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# *A Cross-Sector Agro-Marine Innovation Management Model for Integrated Sustainability*

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***ABSTRACT***

*Contemporary natural resource-based economies, particularly agriculture and marine sectors, are increasingly challenged to reconcile productivity growth with environmental sustainability and systemic resilience. However, existing literature continues to conceptualize green and blue domains in isolation, revealing a persistent gap in the development of an integrated agro-marine innovation framework. This study addresses this gap by developing a cross-sector conceptual model that integrates agro and marine innovation within a sustainability-oriented systems perspective. A qualitative grounded theory approach is employed based on systematic analysis of 583 Scopus-indexed publications. Data were analyzed through open, axial, and selective coding using NVivo to construct an inductive conceptual model. Findings indicate that innovation operates as an interconnected system comprising four causal layers, namely drivers, mechanisms, outputs, and outcomes. Technological innovation, institutional arrangements, financial mechanisms, and multi-actor collaboration emerge as interdependent drivers shaping agro-marine transformation through production system reconfiguration, business model innovation, and value chain restructuring. These mechanisms enhance efficiency and economic performance, facilitating broader transitions toward sustainability, resilience, and inclusive development. From a policy perspective, the model highlights the need for integrated governance structures, coherent green-blue financing systems, and coordinated transformation strategies. From a societal perspective, it suggests improvements in livelihood quality, spatial equity, and food system resilience. The originality of this study lies in proposing the Integrated Sustainable Agro-Marine Innovation System as a novel conceptual model derived from Scopus-based grounded theory synthesis, offering a unified systemic framework that integrates green and blue economy paradigms within a single analytical structure for sustainability transitions.*

Kata Kunci*: E-Service Quality, E-Promotion, Perceived Value, Costumer Loyalty, GoFood*

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## INTRODUCTION

Natural resource based economic systems have increasingly become a central concern in global sustainable development discourse due to their strategic role in supporting economic growth (Ahammed, 2025; Ahmad, 2022; Anser, 2021; Hwang, 2023), food security (Food Security Department and FELCRA Technology et al., 2024; Gonzalez, 2021; Gundogdu, 2023; Pawlak & Kołodziejczak, 2020), environmental balance (Armeanu et al., 2018), and social welfare (Aanesen, 2023). In this context, the agricultural and marine sectors represent two interconnected fundamental pillars that sustain human life through the provision of food resources (Pawlak & Kołodziejczak, 2020), employment opportunities (Manzoor et al., 2019), industrial raw materials (Gu et al., 2021), and ecological services (D'Amato, 2021). However, the acceleration of climate change (Badîrcea, 2021; Bandh, 2023), environmental degradation (Ma, 2023), geopolitical instability (Akhtar, 2023; Saddington, 2023), and global economic transformation has simultaneously intensified pressures on both sectors. Contemporary development challenges are no longer limited to increasing productivity, but also encompass the need to maintain environmental sustainability (Arsawan, 2024), strengthen economic resilience (Shang & Liu, 2024), and promote inclusive social welfare (Aanesen, 2023). In response to these challenges, various paradigms such as the green economy, blue economy, circular economy, and resilience-based development have emerged as strategic approaches for advancing sustainable development transformation. Nevertheless, despite sharing similar sustainability objectives, previous studies have largely developed these paradigms separately, resulting in a fragmented understanding of the relationship between terrestrial and marine economic systems.

Research on the green economy generally focuses on land-based economic transformation through green innovation, energy efficiency, green finance, digital economy, and industrial sustainability. This orientation can be observed in the studies conducted by Q. Wang (Wang, 2025), J. Dai (Dai, 2025), B. Li (Li, 2025), L. Sethi (Sethi, 2024), X. Yang (Yang, 2024), and M. Anas (Anas, 2024), whose studies primarily emphasize green innovation, green finance, digital economy, and environmental sustainability within industrial and national economic contexts. In contrast, blue economy studies predominantly address the sustainability of marine resources, coastal governance, blue finance, marine biotechnology, fisheries development, and marine tourism, as reflected in the works of V. Sharma (Alazaiza, 2022), F. Picken (Picken, 2025), K. Karuppiah (Karuppiah, 2025), D. Benzaken (Benzaken, 2024), R.L. Stephenson (Stephenson, 2024), B.K. Gesami (Gesami, 2024), and M. Yusuf (Yusuf, 2024). Although both streams of research address innovation and sustainability, most studies continue to treat the agricultural and marine sectors as separate domains. To date, there remains very limited research that specifically integrates agro and marine systems within a unified sustainability conceptual model based on systemic innovation, thereby leaving the ecological, economic, and institutional interconnections between terrestrial and marine systems insufficiently explained in a comprehensive manner.

