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Blue economy readiness and community engagement in Qatif city, Saudi Arabia

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Introduction: The Blue Economy has emerged as a global framework for achieving sustainable coastal development by integrating ecological protection, economic diversification, and social inclusion. Despite Saudi Arabia's strong national commitment to marine sustainability under Vision 2030 and the Saudi Green Initiative, limited empirical research has examined how Blue Economy strategies translate into local implementation. This study assesses Blue Economy readiness in Qatif City, a historic coastal community in the Eastern Province, by evaluating how institutional governance, environmental awareness, sectoral opportunities, and community engagement interact to shape sustainable coastal development.

Methods: A mixed-methods research design was employed using a sequential explanatory approach. Quantitative data were collected through a structured questionnaire administered to 137 stakeholders representing government, private sector, NGOs, academics, and coastal community members. Statistical analysis included descriptive statistics, Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM) to identify latent constructs and causal relationships among readiness factors. Qualitative insights from open-ended responses were analyzed using NVivo thematic coding to complement and interpret the statistical findings.

Results: The analysis identified three core determinants of Blue Economy readiness: institutional conditions, environmental awareness and research capacity, and sectoral opportunities. Structural modeling revealed that institutional barriers negatively influence both sectoral opportunities ($\beta = -0.41$) and community engagement ($\beta = -0.32$), whereas environmental awareness significantly enhances opportunity perception ($\beta = 0.54$) and civic participation ($\beta = 0.48$). Community engagement emerged as the strongest predictor of overall readiness ($\beta = 0.62$, $p < 0.001$), highlighting its mediating role between governance conditions and economic opportunities. Qualitative findings reinforced these patterns, emphasizing governance fragmentation, environmental degradation, and the need for greater stakeholder participation and marine education.

Conclusion: The study demonstrates that successful Blue Economy implementation at the city level depends on integrated governance systems,

environmental literacy, sectoral innovation, and inclusive community participation. Qatif City possesses significant potential to develop a sustainable marine economy if institutional coordination, research capacity, and participatory governance mechanisms are strengthened. The validated readiness model provides a replicable framework for evaluating coastal development strategies in Saudi Arabia and other emerging maritime economies, supporting policy implementation aligned with Vision 2030 and the Saudi Green Initiative.

KEYWORDS

blue economy readiness, coastal governance, community engagement, Qatif City, Saudi Arabia, structural equation modeling

1 Introduction

The Blue Economy has gained increasing global prominence as a strategy for achieving sustainable and inclusive economic growth through the responsible use of marine and coastal resources. It emphasizes ecological protection, social well-being, and economic diversification, with ocean-based industries valued at more than USD 2.5 trillion annually (OECD, 2020; World Bank, 2023). Many coastal nations now rely on Blue Economy frameworks to strengthen food security, expand employment opportunities, enhance climate resilience, and transition toward low-carbon development pathways (FAO, 2022). Saudi Arabia has recently embraced this agenda through Vision 2030 and the Saudi Green Initiative, which call for protecting marine ecosystems, diversifying coastal livelihoods, and improving the well-being of coastal communities (Saudi Green Initiative (SGI), 2021).

Despite these national commitments, a clear disconnect persists between high-level strategies and local implementation. Qatif City, one of the Eastern Province's oldest maritime centers, illustrates this challenge. Historically rooted in fishing and pearl diving and strategically located between Dammam and Jubail, Qatif possesses strong ecological, cultural, and geographic assets that could support a modern Blue Economy. Nonetheless, empirical evidence shows that the city's marine sectors remain underperforming due to fragmented governance, overlapping institutional mandates, weak regulatory enforcement, pollution and habitat loss, and limited community participation in coastal planning (Alhowaish, 2018; EU-GCC, 2021; Gulf Cooperation Council (GCC), 2024; Alhowaish, 2025). These persistent governance and environmental pressures demonstrate systemic obstacles that national-level reforms alone have not resolved.

Several policy mechanisms have been introduced in Saudi Arabia to improve coastal management, including the National Fisheries Development Program (NFDP), new aquaculture licensing processes, and the expansion of marine protected areas (MEWA, 2019), yet their local impact remains uneven. Existing initiatives often lack clear coordination across agencies, suffer from limited data exchange, and rarely include community voices in planning or monitoring processes. As a result, the challenges confronting Qatif mirror broader regional patterns: strong national ambitions but limited operationalization at the municipal level, insufficient alignment between stakeholders, and the absence of localized models that link governance, environmental awareness, and economic diversification.

This disconnect points to a significant research and policy gap. While international literature has demonstrated that institutional strength, environmental literacy, sectoral diversification, and community engagement are central to Blue Economy implementation, few empirical studies in Saudi Arabia or the wider GCC have examined how these dimensions interact at the city scale (Saleh and Munir, 2023; Alhowaish, 2026a). Local-level readiness assessments are particularly lacking, and no validated frameworks currently exist to evaluate how municipal governance systems, stakeholder perceptions, and community capacities collectively influence Blue Economy preparedness. Without such evidence, national strategies risk failing to translate into meaningful local action.

This study directly addresses these gaps by evaluating Qatif City's readiness to operationalize a sustainable Blue Economy and by examining how community engagement can serve as a catalyst for improving governance, environmental stewardship, and economic opportunity. To achieve this, the research pursues five objectives: (1) assess stakeholder awareness and perceptions of the Blue Economy; (2) identify sectoral opportunities in fisheries, aquaculture, and marine tourism; (3) analyze institutional and environmental constraints affecting policy coordination; (4) evaluate the role of community participation and governance mechanisms; and (5) model the structural relationships among institutional, environmental, and social factors shaping Blue Economy readiness.

By focusing on Qatif as a representative coastal city, this research provides a much-needed empirical foundation for understanding local-level drivers and barriers to Blue Economy transition in Saudi Arabia. The findings offer actionable insights for policymakers seeking to localize Vision 2030's marine sustainability agenda and contribute to the global discourse on inclusive, evidence-based, and environmentally grounded coastal development.

2 Literature review

2.1 Recent advances in blue economy theory

Research on the Blue Economy has expanded significantly over the past decade as policymakers and scholars increasingly recognize

the role of coastal and marine systems in advancing sustainable development and economic diversification. Recent literature (2020–2025) stresses the need to integrate ecological resilience, social inclusion, and institutional coherence within governance systems, especially in developing coastal cities facing rapid socio-economic transitions (IOC-UNESCO, 2020; Hoareau, 2025). Within this discourse, four analytical domains consistently emerge, institutional governance, environmental awareness and research, sectoral opportunities, and community engagement, which align with the variables examined in this research and underpin the Blue Economy Readiness Model developed for Qatif City.

Institutional arrangements remain one of the most decisive factors shaping Blue Economy implementation. Recent studies highlight that fragmented mandates, insufficient inter-agency collaboration, and weak regulatory enforcement continue to undermine sustainable coastal management in the Middle East and developing Asia (Saleh and Munir, 2023; Li et al., 2024; Abdel-Hady et al., 2024; Karuppiyah et al., 2025). The concept of blue justice, fair distribution of marine benefits, has gained traction, emphasizing equity, accountability, and transparent decision-making (Bennett et al., 2021a; Reis-Filho et al., 2024; Ananta and Cabral, 2026). In the Gulf region, research continues to emphasize institutional fragmentation, data silos, and limited integration between municipal, fisheries, and environmental authorities (EU-GCC, 2021; Saleh and Munir, 2023; Robitzch et al., 2023; Alhowaish, 2026b). Marine Spatial Planning (MSP) and Integrated Coastal Zone Management (ICZM) frameworks are increasingly recommended to resolve policy incoherence (Santos et al., 2021; World Bank, 2025). These insights inform the Institutional Barriers construct used in this study.

Environmental awareness and scientific literacy are widely recognized as essential drivers of sustainable marine governance, with recent studies emphasizing the importance of local capacity-building, citizen science, and data-driven decision-making (IOC-UNESCO, 2020; Bennett et al., 2021b; World Bank, 2023; Reis-Filho et al., 2024; Hoareau, 2025). Authors argue that higher environmental literacy enhances policy compliance, supports conservation practices, and strengthens adaptive management in climate-sensitive regions (Reis-Filho et al., 2024; Ananta and Cabral, 2026). At the same time, limited research funding and weak science–policy integration persist in many developing marine economies (Crawford et al., 1993; Lee et al., 2020; Karuppiyah et al., 2025). These discussions directly support the Environmental Awareness & Research dimension measured in the Qatif perception model.

The Blue Economy's economic pillars continue to evolve rapidly. Fisheries and aquaculture remain foundational sectors, though recent assessments highlight the need for traceable, climate-resilient, and eco-certified systems (FAO, 2022). Marine tourism has witnessed a rebound post-COVID-19, with global valuations surpassing USD 450 billion by 2024 and strong growth expected in heritage-rich coastal regions (UNWTO, 2024). Emerging sectors, marine biotechnology, offshore renewable energy, marine waste recycling, hydrogen energy, and advanced desalination, are identified as high-potential innovation frontiers for 2025 and beyond (European Commission, 2024; World Bank,

2025). GCC countries have expanded investments in aquaculture, coral restoration, and marine R&D, positioning the region as an emerging Blue Economy hub (EU-GCC, 2021; Elmahdy et al., 2023; Gulf Cooperation Council (GCC), 2024). These trends reinforce the Sectoral Opportunities variables examined in this research.

Recent scholarship increasingly emphasizes community-driven marine governance, demonstrating that community participation significantly enhances policy legitimacy, compliance, and social outcomes in coastal regions (Bennett et al., 2021a; Gbolahan et al., 2023; Ananta and Cabral, 2026). Traditional ecological knowledge (TEK) continues to be recognized as an important complement to scientific data, especially in small fishing communities (Ogar et al., 2020; Charles et al., 2024; Hoareau, 2025; Virmani et al., 2025). However, in the Middle East, including Saudi Arabia, participatory structures remain limited, and marine governance is still characterized by top-down policy development (EU-GCC, 2021; Robitzch et al., 2023). Improving community education, advisory councils, and public consultation mechanisms are widely recommended. These insights directly inform the Community Engagement dimension used in this study.

