviews with 12 key informants representing Quadruple Helix actors: local government (related agencies), academics, business/industry actors, and representatives of the community.

Coastal areas. Qualitative data were used to deepen the explanation of the quantitative findings, particularly regarding coordination barriers, innovation needs, and collaboration model design.

Quantitative data were analyzed using descriptive statistics, while qualitative data were analyzed thematically. The results were integrated during the interpretation stage to formulate a conceptual model for blue economy development that connects AD-AS dynamics through the Quadruple Helix mechanism.

4. Results and Discussion

4.1. Dynamics of Aggregate Demand and Aggregate Supply in Bone Regency

The demand component (AD) in Bone Regency is relatively supported by domestic consumption with demand for fresh fish and simple foods that tend to be stable due to the culture of eating fish and the existence of local markets, in line with empirical evidence in Indonesia which shows that traditional markets, street vendors, and food stalls are the most frequently used access points for people to purchase seafood, with consumption patterns that can be read down to the district/city level (Partelow et al., 2023). However, in addition to your other findings namely limited private investment and access to capital for MSMEs that hinder business capacity building and providing standard quality for modern markets it is in line with a study of fish processing MSMEs in Indonesia that highlights obstacles in the form of inadequate capital and technology (Yudhanto et al., 2023), as well as a study of small-scale tuna value chains in Indonesia that shows that the implementation of standards (e.g., certification) along the value chain faces governance complexity and imbalances in bargaining power between actors which in practice requires improvements and capacity to meet standards if you want to enter higher-value markets (Wiranthi et al., 2024).

Government spending has provided assistance through fishing gear and empowerment programs, but the need for cold chain infrastructure, improved production road access, and fishing port facilities remains significant. Export potential for leading commodities (e.g., tuna/skipjack tuna and seaweed) has not been optimal due to logistical constraints, certification, and supply consistency.

In the US, marine resource availability is relatively adequate, but post-harvest performance, technology adoption, and distribution efficiency are weaknesses. Production remains heavily influenced by seasonality, processing and drying technologies are largely traditional, and long supply chains increase costs and depress prices at the producer level. This creates a gap: domestic agricultural production is strong, but the US is unable to efficiently and sustainably supply high-value-added products.

Table 1. AD-AS gap and Quadruple Helix-based intervention directions.

The Gap	Indication of Findings	Innovation Intervention	Driving Factor (QH)
Low added value	Dominant products are fresh/simple processed fish; quality standards not yet consistent.	Diversification of processed products (fillets, nuggets, carrageenan); quality standardization.	Academics–Industry–MSMEs
Weak investment, limited access to financing	Micro-businesses struggle to expand.	Inclusive financing scheme (KUR/cooperative); incentives for green investment.	Government–Industry
Distribution inefficiencies	Long supply chains; high post-harvest losses; limited cold chain.	Strengthening cold storage & refrigerated transport; shorten the supply chain.	Government–Industry–Public

4.2. Dynamics of Aggregate Demand and Aggregate Supply in Bone Regency

The innovative blue economy development model in Bone Regency can be positioned as a bridge between market potential and production capacity through four pillars of innovation (product innovation, technological innovation, distribution innovation, and market innovation), which serve as intervention points to reduce post-harvest losses, improve quality and added value, and expand access to domestic and export markets. The literature shows that post-harvest losses in fisheries are often driven by limited ice, insulated containers, cold storage facilities, and marketing delays; therefore, increasing storage capacity and improving handling infrastructure are key to reducing losses (Mandal et al., 2024).

At the same time, expansion into modern markets demands compliance with quality and sustainability standards; a study of Fair Trade certification in small-scale tuna fisheries in Indonesia demonstrates how standards can be "translated" down to the producer level and form multi-tiered captive relationships, making capacity upgrading, institutional support, and compliance facilitation essential prerequisites for accessing higher-value markets (Wiranthi et al., 2024). Therefore, the role of local governments as enablers through pro-sustainability regulations/incentives, development of port-fishery and cold chain infrastructure, financing facilitation, and strengthening human resources and innovation incubation aligns with the finding that blue economy implementation is highly dependent on concrete governance tools, plans, and funding mechanisms (Wuwung et al., 2022).

Institutionally, the establishment of blue economy clusters and Quadruple Helix coordination platforms is relevant because the Quadruple Helix model in the blue economy context emphasizes the importance of community engagement and a "common language" for cross-actor collaboration (Sampaolo et al., 2021), while studies of living labs (as a form of Quadruple Helix collaboration) emphasize that leadership and partnership coordination are crucial for bridging the expectation-implementation gap and maintaining the sustainability of collaboration (Nguyen & Marques, 2022).

At the fish processing MSME level, strengthening strategic entrepreneurship (including resource orchestration, capital access, and competitiveness) has also been shown to be associated with processing unit performance, thus supporting the design of incubation programs and financing facilitation as levers for increasing capacity and meeting modern market standards (Yudhanto et al., 2023).

5. Conclusion

This study shows that the development of the blue economy in Bone Regency is supported by strong domestic demand, but is still constrained by weak investment, logistics infrastructure, and export market access. On the supply side, marine resources are relatively adequate, but productivity, post-harvest quality, technology adoption, and distribution efficiency are suboptimal, resulting in suboptimal added value creation.

The proposed conceptual model emphasizes that AD-AS alignment needs to be achieved through product, technology, distribution, and market innovation within a Quadruple Helix collaborative ecosystem. Emphasis on the role of government as an enabler, academia as a research and human resource enhancer, industry as a driver of investment and market access, and the community as a guarantor of socio-ecological legitimacy are key to accelerating an inclusive and sustainable blue economy in Bone Regency.

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