Empirically, the interconnection between agro and marine systems can be observed through various ecological and economic dimensions. Agricultural waste ("Technological Innovations in Agricultural Waste Management in Malaysia," 2023), excessive chemical fertilizer use (Oliveira, 2021), and industrial runoff from terrestrial areas frequently contribute to marine pollution (Bandh,

2023; Liu, 2023), eutrophication (Cakmak, 2022), coastal ecosystem degradation (Ayilu, 2023a), and declining fisheries productivity (Ayilu, 2023b; Kyvelou, 2023). Conversely, the degradation of marine ecosystems may threaten coastal livelihoods (Ayilu, 2023a; Shalli, 2024), weaken food security (Pawlak & Kołodziejczak, 2020), and reduce regional economic resilience (Agarwal & Ussif, 2022). These conditions indicate that terrestrial and marine systems actually operate within an interconnected ecological-economic nexus rather than as isolated sectors. In this regard, innovation is increasingly regarded as a strategic mechanism for enhancing sustainability and resilience within natural resource–based economies through the utilization of artificial intelligence (Gesami, 2024; Wang, 2025), the Internet of Things (IoT) (Kliestik et al., 2024; Rejeb et al., 2021), smart farming (Moore, 2022), smart aquaculture (Aanesen, 2023; Campanati, 2022; Hughes, 2021; Knol-Kauffman, 2023), big data analytics (Khan, 2024; Lyu, 2024), biotechnology (Thompson, 2024), and climate-smart systems (Vishnoi & Goel, 2024; World Bank Group, 2026). However, previous studies suggest that the success of innovation is determined not only by technological advancement, but also by governance quality (Li, 2025; Saddington, 2023), institutional support (Huo, 2022), financial accessibility (Nuryakin, 2021), and multi-actor collaboration (Bai, 2024). From a theoretical perspective, Innovation System Theory emphasizes the importance of interactions among actors, institutions, and knowledge systems in driving innovation diffusion (Wentao & Zhufeng, 2017), while Institutional Theory highlights the role of governance structures and regulatory mechanisms in shaping development trajectories (Eitrem et al., 2024; Pinto, 2017). Similarly, Sustainability Transition Theory argues that sustainability requires systemic socio-technical transformation involving technologies, institutions, and social practices (Biely & Chakori, 2025; Petrović, 2024). Nevertheless, these theories have generally been applied within separate sectoral contexts, thereby limiting their ability to explain the integrated dynamics between agricultural and marine systems simultaneously.

Despite these developments, previous studies still exhibit several important limitations, including the dominance of sectoral approaches, the limited integration between green economy and blue economy paradigms, and the insufficient exploration of the systemic relationships among innovation, industrial transformation, governance, financing mechanisms, and sustainability within agro-marine contexts. Furthermore, most existing studies primarily emphasize the direct relationship between innovation and sustainability without adequately examining how industrial transformation and sustainable business models function as mediating mechanisms linking the two. Therefore, this study contributes to the literature by developing an integrative conceptual model based on grounded theory capable of bridging agro and marine sustainability systems within a systemic innovation framework. The novelty of this study lies in the integration of green economy and blue economy paradigms, which is inductively developed through systematic literature analysis. Consequently, this study not only offers a new theoretical perspective for understanding sustainability transitions within interconnected land–sea economic systems, but also provides practical implications for policy development, governance, sustainable financing, and cross-sector collaboration. Based on these research gaps, the objective of this study is to develop and explain an integrated agro-marine innovation model.