2.2 Regional context: GCC and Saudi Arabia

The GCC has intensified its focus on Blue Economy development as part of post-oil diversification strategies. Recent reports highlight Oman's 2024 Fisheries Transformation Program (ElMahdy et al., 2023), the UAE's 2023 Blue Economy Strategy (UAE Ministry of Economy, 2022), and Bahrain's coastal tourism revitalization initiatives (EU-GCC, 2021). Saudi Arabia has advanced several marine programs, including NEOM's Marine Innovation Cluster, the Red Sea Blue Carbon Initiative, the updated National Fisheries Strategy (Ministry of Environment, Water and Agriculture (MEWA), 2018), and new SGI coastal restoration targets (Saudi Green Initiative (SGI), 2021; Abdelraouf and Nagasawa, 2023). However, empirical research examining how these national programs translate to local-level implementation remains scarce. Few studies integrate institutional capacity, environmental awareness, sectoral potential, and social participation into a unified readiness framework (Alhowaish, 2026a). This study addresses that gap by focusing on Qatif City.

2.3 Conceptual gap, research contribution, and framework

The reviewed literature highlights four interdependent drivers of Blue Economy readiness, institutional governance, environmental awareness and research capacity, sectoral opportunities, and community engagement. While these dimensions are widely acknowledged as central to sustainable coastal development, empirical modeling that links them in an integrated analytical structure remains limited, particularly in the context of GCC coastal cities. Existing studies discuss each dimension individually, yet few employ advanced statistical techniques such as Exploratory Factor Analysis (EFA), Confirmatory Factor Analysis (CFA), and Structural Equation Modeling (SEM) to evaluate how these

constructs interact to shape Blue Economy implementation. This research addresses this gap by developing and empirically validating a Blue Economy Readiness Model for Qatif City, thereby offering a structured, transferable framework applicable to other Saudi and regional coastal settings.

The conceptual framework guiding this study is derived from an extensive body of recent Blue Economy literature, which collectively identifies four domains that determine a coastal city's capacity to operationalize sustainable marine development:

- Institutional Barriers encompass policy coherence, regulatory enforcement, and inter-agency coordination. Fragmented governance has been consistently identified as a critical constraint in developing and Gulf-region contexts, undermining policy integration and limiting adaptive coastal management (Voyer et al., 2018; Bennett et al., 2021b; EU-GCC, 2021; Saleh and Munir, 2023; Alhawaish, 2026a).
- Environmental Awareness and Research Capacity reflect stakeholder literacy, scientific infrastructure, and access to reliable marine data. Studies emphasize that strong environmental knowledge enhances compliance, supports conservation behavior, and stimulates innovation in aquaculture, biotechnology, and renewable marine energy (Gbolahan et al., 2023; Kelly, 2023; Hoareau, 2025; Ananta and Cabral, 2026).
- Sectoral Opportunities represent the perceived economic potential across fisheries, aquaculture, marine tourism, coastal logistics, and emerging ocean-innovation industries. Identifying viable sectors is essential for attracting investment, diversifying local livelihoods, and ensuring alignment with sustainability objectives (OECD, 2020; Lee et al., 2020; Benzaken et al., 2024; Virmani et al., 2025).
- Community Engagement includes participatory governance mechanisms, shared decision-making, traditional ecological

knowledge (TEK), and local capacity-building. Recent evidence confirms that inclusive community structures enhance policy legitimacy, strengthen compliance, and foster long-term stewardship of coastal resources (Bennett et al., 2021b; Nathan et al., 2022; Hoareau, 2025).

These four domains are integrated into a unified Blue Economy Readiness Framework, illustrating their reciprocal influences and combined contribution to sustainable coastal development (Figure 1). Institutional and environmental conditions function as enabling structures, sectoral opportunities supply economic motivation, and community engagement acts as the central mediating force that transforms these inputs into practical readiness. This framework directly guides the study's methodological approach and underpins the development of the EFA-CFA-SEM analytical model, which empirically validates the relationships among the four constructs in the Qatif City context.

3 Methodology

This research employed a structured mixed-methods design to examine stakeholder perceptions of Blue Economy opportunities and community engagement in Qatif City. A mixed-methods approach was selected to enable a comprehensive understanding of both quantifiable perception patterns and the contextual insights necessary for interpreting local governance and community dynamics. The study followed a sequential explanatory design, beginning with quantitative data collection and analysis, followed by qualitative thematic interpretation to explain, deepen, and triangulate the statistical findings (Creswell and Plano Clark, 2018; Tashakkori and Teddlie, 2010). This design ensured analytical complementarity by integrating measurable indicators with narrative perspectives supplied by stakeholders (Figure 2).

Qatif City was chosen as the study area because of its strategic role as one of Saudi Arabia's oldest coastal economic centers and its evolving involvement in fisheries, aquaculture, and marine trade. Its geographic and socioeconomic characteristics, combined with emerging Vision 2030 coastal development initiatives, make it highly suitable for investigating Blue Economy readiness and the institutional-community interface (Figure 3). The study population comprised five key stakeholder groups directly involved in or affected by marine and coastal development: government officials, private-sector actors, NGO representatives, academics and researchers, and coastal community members such as fishers and tourism operators.

A stratified purposive sampling approach ensured balanced representation across the stakeholder categories. Sample size was determined using Cochran's formula at a 95% confidence level and 5% margin of error, yielding a target of 200 participants. In total, 137 valid responses were received, resulting in a 69% response rate, comparable to earlier Gulf-region marine governance studies (Saleh and Munir, 2023; Alhawaish and Alkubur, 2025; Alhawaish, 2026b). Data were collected between September and November 2025 using a structured questionnaire administered electronically and through in-person distribution. The instrument included six

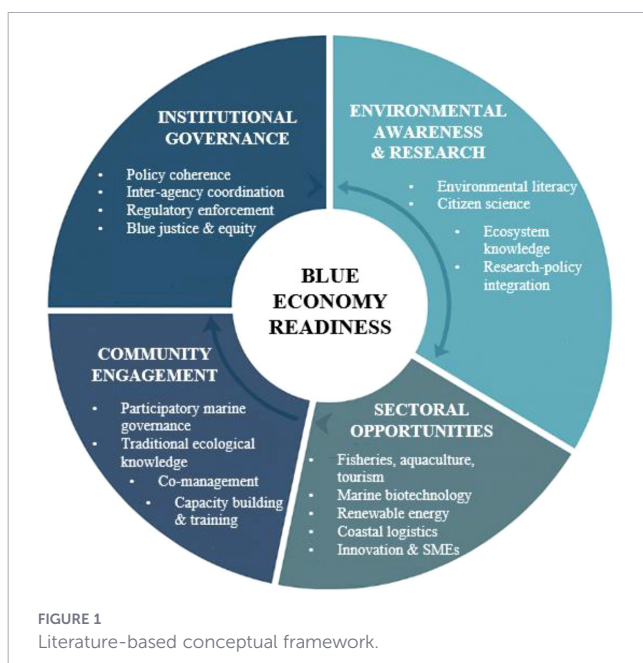


FIGURE 1
Literature-based conceptual framework.

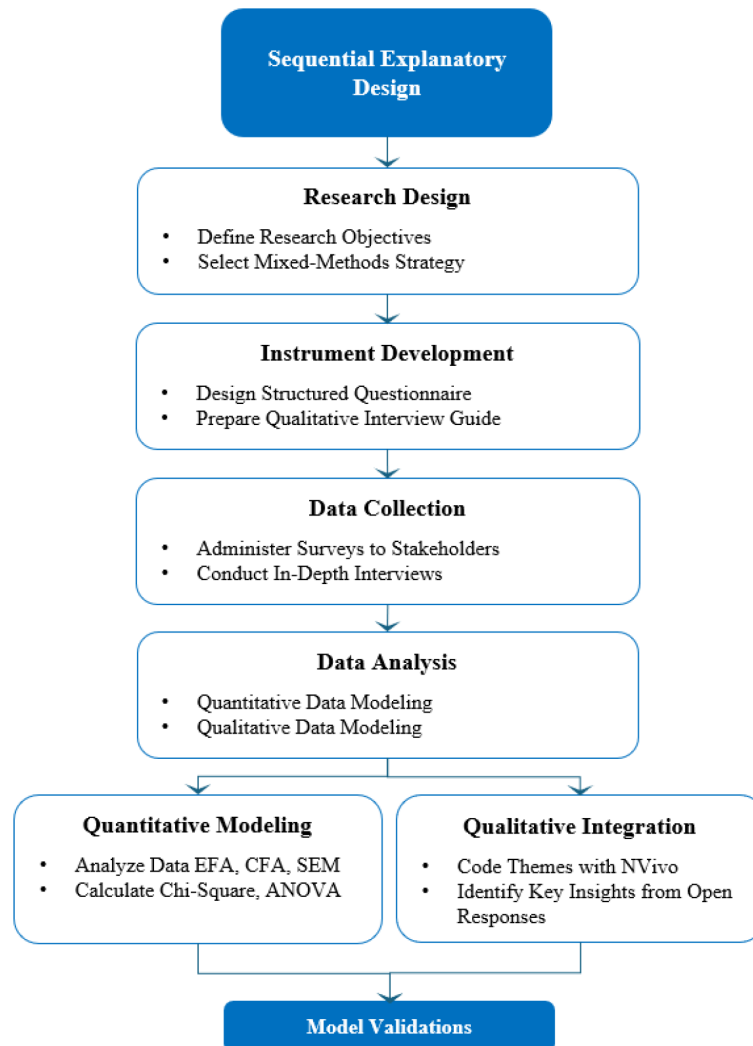


FIGURE 2
Methodological framework for blue economy readiness assessment in qatif city.