## RESEARCH METHODOLOGY

This study employed a qualitative grounded theory design to develop an integrated cross-sector agro-marine innovation model for sustainability based on existing literature (Al-Eisawi, 2022; Chun Tie et al., 2019). The study utilized secondary data derived from 583 Scopus-indexed publications published between 2021 and 2025. The publications were retrieved using Harzing's Publish or Perish through separate title-word searches on "green economy" and "blue economy" to ensure comprehensive coverage of both terrestrial and marine sustainability research domains. The separate search strategy was intended to capture the distinct conceptual trajectories of each paradigm prior to their integration into a unified analytical framework. The inclusion criteria comprised peer-reviewed Scopus-indexed journal articles written in English and directly related to innovation, sustainability, governance, finance, industrial transformation, and resilience within green economy or blue economy contexts, while duplicate, non-relevant, and incomplete publications were excluded from the analysis. Subsequently, all selected studies were analyzed simultaneously using grounded theory procedures to identify recurring themes, conceptual relationships, and emerging theoretical categories across both sectors. Data analysis was conducted using NVivo 12 Pro through three sequential coding stages, namely open coding, axial coding, and selective coding (An, 2019; Hutchison et al., 2010). Open coding was applied to identify and classify key concepts and indicators emerging from the literature, axial coding was used to establish relationships among categories and explore systemic interconnections, while selective coding was employed to synthesize the categories into a central theoretical construct. Through this inductive and systematic analytical process, the study generated an integrated conceptual model explaining how innovation systems, governance structures, financial mechanisms, and industrial transformation interact in shaping sustainable agro-marine development.

## RESULT AND DISCUSSION

The open coding stage identified a broad range of recurring concepts across 583 Scopus-indexed publications related to green economy and blue economy studies. Using NVivo 12 Pro, the extracted keywords and thematic patterns were inductively coded and systematically grouped into conceptual clusters. The clustering process enabled the identification of dominant research themes, conceptual relationships, and emerging interdisciplinary connections within the green and blue economy discourse. The results of the cluster analysis revealed eleven major thematic clusters.

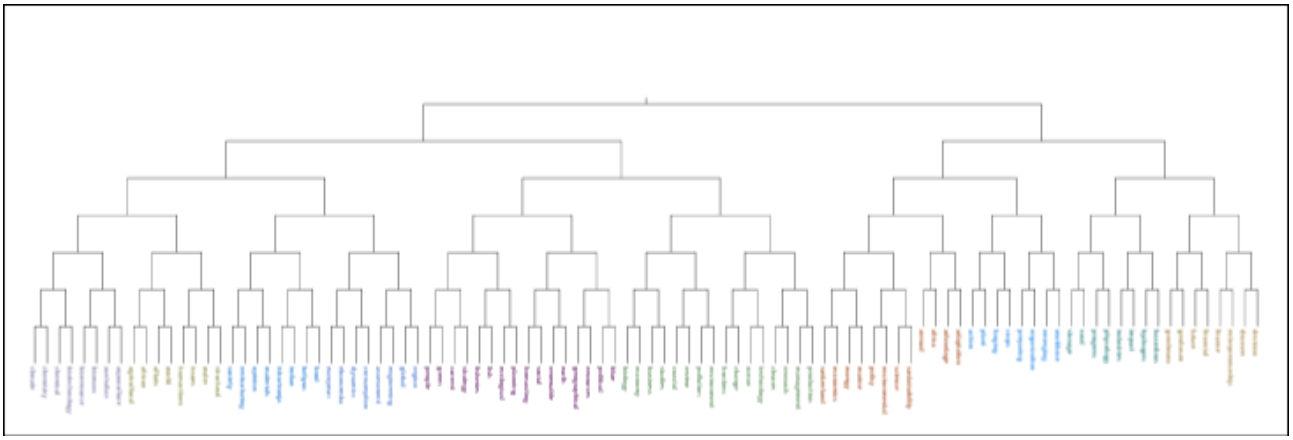

**Figure 1 Cluster Analysis**
Source: NVivo 12 Pro (2026)

The cluster analysis generated eleven major thematic clusters, each representing a distinct conceptual domain within the literature. Figure 1 presents the visual cluster analysis generated by NVivo, while Table 1 summarizes the characteristics of each cluster.