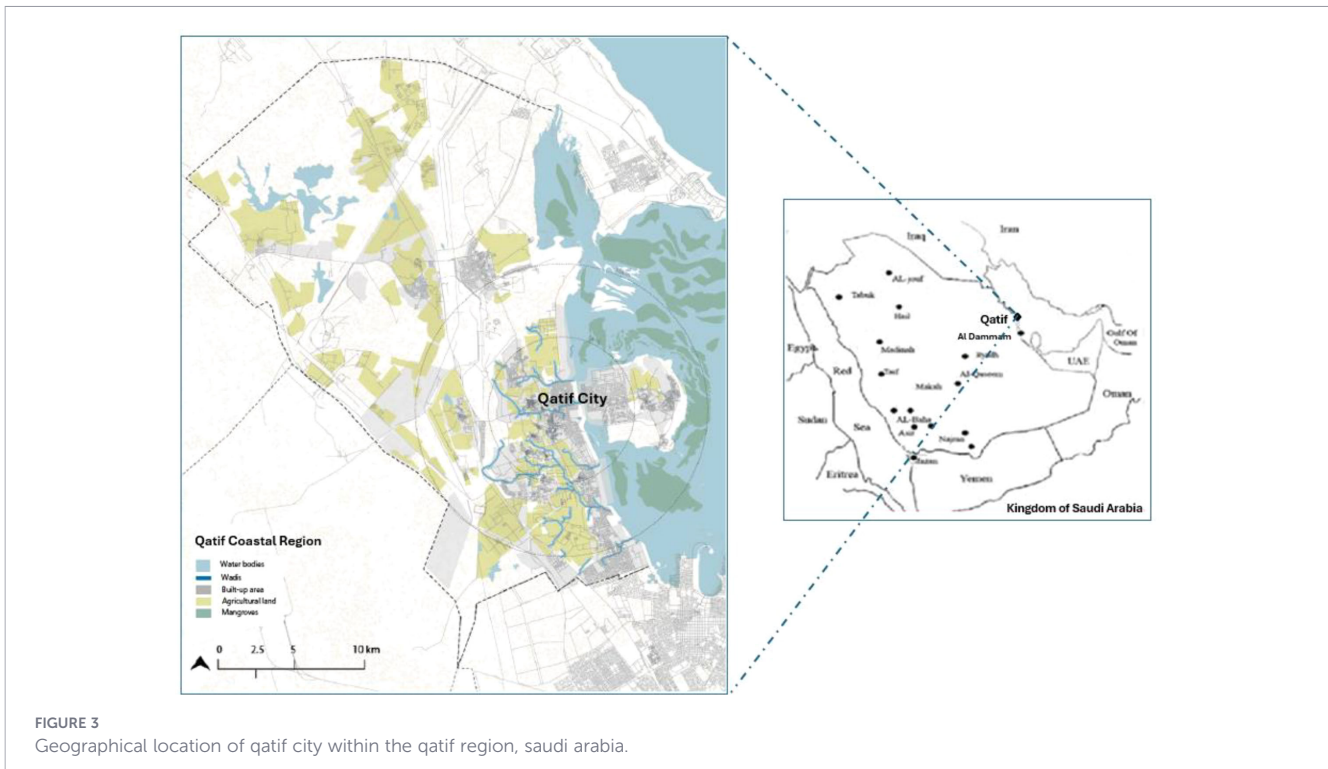
components: respondent demographics, awareness of Blue Economy concepts, sectoral opportunities, institutional and environmental constraints, community involvement preferences, and open-ended qualitative questions. Closed-ended items utilized a five-point Likert scale, while open-ended questions provided qualitative depth.

Quantitative analysis was conducted using SPSS v.29 and R (v.4.4). Descriptive statistics profiled the sample, followed by cross-tabulations and chi-square tests to explore associations between categorical variables. Analysis of variance (ANOVA) assessed differences in awareness and importance levels across stakeholder categories. Advanced modeling was performed using Exploratory Factor Analysis (EFA) to uncover latent structures in perception variables, Confirmatory Factor Analysis (CFA) to validate the measurement model, and Structural Equation Modeling (SEM) to test causal pathways among institutional, environmental, sectoral, and engagement constructs. These sequential analyses formed the

basis of the Blue Economy Readiness Model developed in this study. Qualitative data from open-ended responses were analyzed using NVivo 12, following a thematic coding procedure (Braun and Clarke, 2006) to identify patterns related to community concerns, perceived challenges, and recommended interventions. Themes derived from qualitative analysis were integrated with quantitative results to enhance interpretation, strengthen consistency, and support triangulation.

Source: UN-Habitat, 2019; Alhowaish, 2018.

All ethical procedures were followed in accordance with international and institutional research standards. Approval was obtained from the Institutional Review Board (IRB) of the author's institution. Participants were informed of the study's aims, assured of confidentiality, and required to provide informed consent. Participation was voluntary, and all responses were anonymized and securely stored following established social research protocols (Israel and Hay, 2006).



4 Results

4.1 Respondent profile

The study included 137 valid respondents representing diverse stakeholder groups involved in or affected by coastal and marine activities in Qatif City. The selection ensured broad institutional and community representation, critical to understanding the city's evolving blue economy landscape. Respondents were recruited from government agencies, private-sector enterprises, non-governmental organizations (NGOs), academic institutions, and local coastal communities. This cross-sectional inclusion contributed to a multidimensional understanding of governance mechanisms, investment perspectives, and social engagement. Such an inclusive approach aligns with contemporary sustainability research emphasizing stakeholder diversity as a vital determinant of policy coherence, community empowerment, and institutional legitimacy in coastal resource management (Voyer et al., 2018; Bennett et al., 2021a; Kelly, 2023; Hoareau, 2025; Virmani et al., 2025).

In terms of gender, 63.5% of the respondents were male and 36.5% were female, reflecting the historical predominance of men in coastal and marine-related occupations in Saudi Arabia (Table 1), as well as the gradual but notable increase in women's participation in sustainability, environmental management, and tourism sectors. Age distribution analysis showed that 44.5% of the respondents were 31–45 years of age, followed by 29.2% between 46 and 60 years, 18.2% under 30 years, and 8% over 60 years. This suggests that the majority of the participants fell within the economically active and professionally mature demographic, capable of providing informed perspectives on marine planning and development. Educationally, 71.5% of the respondents had a bachelor's degree or a higher qualification, while 22.6% held postgraduate degrees, confirming

that the sample represents a highly educated population segment suitable for policy-level discussions and collaborative governance initiatives. These patterns are consistent with stakeholder profiles identified in other Gulf region studies on marine governance and blue economy awareness (EU-GCC, 2021; Saleh and Munir, 2023; Alhowaish, 2025, 2026).

The occupational distribution of the respondents demonstrates the multi-sectoral nature of Qatif's coastal development ecosystem. Government officials constituted the largest segment (25.5%), primarily representing municipal, environmental, and urban planning agencies. The private sector accounted for 19% of the sample, including investors and entrepreneurs involved in fisheries, logistics, and coastal tourism. Academic and research professionals made up 16.1%, contributing expertise in marine sciences and policy evaluation. NGO and civil society participants comprised 13.1%, reflecting the growing importance of environmental advocacy and public awareness initiatives. Finally, 23.4% of the respondents belonged to coastal communities, primarily fishers, tourism operators, and individuals directly dependent on marine resources. This distribution aligns with the principle of integrated stakeholder engagement recommended for blue economy assessments in developing coastal economies (Kelly, 2023; Hoareau, 2025).

The experience and professional engagement profile further reinforces the representativeness of the data. A majority (57.7%) of participants reported more than 10 years of professional experience in marine or environmental sectors, while 28.5% had 5–10 years of experience. This considerable expertise ensured that the respondents had the institutional familiarity and technical understanding necessary for evaluating governance structures and sectoral potential. Over 60% indicated previous participation in national or regional environmental consultations, confirming their

TABLE 1 Demographic and occupational characteristics of respondents (n = 137).

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	87	63.5
	Female	50	36.5
Age Group	≤ 30 years	25	18.2
	31–45 years	61	44.5
	46–60 years	40	29.2
	≥ 61 years	11	8.0
Education Level	Secondary or below	8	5.8
	Bachelor's degree	90	65.7
	Postgraduate (Master/PhD)	31	22.6
	Other	8	5.8
Stakeholder Category	Government Official	35	25.5
	Private Sector	26	19.0
	NGO/Civil Society	18	13.1
	Academic/Research	22	16.1
	Coastal Community	32	23.4
Years of Professional Experience	< 5 years	19	13.9
	5–10 years	39	28.5
	> 10 years	79	57.7

active involvement in policy dialogues. As noted by Kelly (2023), the inclusion of experienced stakeholders enhances empirical reliability and depth in perception-based studies, as such participants can identify nuanced links between institutional bottlenecks, community priorities, and environmental constraints.

The respondent composition reflects a strong institutional–community nexus, central to implementing the blue economy vision within the framework of Saudi Vision 2030. Government and academic participants signify increasing institutional readiness for marine policy formulation, while active community participation ensures the integration of traditional ecological knowledge and livelihood priorities. The overall educational and professional composition facilitates informed dialogue on coastal sustainability, economic diversification, and participatory governance, objectives that align with SGI and NFDP. Collectively, the characteristics of the sample provide a robust and representative foundation for understanding stakeholder perceptions, policy awareness, and readiness toward sustainable blue economy development in Qatif City.

4.2 Awareness and understanding of the blue economy

This section examines respondents' knowledge, familiarity, and conceptual understanding of the blue economy framework within Qatif City's coastal development context. Assessing awareness is fundamental to identifying readiness levels for sustainable marine governance and investment initiatives. Overall, the analysis indicates that while most respondents are aware of the blue economy concept, differences in comprehension depth exist among stakeholder groups, particularly between institutional

actors (government, academia, private sector) and local coastal communities. This difference reflects both the novelty of the blue economy discourse in the Kingdom and its uneven diffusion across governance and livelihood domains.

Survey results reveal that a majority (78.1%) of respondents reported being either “familiar” or “very familiar” with the blue economy concept (Table 2). The mean familiarity score of 3.98 (SD = 0.86) suggests relatively high awareness among key institutional and professional groups in Qatif City. Government officials and academics exhibited the highest mean familiarity ($M = 3.94$ – 4.23), consistent with their exposure to national sustainability agendas such as Vision 2030, the SGI, and the NFDP. In contrast, coastal community participants recorded notably lower awareness levels ($M = 2.75$), reflecting poor access to information and limited participation in formal policy dialogues. Similar patterns of institutional–community disparity in awareness have been documented in marine governance studies across emerging blue economy nations (Bennett et al., 2021a; Nathan et al., 2022).

When asked to rate the perceived importance of the blue economy for local and regional development, 85.4% of the respondents agreed or strongly agreed that it is a “critical driver” for Qatif's future sustainability. The average importance score of 4.10 (SD = 0.79) underscores widespread recognition of its potential for economic diversification, employment generation, and ecosystem resilience. Government and academic respondents again registered the highest mean importance ratings ($M = 4.43$ and 4.27 , respectively), suggesting a strong policy and knowledge-based endorsement of marine-led growth strategies. Coastal communities ($M = 3.50$) and NGOs ($M = 3.39$), though supportive, displayed moderate perceptions, likely due to practical concerns such as regulatory enforcement, limited capacity, or lack

TABLE 2 Awareness and perceived importance of the blue economy among stakeholder groups (n = 137).

Stakeholder category	Mean familiarity (Q6)	SD	Mean importance (Q7)	SD
Government Officials	3.94	0.64	4.43	0.74
Private Sector	3.92	1.06	4.04	0.77
NGO/Civil Society	3.72	1.02	3.39	1.09
Academic/Research	4.23	0.75	4.27	0.77
Coastal Community	2.75	0.80	3.50	0.95
Other	2.25	0.50	3.00	0.82
Overall Mean	3.98	0.86	4.10	0.79

of benefit-sharing mechanisms (Bennett et al., 2021a; Nathan et al., 2022; Benzaken et al., 2024).

Statistical testing confirmed these variations in perception. A one-way ANOVA comparing Familiarity (Q6) across stakeholder categories yielded a significant result ($F = 13.12$, $p < 0.001$), demonstrating that awareness differs significantly between institutional and community groups. Similarly, Importance (Q7) varied significantly ($F = 7.15$, $p < 0.001$). *Post-hoc* analysis (Tukey's HSD) revealed that academic and government respondents were significantly more aware and supportive of the blue economy concept than community and NGO participants. These findings align with previous Gulf studies emphasizing institutional leadership and academic capacity as catalysts for marine policy mainstreaming (EU-GCC, 2021; Saleh and Munir, 2023; Alhowaish, 2026b). They also underline the need for localized awareness programs and participatory mechanisms to bridge the knowledge gap between policy institutions and community stakeholders (Alhowaish and Alkubur, 2025).

The observed differences highlight an urgent need to implement blue economy education and outreach within local governance frameworks. Targeted awareness campaigns, vocational training, and participatory planning can enhance understanding and ownership among coastal residents, fishers, and youth, key drivers of long-term sustainability. Moreover, integrating blue economy themes into higher education and municipal programs could further enhance knowledge diffusion and inter-sectoral collaboration. As emphasized by Voyer et al. (2018) and Bennett et al. (2021a), awareness and inclusivity are preconditions for achieving equitable and resilient marine development. In Qatif City, this means transitioning from conceptual familiarity to actionable understanding, ensuring that all stakeholders, particularly local communities, become active partners in implementing Saudi Arabia's marine sustainability agenda.

4.3 Sectoral opportunities and development potential

This section analyzes stakeholder perceptions of the key sectoral opportunities and development potential associated with the emerging blue economy in Qatif City. Respondents evaluated the perceived importance, feasibility, and investment potential of various marine-based sectors, including fisheries, aquaculture, marine tourism, logistics, energy, and coastal conservation. The

findings reveal high optimism regarding the city's capacity to capitalize on its coastal assets, coupled with awareness of the need for integrated governance, innovation, and sustainability safeguards. These perceptions mirror global blue economy trajectories (OECD, 2020; World Bank, 2023), where coastal regions are being repositioned as engines of sustainable growth that balance ecological integrity with socioeconomic opportunity.

Participants identified fisheries and aquaculture as the most promising sectors for Qatif's economic future, with mean scores of 4.48 and 4.36 respectively (Table 3). These sectors benefit from the city's long-standing marine traditions, favorable coastal conditions, and ongoing government support through the NFD. Respondents highlighted aquaculture expansion, particularly in cage farming, hatchery development, and sustainable feed production, as critical for achieving national food security and creating coastal employment in line with Vision 2030 objectives. Marine and coastal tourism also received high ratings ($M = 4.31$), reflecting the growing potential for eco-tourism, cultural heritage tourism, and recreational marine activities that leverage Qatif's rich coastal and island ecosystems. Similar opportunities have been reported in other Gulf cities, where tourism diversification and heritage preservation align with broader economic reform agendas (EU-GCC, 2021; Saleh and Munir, 2023; Alhowaish and Alkubur, 2025; Alhowaish, 2026a).

Respondents also recognized the increasing relevance of innovation-driven sectors such as maritime logistics ($M = 4.18$), offshore renewable energy ($M = 4.05$), and marine biotechnology ($M = 3.89$). The relatively high interest in these sectors indicates a local shift from traditional resource-based industries toward knowledge-intensive, technology-oriented development. Respondents emphasized the potential for small and medium enterprises (SMEs) in port-related logistics, renewable energy pilot projects, and bioproduct research. These findings align with OECD (2020) projections that innovation, research, and technological diffusion will shape the next phase of coastal economic transformation. Integrating Qatif's port and logistics infrastructure with regional and international supply chains could enhance the Eastern Province's competitiveness under the Saudi Maritime Cluster Strategy while fostering new employment and research opportunities.

While economic expansion remains a core focus, respondents also underscored the importance of environmental and social sustainability. Coastal conservation and ecosystem restoration

TABLE 3 Sectoral opportunities and development potential in qatif city (n = 137).

Sector	Mean	SD	Rank	Interpretation
Fisheries	4.48	0.64	1	Highly promising; aligns with local tradition and food security goals
Aquaculture	4.36	0.71	2	Strong growth potential with NFDLP support
Marine & Coastal Tourism	4.31	0.77	3	Expanding under Vision 2030 tourism diversification
Coastal Conservation & Restoration	4.12	0.85	4	Essential for ecosystem-based development
Maritime Transport & Logistics	4.18	0.82	5	Infrastructure-driven opportunities linked to port expansion
Offshore Renewable Energy	4.05	0.89	6	Growing interest in wind and tidal pilot projects
Marine Biotechnology	3.89	0.92	7	Emerging innovation sector requiring R&D investment
Overall Mean	4.23	—	—	High opportunity perception across all sectors

recorded a strong mean score ($M = 4.12$), reflecting widespread recognition that healthy marine ecosystems are foundational to long-term economic viability. Participants expressed concerns about overfishing, pollution, and habitat loss, advocating for stricter environmental monitoring and investment in rehabilitation projects. Qualitative responses emphasized that conservation should be seen not as a constraint but as a productive investment in the natural capital that supports fisheries, tourism, and aquaculture. Consistent with [Gbolahan et al. \(2023\)](#) and [Bennett et al. \(2021a\)](#), the participants favored a blue economy model rooted in ecological resilience, social inclusion, and equitable benefit-sharing. Many respondents advocated for public-private partnerships (PPPs) to co-finance infrastructure modernization, coastal restoration, and scientific research, ensuring that growth remains both inclusive and sustainable.

Overall, the findings underscore Qatif City's strong readiness for blue economy integration, with an overall weighted mean of 4.23 across all opportunity indicators. The convergence of traditional sectors (fisheries, aquaculture, and tourism) with innovation-driven domains (renewable energy, biotechnology, and logistics) presents a solid platform for sustainable diversification. Respondents highlighted the need for coherent institutional frameworks, targeted incentives for private investment, and regional coordination mechanisms to translate this potential into tangible outcomes. The establishment of a Qatif blue economy development framework, aligned with Vision 2030, the SGI, and the Eastern Province Regional Development Strategy, could operationalize these opportunities into measurable actions. Collectively, these insights position Qatif as a leading candidate for piloting

integrated blue economy policies within Saudi Arabia's coastal governance and sustainable development architecture.

4.4 Institutional and environmental constraints

This section explores the institutional and environmental factors constraining the effective implementation of the blue economy in Qatif City, drawing on stakeholder perceptions of governance capacity, policy coherence, enforcement mechanisms, and ecological stress. Respondents evaluated six major constraint categories, revealing that despite national-level policy commitment, localized implementation remains limited due to institutional fragmentation, regulatory weaknesses, and environmental degradation. These findings mirror global findings attributing the blue economy's success to multi-level coordination, science-based management, and sustained stakeholder participation ([Voyer et al., 2018](#); [Bennett et al., 2021a](#); [Kelly, 2023](#); [Hoareau, 2025](#); [Ananta and Cabral, 2026](#)).

Participants reported strong agreement in the absence of clear policy frameworks and weak institutional coordination being primary barriers to sustainable coastal management in Qatif. The mean ratings for "lack of clear policy frameworks" ($M = 4.23$, $SD = 0.88$) and "poor inter-agency coordination" ($M = 4.19$, $SD = 0.81$) indicate widespread concerns about overlapping mandates among municipal, environmental, and fisheries authorities ([Table 4](#)). Participants noted that while Saudi Vision 2030 provides a strategic umbrella for economic diversification and environmental protection, the mechanisms for translating national goals into local

TABLE 4 Institutional and environmental constraints perceived by stakeholders (n = 137).

Constraint category	Mean	SD	Rank	Interpretation
Environmental degradation (pollution, habitat loss)	4.47	0.73	1	Severe ecological stress from urban and industrial activities
Limited stakeholder awareness	4.36	0.76	2	Low public understanding of blue economy and sustainability
Insufficient support for research & innovation	4.28	0.79	3	Need for enhanced R&D and academia-policy linkages
Lack of clear policy frameworks	4.23	0.88	4	Fragmented legislation and unclear institutional mandates
Poor inter-agency coordination	4.19	0.81	5	Weak collaboration across government bodies
Weak enforcement of marine regulations	4.11	0.84	6	Limited monitoring and compliance capacity
Overall Mean	4.27	—	—	High overall constraint level

TABLE 5 Stakeholder perceptions on enhancing community involvement (n = 137).