**Table 1. Cluster Analysis Results**

| Cluster Color | Cluster Name | Items | Description |
|---|---|---|---|
| Orange | Innovation, Entrepreneurship & Finance | decision, discover, entrepreneurship, finance, financial, future, geoforum, Gondwana | Focuses on decision-making, discovery, entrepreneurship, financial aspects, future issues, as well as geoforum and geoscience contexts. |
| Teal | Energy, Impact & Industrial Sector | hazardous, hydrogen, impact, industries, phycology, progress, rural, storage, workforce | Covers energy issues (particularly hydrogen), hazards, impacts, industrial sectors, psychology/behavior, progress, rural areas, storage, and workforce. |
| Blue | Production, Organization & Process | emerging, organization, preparing, crops, forging, plant, action | Focuses on emergence, organization, preparation, crop production, formation, and operational actions. |
| Red | Adaptation & Advantage | adaptation, advantage, africa, annual | Contains themes of adaptation, advantage/benefit, African context, and annual dynamics. |
| Brown | Sustainability, Policy & Strategic Sectors | sustainability, science, environmental, policy, marine, energy, economics, Switzerland | Discusses sustainability, science, environment, policy, marine sectors, energy, economics, and specific geographical contexts. |
| Green | Research, Technology & Environment | production, management, research, cleaner, technology, ocean, change, frontiers, environment, pollution, review | Focuses on production, management, research, cleaner technology, innovation, oceans, change, environment, pollution, and scientific evaluation. |
| Purple | Sector, Resources & Development | coastal, studies, business, economy, biology, blue, political, resources, geographical, earth, renewable, social, forecasting | Encompasses coastal studies, business, economy, biology, blue economy, politics, resources, geography, earth systems, renewable energy, social dimensions, and forecasting. |
| Light Blue | Planning, Evaluation & Global Context | planning, ecological, fish, fisheries, strategy, current, green, people, region, global, | Includes planning, ecology, fisheries, strategy, current issues, green economy, society, regional aspects, globalization, |

| Cluster Color | Cluster Name | Items | Description |
|---|---|---|---|
| | | engineering, assessment | engineering, and assessment. |
| Navy | Economy, Consumption & Regional Context | consumption, dynamics, ekonomska, european, food, helyon, indian, istrazivanja, materials, opinion, restructuring, society | Discusses consumption, economic dynamics, European/Indian regional contexts, food, materials, opinion, restructuring, and society. |
| Mustard | Structure, Global Issues & Partnerships | structural, water, issues, transactions, world, affairs, African | Focuses on structure, water resources, global issues, transactions, world affairs, and African context. |
| Lavender | Agriculture, Aquatic Systems & Applied Science | agricultural, aquaculture, australian, biomass, bioresource, biotechnology, chemical, chemistry, climate | Contains agriculture, aquaculture, biomass, bioresources, biotechnology, chemistry, and climate change. |

Source: NVivo 12 Pro (2026)

The coding results demonstrate that open codes were systematically grouped into broader conceptual dimensions through axial coding, which established relational structures among categories and organized them into higher-order analytical constructs. This process generated major dimensions including Technological Innovation, Governance, Finance, Multi-Actor Collaboration, Industrial Transformation, Innovation Systems, Sustainable Business Models, Productivity Improvement, Efficiency Enhancement, Economic Performance, Sustainability, Resilience, and Inclusive Social Welfare. Through selective coding, these dimensions were then integrated into a comprehensive Input–Process–Output–Outcome (IPOO) framework that forms the conceptual foundation of the Integrated Sustainable Agro-Marine Innovation System.

At the input level, technological resources such as technology, biotechnology, biomass, hydrogen, and engineering, combined with innovation readiness, governance systems, organizational capacity, financial resources, entrepreneurial capability, and multi-actor collaboration across regional and international contexts, function as foundational drivers that strengthen innovation capacity, institutional readiness, and stakeholder engagement. At the process level, these inputs stimulate agro-marine industrial transformation through production, fisheries, aquaculture, and marine integration, while simultaneously advancing green and blue economy transitions, adaptive innovation systems, research integration, and sustainable business models based on cleaner production, renewable resources, and integrated agro-marine resource management.