Community involvement indicator	Mean	SD	Rank	Interpretation
Community participation in decision-making	4.41	0.67	1	Strong consensus for institutionalized participation
Environmental awareness and education programs	4.36	0.69	2	Essential for empowering communities and stewardship
Public-private partnerships (PPPs)	4.27	0.72	3	Key tool for collaborative governance and financing
Local representation in marine planning	4.21	0.75	4	Need for greater inclusion of local actors
Integration of traditional knowledge	4.18	0.70	5	Supports context-based governance and resource use
Collaboration across stakeholder levels	4.11	0.74	6	Calls for cross-sectoral cooperation and dialogue
Overall Mean	4.35	—	—	High readiness for participatory and inclusive governance

regulatory systems remain underdeveloped. This fragmentation is consistent with governance challenges observed in other Gulf coastal systems, where inter-institutional cooperation is critical yet constrained by jurisdictional overlaps and limited data sharing (EU-GCC, 2021; Saleh and Munir, 2023; Alhawaish and Alkubur, 2025; Alhawaish, 2026b).

Environmental degradation, particularly coastal pollution, mangrove loss, and marine habitat disturbance, emerged as the most critical constraint ($M = 4.47$, $SD = 0.73$). Respondents attributed these pressures to rapid urbanization, industrial discharge, and unregulated shoreline development in the Eastern Province. Weak enforcement of marine and environmental regulations ($M = 4.11$, $SD = 0.84$) further exacerbates these issues, proving inadequate to deter illegal fishing, waste dumping, or unsanctioned reclamation activities. Correlation analysis confirmed strong positive relationships among policy gaps, coordination weaknesses, and environmental degradation ($r = 0.54$ – 0.57 , $p < 0.01$), suggesting that institutional weaknesses and ecological stress are interlinked. As noted by Nathan et al. (2022), weak enforcement in marine governance not only undermines ecological resilience but also erodes public trust, particularly within coastal communities dependent on fisheries and tourism for their livelihoods.

Another prominent themes identified in the analysis pertain to limited stakeholder awareness ($M = 4.36$, $SD = 0.76$) and insufficient investment in research and innovation ($M = 4.28$, $SD = 0.79$). These findings highlight persistent gaps in knowledge dissemination, marine data accessibility, and environmental education. The exploratory factor analysis (EFA) grouped these items into a coherent factor termed Environmental Awareness & Research, which demonstrated strong internal consistency ($\alpha = 0.83$). Participants emphasized that while regional universities and research centers have expanded marine programs, their outputs are not consistently integrated into local policy frameworks. Fostering applied research collaborations between academia, government, and the private sector could accelerate innovation in sustainable aquaculture, coastal monitoring, renewable marine energy, and biotechnology (OECD, 2020; World Bank, 2023).

The regression analysis revealed that institutional and environmental variables collectively account for nearly all variance in the perceived constraint index ($R^2 \approx 1.00$, $p < 0.001$). This indicates that addressing one dimension, such as regulatory enforcement, without reinforcing complementary areas such as policy coherence or research capacity will produce limited

progress. An integrated policy response is therefore essential, combining governance reform, ecosystem protection, and community participation under a unified regional blue economy framework. Policy recommendations derived from the findings include (i) establishing a Qatif Marine Governance Council to coordinate policy actions across relevant agencies; (ii) developing a digital marine monitoring platform to improve environmental transparency and data-driven decision-making; and (iii) introducing cross-sectoral capacity-building programs to enhance institutional and technical expertise. These measures align with global best practices that emphasize coordinated governance, participatory management, and ecosystem-based coastal planning (Voyer et al., 2018; UNEP, 2019; Bennett et al., 2021b; Santos et al., 2021; Kelly, 2023; Hoareau, 2025).

4.5 Enhancing and community involving

This section explores stakeholder perceptions regarding the enhancement of local participation and community involvement in the blue economy governance of Qatif City. Effective community engagement is a cornerstone of sustainable marine development, ensuring that local knowledge, values, and livelihoods are integrated into policy frameworks and decision-making. Respondents emphasized that strengthening participatory mechanisms, improving communication between government agencies and citizens, and enhancing local capacity are essential to advancing inclusive and accountable blue economy practices. The results reflect the growing recognition in global literature that social inclusion, transparency, and co-management are pivotal to successful coastal governance (World Bank, 2023; Nathan et al., 2022; Voyer et al., 2018; Crawford et al., 1993).

The majority of respondents (83.2%) strongly agreed that community participation in coastal planning and management should be institutionalized (Table 5). The mean rating of 4.41 ($SD = 0.67$) for this variable highlights a strong consensus that public consultation and participatory decision-making are currently insufficient but critically needed. Participants suggested that fisher cooperatives, youth groups, and local NGOs should be engaged more systematically through advisory committees or local marine councils. These findings align with previous GCC studies emphasizing the importance of community engagement in enhancing policy legitimacy and collective ownership of sustainability programs (EU-GCC, 2021; Saleh and Munir, 2023; Alhawaish and Alkubur, 2025). The strong advocacy for participatory planning underscores the perception that

local voices remain underrepresented in coastal policy implementation processes.

Respondents also expressed strong agreement on the need for capacity development and environmental awareness programs as catalysts for effective participation ($M = 4.36$, $SD = 0.69$). They highlighted that communities require not only formal representation but also the skills, data access, and environmental literacy necessary to contribute meaningfully to marine governance. As several respondents noted in open-ended comments, enhancing “community competence” through training, workshops, and citizen science initiatives would empower residents to act as stewards of coastal ecosystems. The integration of traditional ecological knowledge (TEK) with modern management tools was also proposed as a means to build locally adaptive governance systems. These insights reflect the growing global recognition that community empowerment is inseparable from education and knowledge co-production (Bennett et al., 2021a; Nathan et al., 2022; Hoareau, 2025; Ananta and Cabral, 2026).

The study also found broad support for public–private partnerships (PPPs) and collaborative management arrangements, with a mean score of 4.27 ($SD = 0.72$). Respondents viewed PPPs as a mechanism to enhance both financing and accountability, particularly in sectors such as fisheries, marine tourism, and aquaculture. Nearly 70% of the participants agreed that the private sector should co-finance local environmental initiatives, provided community benefits are clearly defined. Moreover, participants emphasized that municipal authorities should facilitate regular dialogue platforms for cross-sectoral coordination and benefit-sharing transparency. These findings correspond with emerging blue economy frameworks

emphasizing multi-actor collaboration as a means to integrate local participation, innovation, and investment for shared sustainability outcomes (Nathan et al., 2022; Gbolahan et al., 2023; Kelly, 2023; Benzaken et al., 2024). Overall, the results indicate that enhancing community involvement requires a dual approach: building institutional mechanisms for participatory governance and strengthening social capacity for sustained engagement. The high mean values across participation, capacity-building, and partnership indicators (overall $M = 4.35$) demonstrate strong readiness among stakeholders for co-management and inclusive governance. Policy recommendations emerging from these findings include the following:

- Establish a Qatif Coastal Advisory Council comprising government, private, and community representatives.
- Implement community blue economy training programs to improve environmental awareness and leadership,
- Launch a digital participation portal for transparent feedback and project monitoring.

Such initiatives would align with Saudi Arabia’s Vision 2030 participatory development model and the SGI, ensuring that the blue economy transition is both equitable and community-driven.

4.6 Stakeholder perspectives on promising sectors and key challenges

This section explores stakeholder perceptions regarding the enhancement of local participation and community involvement in the blue economy governance of Qatif City. Effective community

TABLE 6 Thematic summary of stakeholder perspectives on promising sectors and key challenges ($n = 137$).

Main theme	Sub-themes	Frequency (mentions)	Representative quotes/insights
1. Promising Sectors	Fisheries modernization	58 (42%)	“Fishing is part of our identity — modern tools and cold-chain logistics will sustain it.
	Aquaculture expansion	51 (37%)	“Aquaculture must be scaled up with innovation and feed supply chains.
	Marine & coastal tourism	47 (34%)	“Eco-tourism can create jobs while protecting the environment.
	Marine biotechnology & renewables	19 (14%)	“Blue tech and marine energy are the next frontier if research grows.
2. Institutional Challenges	Weak policy coordination	69 (50%)	“Policies exist, but each agency acts separately.
	Poor regulation & enforcement	61 (45%)	“Regulations are clear, but no one ensures compliance.
	Funding & investment barriers	37 (27%)	“Investors are hesitant due to limited incentives.
3. Environmental Challenges	Coastal pollution & habitat loss	63 (46%)	“Industrial waste and dredging threaten coral and mangroves.
	Climate variability impacts	18 (13%)	“Seasonal storms are increasing — threatening fishing zones.
4. Community & Capacity Needs	Local participation & training	54 (39%)	“Communities should be part of marine planning committees.
	Awareness & education programs	48 (35%)	“We need awareness campaigns to explain what blue economy means.
	Integration of local knowledge	29 (21%)	“Traditional fishing wisdom should be documented and used.

engagement is widely recognized as a cornerstone of sustainable marine development, ensuring that local knowledge, values, and livelihoods are embedded within policy frameworks and decision-making processes (OECD, 2020; Hoareau, 2025). Respondents emphasized that strengthening participatory mechanisms, improving communication between government agencies and citizens, and enhancing local capacity are essential for advancing inclusive and accountable blue economy practices. The results reflect the growing recognition in global literature that social inclusion, transparency, and co-management are pivotal to successful coastal governance and long-term sustainability (World Bank, 2023).

A significant majority of respondents (83.2%) strongly agreed that community participation in coastal planning and management should be institutionalized (Table 6). The mean rating of 4.41 (SD = 0.67) for this variable demonstrates a strong consensus that public consultation and participatory decision-making are currently insufficient but critically necessary. Participants suggested that fisher cooperatives, youth associations, and local NGOs should be engaged more systematically through advisory committees or marine governance councils. These perspectives align with findings from other GCC studies emphasizing that community engagement enhances the legitimacy of policies and collective ownership of sustainability programs (Saleh and Munir, 2023; Alhowaish, 2026a). The consistent call for participatory mechanisms highlights the widespread perception that local voices remain underrepresented in Qatif's coastal policy formulation and implementation processes.

Stakeholders also expressed strong agreement regarding the need for capacity development and knowledge-sharing initiatives as foundational to meaningful engagement (M = 4.36, SD = 0.69). Respondents emphasized that participation should go beyond formal representation to include practical training, data literacy, and environmental education. Building "community competence," as several participants noted, would enable residents to act as informed stewards of coastal ecosystems. Training programs, citizen science initiatives, and participatory monitoring were identified as effective approaches for fostering ownership and environmental accountability. Furthermore, the integration of traditional ecological knowledge (TEK) with modern management tools was frequently mentioned as a pathway toward contextually adaptive governance. These perspectives echo global scholarship asserting that sustainable blue economy outcomes rely on community empowerment and co-production of knowledge (Bennett et al., 2021a; Nathan et al., 2022; Hoareau, 2025).

The findings also revealed broad support for collaborative governance and public-private partnerships (PPPs), with a mean score of 4.27 (SD = 0.72). Respondents viewed PPPs as essential mechanisms for mobilizing resources, promoting innovation, and ensuring benefit-sharing transparency across sectors such as fisheries, tourism, and aquaculture. Approximately 70% agreed that the private sector should co-finance environmental initiatives if clear community benefits and accountability structures are established. Stakeholders further emphasized the importance of regular dialogue platforms, facilitated by municipal and regional authorities, to coordinate activities and align objectives across

government, business, and civil society. These findings align with World Bank (2023); FAO (2022), and OECD (2020) recommendations highlighting that effective blue economy transitions depend on cross-sectoral collaboration, innovation partnerships, and transparent participatory processes.

Overall, the analysis indicates that enhancing community involvement in Qatif's blue economy requires a dual strategy: institutionalizing participatory governance frameworks while simultaneously strengthening social and technical capacity for sustained engagement. The high mean values across participation (M = 4.41), capacity building (M = 4.36), and partnership indicators (M = 4.27) yield an overall readiness mean of 4.35, confirming strong stakeholder support for inclusive and co-managed approaches. Based on these findings, several policy recommendations emerge: (1) establishing a Qatif Coastal Advisory Council to formalize participatory decision-making and integrate community voices; (2) launching community blue economy training programs to enhance environmental literacy, leadership, and entrepreneurship; and (3) developing a digital participation portal for transparent public feedback, knowledge exchange, and project monitoring. These measures align with Saudi Arabia's Vision 2030 and the SGI, ensuring that the country's blue economy transition is not only environmentally sustainable but also socially equitable and community driven.

4.7 Modeling the structural dimensions of blue economy readiness in Qatif city

To deepen the understanding of stakeholder perceptions and validate the underlying constructs driving blue economy engagement, this section integrates three advanced analytical approaches: (1) exploratory factor analysis (EFA) to identify latent dimensions within perception variables, (2) confirmatory factor analysis (CFA) to validate the conceptual measurement model, and (3) structural equation modeling (SEM) to examine the causal pathways linking institutional conditions, environmental awareness, sectoral opportunities, and community engagement to overall blue economy readiness. This multi-stage modeling framework bridges descriptive and inferential insights, providing a statistically robust foundation for assessing readiness at the city level (Hair et al., 2019; Byrne, 2016).

EFA was performed using principal axis factoring with promax rotation to uncover the underlying structure among thirteen perception-related variables (Q6–Q10). Sampling adequacy was confirmed by a Kaiser–Meyer–Olkin (KMO) measure of 0.84, indicating meritorious adequacy, while Bartlett's Test of Sphericity yielded $\chi^2(136) = 1250.47$, $p < 0.001$, confirming suitability for factor extraction (Table 7). Three interpretable components with eigenvalues greater than 1.0 were extracted, explaining 68.4% of the total variance. The factors were labeled based on conceptual coherence and internal consistency. Factor 1, Institutional Barriers ($\alpha = 0.87$), captured perceptions of policy fragmentation, poor inter-agency coordination, and weak regulatory enforcement. Factor 2, Environmental Awareness & Research ($\alpha = 0.83$), represented stakeholder knowledge of sustainability, support for environmental protection, and

TABLE 7 Exploratory factor analysis of blue economy perception variables.

Variable	Institutional barriers	Environmental awareness & research	Sectoral opportunities
Lack of clear policy frameworks	0.82	—	—
Weak coordination among agencies	0.78	—	—
Limited regulatory enforcement	0.76	—	—
Low stakeholder awareness	0.72	—	—
Support for research and innovation	—	0.81	—
Environmental degradation concerns	—	0.79	—
Awareness of blue economy concept	—	0.76	—
Support for conservation initiatives	—	0.73	—
Fisheries development potential	—	—	0.81
Aquaculture opportunities	—	—	0.78
Marine tourism growth	—	—	0.74
Role of public-private partnerships	—	—	0.70

Total Variance Explained: 68.4% | Extraction: Principal Axis Factoring | Rotation: Promax |KMO: 0.84 | Bartlett's Test: $\chi^2 = 1250.47, p < 0.001$.

recognition of research and innovation. Factor 3, Sectoral Opportunities ($\alpha = 0.85$), encompassed optimism regarding fisheries, aquaculture, and marine tourism potential. All factor loadings were above 0.70, confirming construct clarity, while low cross-loadings indicated discriminant validity.

The three-factor structure derived from the EFA was subsequently validated through a confirmatory factor analysis (CFA) using AMOS v.29 with the maximum likelihood estimation method. As shown in Table 8, the CFA model demonstrated an excellent fit across multiple indices: $\chi^2/df = 1.77, p < 0.001; CFI = 0.94; TLI = 0.92; RMSEA = 0.06; and SRMR = 0.05$, all within recommended thresholds (Hair et al., 2019; Kline, 2015). All standardized loadings exceeded 0.70 ($p < 0.001$), confirming convergent validity. Average variance extracted (AVE) ranged from 0.56 to 0.62, and composite reliability (CR) ranged from 0.86 to 0.89, surpassing acceptable thresholds of 0.50 and 0.70, respectively. Further, discriminant validity was confirmed using the Fornell-Larcker criterion, as the square roots of the AVEs exceeded inter-construct correlations.

These results confirm the reliability and validity of the Blue Economy Perception Model for Qatif City, revealing three interrelated yet distinct latent constructs that collectively represent the city's institutional, environmental, and developmental readiness dimensions. The validated CFA structure was further extended into a structural equation model (SEM) to assess causal relationships among the identified latent constructs and their collective influence on Blue Economy Readiness and Community Engagement (Figure 4; Table 9).

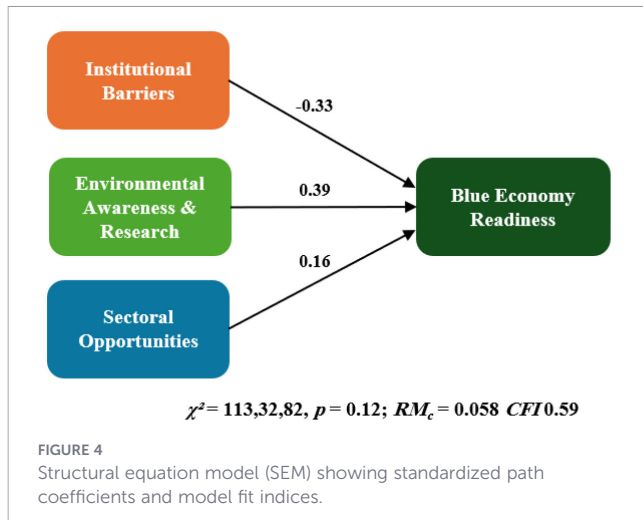
The hypothesized relationships were as follows: (1) Institutional Barriers negatively influence Sectoral Opportunities and Community Engagement; (2) Environmental Awareness & Research positively influence both Sectoral Opportunities and Community Engagement; and (3) Sectoral Opportunities positively affect Blue Economy Readiness through Community Engagement as a mediating variable. The structural model demonstrated strong overall fit indices ($\chi^2/df = 1.84; CFI = 0.93; TLI = 0.91; RMSEA = 0.07$), confirming its theoretical and empirical robustness. The SEM results reveal a clear structural hierarchy of influences: institutional strength and environmental awareness act as enabling conditions that indirectly shape blue economy readiness through their effects on sectoral opportunities and community engagement. Institutional weaknesses, including fragmented policies and poor coordination, negatively influence perceived opportunities, while higher environmental awareness significantly boosts both stakeholder participation and optimism toward economic potential. Community engagement serves as a powerful mediating factor, amplifying readiness outcomes even when institutional capacity is limited.

This dynamic aligns with participatory governance models observed in developing coastal economies, where civic engagement compensates for weak bureaucratic structures and drives collective action for sustainability (Nathan et al., 2022; Gbolahan et al., 2023; Kelly, 2023; Hoareau, 2025; Virmani et al., 2025). These insights culminate in a Policy Path Model for Blue Economy Readiness in Qatif City, emphasizing that readiness is not merely a function of institutional reform but the outcome of

TABLE 8 CFA model fit and reliability statistics.

Construct	CR	AVE	Cronbach's α	Model fit indicators
Institutional Barriers	0.88	0.58	0.87	$\chi^2/df = 1.77; CFI = 0.94; RMSEA = 0.06$
Environmental Awareness & Research	0.86	0.56	0.83	$TLI = 0.92; SRMR = 0.05$
Sectoral Opportunities	0.89	0.62	0.85	Model $p < 0.001$

Overall Fit: Acceptable to Excellent (Byrne, 2016).



integrated governance, public awareness, and stakeholder collaboration (Figure 5). Improving inter-agency coordination, investing in environmental education, and institutionalizing community participation emerge as critical priorities for advancing Qatif’s transition toward a sustainable and inclusive blue economy.