At the output level, these processes contribute to productivity improvement, operational efficiency, competitive advantage, strategic planning efficiency, and stronger economic performance through enhanced production systems, industrial growth, entrepreneurship, and market value creation. Finally, at the outcome level, the framework reveals that sustainable agro-marine innovation systems generate three interconnected long-term impacts: sustainability through ecological balance, environmental protection, renewable resource utilization, and cleaner systems; resilience through

adaptive capacity, strategic management, forecasting, and responsiveness to environmental and economic disruptions; and inclusive social welfare through employment generation, food security, entrepreneurship, regional development, and broader socio-economic well-being.

Based on the coding integration process, a conceptual map was developed using NVivo to illustrate the dynamic interconnections among technological innovation, governance, finance, multi-actor collaboration, industrial transformation, and sustainability outcomes within the Integrated Sustainable Agro-Marine Innovation System, demonstrating how continuous interactions between inputs, processes, outputs, and outcomes collectively drive productivity, economic performance, resilience, sustainability, and inclusive social welfare in agro-marine ecosystems.

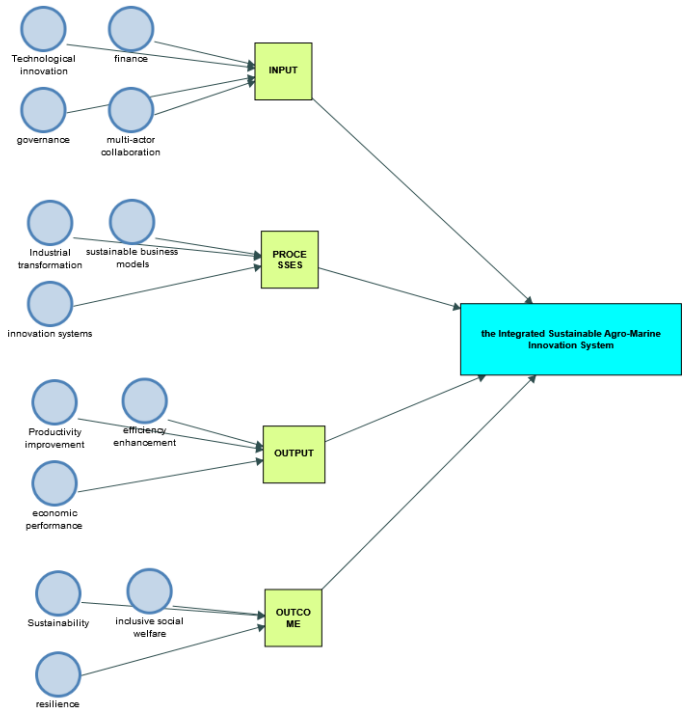


Figure 2 Concept Map

Source: NVivo 12 Pro (2026)

The conceptual mapping analysis demonstrates that the identified concepts can be systematically organized into four major structural dimensions: inputs, processes, outputs, and outcomes. These dimensions illustrate the sequential and interconnected relationships between enabling factors, transformation mechanisms, performance outputs, and long-term sustainability impacts within the agro-marine innovation system.

Table 3. Structural Dimensions of the Integrated Sustainable Agro-Marine Innovation System Conceptual Framework

| Structural Dimension | Main Components |
|---|---|
| Inputs | Technological innovation, governance, finance, multi-actor collaboration |

| Structural Dimension | Main Components |
|---|---|
| Processes | Industrial transformation, innovation systems, sustainable business models |
| Outputs | Productivity improvement, efficiency enhancement, economic performance |
| Outcomes | Sustainability, resilience, inclusive social welfare |

Source: NVivo 12 Pro (2026)

Table 3 presents the structural dimensions of the Integrated Sustainable Agro-Marine Innovation System Conceptual Framework, which is organized into four interconnected dimensions: inputs, processes, outputs, and outcomes. The input dimension includes technological innovation, governance, finance, and multi-actor collaboration as the main enabling factors that support the development of the agro-marine innovation system. These inputs influence the process dimension through industrial transformation, innovation systems, and sustainable business models, which function as the primary mechanisms driving systemic transformation. The implementation of these processes subsequently generates outputs in the form of productivity improvement, efficiency enhancement, and economic performance, which ultimately contribute to long-term outcomes, namely sustainability, resilience, and inclusive social welfare. Overall, the framework demonstrates that sustainable agro-marine development operates through a dynamic interaction among technological, institutional, economic, and social dimensions.