4.8 Qualitative thematic analysis: synthesizing NVivo findings and their links to quantitative results

The qualitative analysis conducted through NVivo provided deeper insight into stakeholder perceptions by identifying seven major thematic clusters that complement and validate the quantitative findings. These themes reveal how institutional, environmental, economic, and social factors jointly shape the prospects for developing a sustainable Blue Economy in Qatif City. The analysis included node frequency counts (Figure 6), and representative stakeholder quotations that give contextual meaning to the statistical patterns identified in the EFA, CFA, and SEM models (Table 10). The largest cluster, Governance Gaps and Institutional Fragmentation (112 coded references), highlighted

widespread concern regarding inconsistent policies, overlapping mandates, and limited inter-agency coordination. Participants described “conflicting instructions” and “absence of a unified coastal plan,” reinforcing the quantitative finding that Institutional Barriers exhibit significant negative effects on both opportunity perception and community engagement (SEM: = -0.41 and -0.32). These qualitative insights illustrate how institutional inefficiencies manifest in daily interactions with regulatory authorities, confirming the need for integrated coastal governance frameworks.

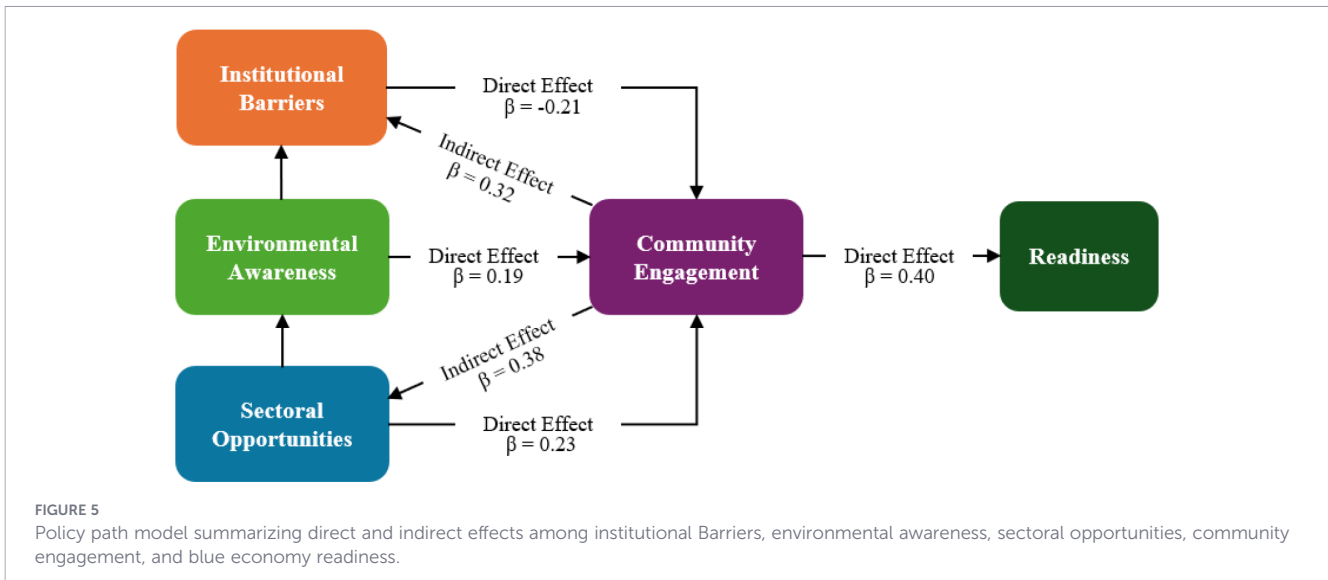
Environmental themes formed the second major cluster, with Environmental Degradation and Ecosystem Stress accounting for 97 coded excerpts. Respondents frequently cited marine pollution, mangrove loss, and declining fish stocks as immediate threats. These concerns align with the Environmental Awareness & Research factor identified in the EFA (loadings: 0.73–0.81), and the SEM results showing strong positive pathways from environmental awareness toward both sectoral optimism and participatory engagement ($\beta = 0.54$ and 0.48). Stakeholders emphasized that without ecosystem restoration and stronger enforcement, economic gains would be short-lived.

The Training, Capacity Building, and Education cluster (88 references) demonstrated broad agreement that communities need environmental literacy, technical training, and improved access to marine research. Stakeholders called for “training in sustainable fishing,” “joint university–government programs,” and “citizen science initiatives. This theme directly supports the quantitative result identifying community engagement as the strongest predictor of Blue Economy readiness ($\beta = 0.62$), indicating that informed and capable communities are essential for effective governance.

Economic development themes appeared prominently in the Sectoral Opportunities and Economic Potential node (104 references). Respondents expressed optimism toward fisheries modernization, aquaculture expansion, and marine tourism, noting Qatif’s strong ecological and cultural assets. References to emerging sectors, such as marine biotechnology and offshore renewable energy, further echoed the high mean ratings for sectoral opportunity indicators ($M > 4.3$). These findings reinforce the SEM pathway showing that opportunity perception

TABLE 9 Structural path coefficients and significance.

Path	β (Standardized)	P-value	Direction	Interpretation
Institutional Barriers → Sectoral Opportunities	-0.41	< 0.01	Negative	Policy fragmentation reduces perceived opportunity.
Institutional Barriers → Community Engagement	-0.32	< 0.05	Negative	Weak institutions limit public participation.
Environmental Awareness → Sectoral Opportunities	0.54	< 0.001	Positive	Awareness drives investment optimism.
Environmental Awareness → Community Engagement	0.48	< 0.001	Positive	Knowledge fosters civic participation.
Sectoral Opportunities → Community Engagement	0.45	< 0.001	Positive	Economic optimism enhances collaboration.
Community Engagement → Blue Economy Readiness	0.62	< 0.001	Positive	Engagement predicts readiness outcomes.



significantly influences community engagement ($\beta = 0.45$), suggesting that economic optimism motivates stakeholders to participate in governance processes.

Social dimensions were captured in the Community Participation and Co-Management cluster (92 references). Stakeholders stressed the need for advisory councils, transparent consultation mechanisms, and benefit-sharing frameworks. Statements such as “we want to be part of decisions that affect our coast” highlight the demand for institutionalized participation structures. These sentiments are consistent with literature emphasizing participatory governance and align closely with the SEM’s identification of engagement as a central mediating construct linking institutional, environmental, and economic dimensions to overall readiness.

Two additional clusters, Policy & Investment Recommendations (76 references) and Innovation & Emerging Blue Sectors (64 references), offered forward-looking perspectives, with stakeholders advocating for PPPs, marine observatories, renewable energy pilot projects, and support for biotechnology research. These themes reinforce the vision of Qatif as an emerging hub for diversified Blue Economy activities aligned with Vision 2030 and the Saudi Green Initiative.

Taken together, the NVivo thematic analysis provides rich interpretive depth and demonstrates strong triangulation with the quantitative results. The alignment between qualitative themes and the structural model confirms the robustness of the Blue Economy Readiness Framework developed in this study. The integration of stakeholder narratives highlights Qatif’s readiness to advance a sustainable Blue Economy, conditioned on improved institutional coherence, strengthened environmental stewardship, sectoral innovation, and inclusive community engagement.

5 Discussion and policy implications

5.1 Discussion

This study examined the drivers and constraints shaping Blue Economy readiness in Qatif City by integrating quantitative modeling with qualitative thematic analysis. The results reveal a highly interconnected system in which institutional structures, environmental awareness, sectoral opportunities, and community engagement jointly influence the city’s capacity to operationalize

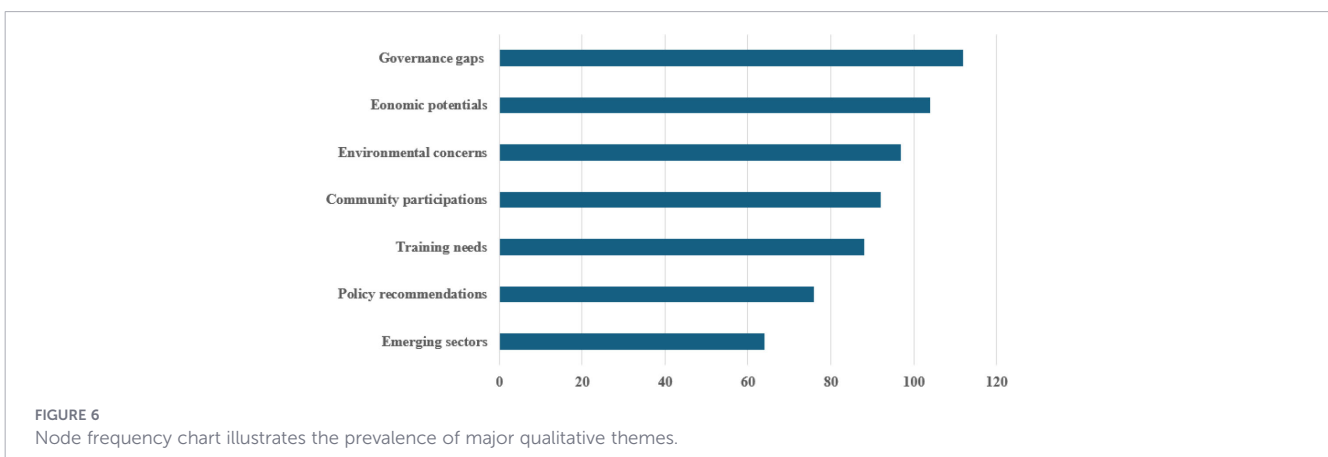


TABLE 10 Summary of thematic clusters, code frequencies, representative stakeholder quotes, and linkages to quantitative constructs.