This study is based on the premise that agricultural and marine sectors are increasingly challenged by productivity demands, environmental sustainability issues, and vulnerability to global crises, while fragmented sectoral approaches may no longer adequately address these complexities. Using a grounded theory approach through open coding, axial coding, and selective coding, the findings reveal that innovation operates as an interconnected system consisting of drivers, mechanisms, outputs, and outcomes. At the driver level, technology, governance, finance, and collaborative actors form the foundation of the agro-marine innovation system, while at the mechanism level these drivers stimulate structural transformation in production systems, business models, value chains, and institutional arrangements. These transformations tend to improve productivity, efficiency, and economic performance, which subsequently contribute to sustainability, system resilience, and inclusive social welfare. The findings therefore indicate that sustainable development outcomes are not generated directly by innovation alone, but emerge through systemic interactions between technological, institutional, economic, and social transformation processes.

## DISCUSSION

The findings of this study indicate that sustainable transformation within agricultural and marine sectors cannot be adequately explained through fragmented sectoral approaches. Instead, the results suggest that sustainability emerges through the interaction of technological innovation, governance, finance, and multi-actor collaboration operating within an interconnected agro-marine system. The proposed Integrated Sustainable Agro-Marine Innovation System demonstrates that innovation functions not merely as a technological process, but as a systemic mechanism involving institutional arrangements, industrial restructuring, and collaborative networks that collectively shape sustainability outcomes. This finding directly addresses the research objective of constructing an

integrative conceptual framework capable of linking agricultural and marine systems within a unified sustainability perspective.

The results extend previous green economy studies that primarily focused on land-based transformation through green innovation, green finance, digital economy, and industrial sustainability, as discussed by Q. Wang (Wang, 2025), J. Dai (Dai, 2025), B. Li (Li, 2025), L. Sethi (Sethi, 2024), X. Yang (Yang, 2024), and M. Anas (Anas, 2024). Similarly, the findings also complement blue economy studies emphasizing marine sustainability, blue finance, fisheries development, marine biotechnology, and coastal governance, as reflected in the works of V. Sharma (Alazaiza, 2022), F. Picken (Picken, 2025), K. Karuppiah (Karuppiah, 2025), D. Benzaken (Benzaken, 2024), R.L. Stephenson (Stephenson, 2024), B.K. Gesami (Gesami, 2024), and M. Yusuf (Yusuf, 2024). However, unlike previous studies that generally treated agro and marine systems separately, this study demonstrates that both sectors are structurally interconnected through ecological, economic, institutional, and technological relationships. In this regard, the findings support empirical evidence suggesting that agricultural waste, industrial runoff, and unsustainable terrestrial production systems may directly affect marine ecosystems through pollution, eutrophication, and declining fisheries productivity (Bandh, 2023; Liu, 2023). Conversely, marine degradation may weaken coastal livelihoods, food security, and regional economic resilience (Ayilu, 2023a; Shalli, 2024). Therefore, the study argues that agricultural and marine sectors should be understood as part of a broader ecological-economic nexus rather than as isolated development domains.

From a theoretical perspective, the findings are consistent with Innovation System Theory, which emphasizes the importance of interactions among actors, institutions, and knowledge systems in supporting innovation diffusion (Wentao & Zhufeng, 2017). The study demonstrates that technological innovation alone may not be sufficient to drive sustainable transformation without governance quality, institutional support, financial accessibility, and collaborative actor networks. This finding also aligns with Institutional Theory, which highlights the role of governance structures and regulatory systems in shaping development trajectories (Eitrem et al., 2024; Pinto, 2017). Furthermore, the results reinforce Sustainability Transition Theory by showing that sustainability transformation requires systemic socio-technical changes involving technologies, institutions, industries, and social practices simultaneously (Biely & Chakori, 2025; Petrović, 2024). Nevertheless, this study extends these theories by integrating them into a cross-sector agro-marine framework, thereby offering a more comprehensive explanation of sustainability transitions across interconnected terrestrial and marine systems.

The findings further indicate that technological innovation serves as an important enabling factor within the agro-marine innovation system. Previous studies identified the growing relevance of artificial intelligence (Gesami, 2024; Wang, 2025), the Internet of Things (IoT) (Kliestik et al., 2024; Rejeb et al., 2021), smart farming (Moore, 2022), smart aquaculture (Aanesen, 2023; Campanati, 2022; Hughes, 2021; Knol-Kauffman, 2023), big data analytics (Khan, 2024; Lyu, 2024), biotechnology (Thompson, 2024), and climate-smart systems (Vishnoi & Goel, 2024; World Bank Group, 2026) in enhancing sustainability and resilience within natural resource-based sectors. The present study confirms the importance of these innovations but also demonstrates that their

effectiveness depends on the existence of institutional coordination, financial support, and integrated governance mechanisms. Thus, innovation should be interpreted as a systemic transformation process rather than merely technological adoption.

At the mechanism level, the study reveals that integrated innovation systems may stimulate structural transformation in production systems, business models, industrial organization, and value chains. This transformation appears to support productivity improvement, operational efficiency, and economic performance. The findings therefore support previous arguments that innovation and operational efficiency can strengthen competitiveness within resource-based industries. However, this study emphasizes that economic performance should not be viewed as the final objective of development. Instead, improved economic performance functions as an intermediate mechanism contributing toward broader sustainability outcomes, including resilience and inclusive social welfare.

The study also provides important practical implications. The findings imply that governments may need to move beyond silo-based development policies by integrating agricultural and marine sectors into unified sustainability strategies. Likewise, businesses and industries may benefit from adopting circular economy-based business models that connect agricultural and marine value chains, such as integrating agricultural waste utilization with fisheries and aquaculture systems. Financial institutions and investors also appear to play an essential role through the strengthening of green finance and blue finance mechanisms that support sustainable transformation processes. In addition, the model suggests broader social implications, including improved welfare for farmers and fishers, reduced disparities between inland and coastal regions, strengthened food security, and greater inclusion of SMEs and vulnerable communities within sustainable development systems.

Despite these contributions, the study has several limitations. First, the research is conceptual and literature-based, relying primarily on grounded theory analysis of existing publications rather than empirical field validation. Second, the study does not specifically examine variations across regional, industrial, or policy contexts, which may influence the applicability of the proposed framework. Third, although the model integrates multiple dimensions, the causal relationships among variables remain conceptual and require empirical testing. Therefore, future studies are recommended to quantitatively and qualitatively validate the proposed model in different agro-marine contexts, particularly within developing countries, coastal economies, and climate-vulnerable regions. Further research may also explore the role of emerging technologies, governance capacity, and circular economy mechanisms in strengthening integrated agro-marine sustainability systems.

Overall, this study argues that future sustainable development may depend not only on technological advancement itself, but also on the extent to which innovation is embedded within integrated systems connecting terrestrial and marine sectors through governance, financial mechanisms, institutional support, and collaborative actor networks. Consequently, the study contributes to the growing discourse on sustainable development by proposing a system-based conceptual framework capable of bridging the traditionally separated domains of green economy and blue economy within a unified agro-marine sustainability perspective.

## CONCLUSION

In conclusion, this study demonstrates that sustainable development in agricultural and marine sectors requires an integrated and systemic approach rather than fragmented sectoral strategies. Through a grounded theory analysis of existing literature, the study develops the Integrated Sustainable Agro-Marine Innovation System model, which explains how technological innovation, governance, financial mechanisms, and multi-actor collaboration interact to drive industrial transformation, innovation systems, and sustainable business models that subsequently enhance productivity, efficiency, and economic performance while contributing to sustainability, resilience, and inclusive social welfare. The study contributes theoretically by bridging the green economy and blue economy within a unified system-based framework and practically by highlighting the importance of integrated policies, sustainable financing, and collaborative governance in supporting agro-marine transformation. Nevertheless, this study is limited to conceptual and literature-based analysis; therefore, future research is recommended to empirically validate the proposed model across different regional and industrial contexts to strengthen its applicability and generalizability in sustainable development studies.

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