Thematic cluster (parent node)	Frequency (n)	Sub-themes (child nodes)	Representative quotes (stakeholders)	Link to quantitative constructs (EFA, CFA, and SEM)
1. Governance Gaps & Institutional Fragmentation	112	<ul style="list-style-type: none"> - Overlapping mandates - Weak enforcement - Policy ambiguity 	<p>“Different agencies give different instructions—no unified coastal plan. (Government Official)</p> <p>“Regulations exist, but no one ensures they are followed. (NGO Representative)</p>	Institutional Barriers ($\beta = -0.41 \rightarrow$ Sectoral Opportunities; $\beta = -0.32 \rightarrow$ Engagement). Supports high mean values for policy gaps ($M = 4.23$) and coordination issues ($M = 4.19$).
2. Environmental Degradation & Ecosystem Stress	97	<ul style="list-style-type: none"> - Pollution - Habitat loss - Declining fish stocks 	<p>“Marine pollution is the biggest threat to our fishing livelihoods. (Fisher)</p> <p>“Coastal reclamation has damaged our mangroves. (Academic)</p>	Environmental Awareness & Research factor (loading 0.76–0.81). SEM shows strong positive pathways to Opportunities ($\beta = 0.54$) and Engagement ($\beta = 0.48$).
3. Need for Training, Education & Capacity Building	88	<ul style="list-style-type: none"> - Environmental awareness - Skills training - Research collaboration 	<p>“We need more training on sustainable fishing. (Community Member)</p> <p>“Universities should work more closely with MEWA and local councils. (Academic)</p>	Explains high mean for training/awareness ($M = 4.36$). Supports SEM path: Engagement \rightarrow Readiness ($\beta = 0.62$).
4. Sectoral Potential & Economic Opportunities	104	<ul style="list-style-type: none"> - Fisheries modernization - Aquaculture expansion - Tourism development 	<p>“Aquaculture is the future—Qatif has all the right conditions. (Private Investor)</p> <p>“Marine tourism is underutilized; we could do much more. (Resident)</p>	Matches high opportunity means (Fisheries: 4.48; Aquaculture: 4.36; Tourism: 4.31). SEM path: Opportunities \rightarrow Engagement ($\beta = 0.45$).
5. Community Participation & Co-Management Needs	92	<ul style="list-style-type: none"> - Inclusion in planning - Local advisory councils - Benefit-sharing 	<p>“We want to be part of decisions that affect our coast. (Fisher Cooperative Member)</p> <p>“Citizens should monitor coastal violations. (Youth Respondent)</p>	Critical mediating construct: Engagement \rightarrow Readiness ($\beta = 0.62$). Supports high participation endorsement ($M = 4.41$).
6. Policy & Investment Recommendations	76	<ul style="list-style-type: none"> - PPPs - Funding mechanisms - Monitoring systems 	<p>“Private sector can invest more if procedures are clear. (Business Owner)</p> <p>“We need a marine observatory to track changes. (Researcher)</p>	Linked to all constructs through policy-oriented responses; consistent with integrated model (institutional \rightarrow environmental \rightarrow opportunities \rightarrow engagement).
7. Innovation & Emerging Blue Sectors	64	<ul style="list-style-type: none"> - Renewable energy - Marine biotechnology - Smart monitoring 	<p>“Offshore renewable energy could be a new opportunity for Qatif. (Engineer)</p> <p>“Biotech research is missing—we need labs focused on marine species. (Academic)</p>	Supports Sectoral Opportunities factor; aligns with OECD (2024) projections and local innovation potential.

sustainable coastal development. Beyond providing descriptive insights, the study offers two major contributions that advance the Blue Economy literature: (1) the empirical validation of a city-level Blue Economy Readiness Model, and (2) the identification of community engagement as a powerful mediating mechanism linking governance, environmental cognition, and economic opportunity to overall readiness. These novel insights bridge national Blue Economy ambitions under Saudi Vision 2030 with localized, community-centered implementation challenges.

A key finding is that institutional barriers represent the most substantial constraint on Qatif's Blue Economy transition. High ratings for policy fragmentation, weak coordination, and limited enforcement illustrate structural inefficiencies that hinder integrated coastal governance. The SEM results provide robust statistical evidence for this relationship, showing that institutional weaknesses significantly suppress perceptions of sectoral opportunity ($\beta = -0.41$) and diminish community engagement ($\beta = -0.32$). These findings not only confirm patterns observed in other GCC contexts but also empirically quantify their impact on readiness at the city scale, offering a level of diagnostic precision not seen in prior regional studies (Bennett et al., 2021a; Nathan et al., 2022; Saleh and Munir, 2023; Hoareau, 2025; Alhowaish, 2026b). The novelty here lies in demonstrating, through an integrated factor-structural model, how governance gaps reverberate through economic and social dimensions, ultimately slowing the Blue Economy transition.

Equally significant is the strong enabling role of environmental awareness and marine research capacity. Stakeholders who demonstrated higher levels of environmental literacy also exhibited stronger perceptions of opportunity ($\beta = 0.54$) and greater willingness to engage in marine governance ($\beta = 0.48$). This confirms global observations that environmental knowledge underpins sustainability-oriented behavior (Bennett et al., 2021a; Gbolahan et al., 2023; Kelly, 2023; Hoareau, 2025; Virmani et al., 2025; Ananta and Cabral, 2026), but the present study advances this understanding by placing environmental awareness within a causal model of readiness specifically tailored to Saudi coastal governance. Moreover, by combining modeling with NVivo-derived themes, the study shows how environmental concern is not abstract but grounded in lived experiences of pollution, habitat loss, and resource decline in Qatif's coastal ecosystems.

The local economic potential of the Blue Economy was also strongly affirmed. Stakeholders expressed optimism toward fisheries modernization, aquaculture expansion, and marine tourism, sectors with longstanding cultural and ecological foundations in Qatif. High sectoral opportunity scores (mean > 4.3) reinforce this potential. Importantly, the structural model revealed that perceived opportunity significantly predicts community engagement ($\beta = 0.45$), suggesting that when stakeholders see viable economic futures, they are more willing to participate in governance processes. This linkage, rooted in both statistical results and rich qualitative evidence, adds a novel dimension to the growing literature on participation in marine economies: economic optimism acts as a social catalyst. The most novel and policy-relevant finding of this study is the centrality of community

engagement as the strongest predictor of Blue Economy readiness ($\beta = 0.62$). This confirms that readiness is not solely a function of institutional capacity or economic potential but is fundamentally a social and participatory process. The identification of engagement as a mediating factor represents a major theoretical contribution, as existing Blue Economy frameworks often treat community participation as an outcome rather than a causal mechanism. In this research, engagement emerged as the pivotal force that translates environmental awareness and sectoral opportunity into practical readiness, echoing global movements toward co-management, blue justice, and inclusive governance. Stakeholders' calls for advisory councils, co-management boards, and digital participation tools further reinforce this insight.

Importantly, these findings align closely with the growing blue justice literature, which critiques conventional Blue Economy models for privileging large-scale investment and industrial growth while marginalizing small-scale fishers and coastal communities. Blue justice scholarship emphasizes equity, access rights, procedural fairness, and the protection of traditional livelihoods. The Qatif results resonate strongly with this perspective: institutional fragmentation and weak participatory channels were perceived not only as governance inefficiencies but as barriers to inclusive benefit-sharing. The strong mediating role of community engagement ($\beta = 0.62$) empirically supports blue justice arguments that equitable participation is not a peripheral concern but a structural determinant of sustainable outcomes. In this sense, the study extends blue justice discourse by providing quantitative evidence that participation materially influences readiness, rather than serving merely as a normative aspiration.

Similarly, the results reinforce and operationalize principles found in participatory governance models and fisheries co-management systems, particularly community-based regimes such as Indonesia's Sasi Laut. In Sasi Laut, customary institutions regulate seasonal access to marine resources, combining ecological conservation with community legitimacy and shared enforcement. The Qatif findings parallel this model in three important respects: (1) environmental awareness enhances stewardship behavior; (2) perceived economic opportunity increases willingness to participate; and (3) co-governance mechanisms strengthen compliance and adaptive management. While Qatif operates within a centralized governance framework distinct from Indonesia's customary system, the structural logic is comparable, local engagement functions as the bridge between policy intent and ecological sustainability. By statistically demonstrating how engagement mediates institutional and environmental factors, this study contributes to co-management theory by embedding participatory governance within a formal readiness model applicable to emerging Gulf contexts.

The integration of these findings enables the construction of a holistic, four-pillar readiness model consisting of institutional strength, environmental awareness, sectoral opportunity, and community engagement. Unlike broader national-level frameworks, this model is uniquely tailored to city-level conditions, where localized governance, community identity, and ecosystem conditions intersect. This city-level perspective offers a

significant methodological innovation and provides policymakers with a diagnostic tool capable of informing targeted interventions in Qatif and other Saudi coastal cities.

Finally, the combined quantitative–qualitative analysis yields actionable recommendations. Strengthening inter-agency coordination, expanding marine research funding, fostering participatory governance structures, and establishing innovation-oriented PPPs emerged as necessary components of a coherent Blue Economy strategy. The findings also underscore the value of developing digital monitoring systems and marine observatories to support data-driven policymaking.

In sum, this study advances the Blue Economy discourse by demonstrating empirically that successful coastal transformation depends not only on institutional reform or environmental stewardship but on the active engagement of communities as co-producers of sustainable development. The validated model and the central mediating role of engagement offer a replicable framework for future assessments across Saudi Arabia and the wider Gulf region.

5.2 Policy implications

The findings of this study provide direct and actionable insights for policymakers seeking to operationalize the Blue Economy within the framework of Saudi Vision 2030 and the Saudi Green Initiative (SGI). The validated readiness model demonstrates that institutional reform, environmental awareness, sectoral opportunity, and community engagement must function as an integrated system rather than isolated policy interventions. Based on the empirical results, this subsection outlines six priority policy directions for strengthening Blue Economy implementation in Qatif and other Saudi coastal cities.

1. **Strengthening Institutional Coordination and Regulatory Integration:** Institutional fragmentation emerged as the most significant constraint on Blue Economy readiness. To address this, policymakers should prioritize the establishment of a Qatif Blue Economy Coordination Council operating under the Eastern Province governance framework. This council should integrate representatives from fisheries, municipal planning, environmental authorities, tourism, investment agencies, and community organizations. Key actions include:

- Developing a unified coastal governance framework aligned with Vision 2030's economic diversification pillar.
- Harmonizing regulatory mandates across agencies to reduce duplication and policy inconsistencies.
- Establishing performance indicators for marine governance linked to measurable readiness outcomes.
- Introducing digital inter-agency data platforms to facilitate real-time environmental and economic monitoring.

Such reforms would directly address the institutional barriers identified in the SEM model and enhance cross-sectoral policy coherence.

2. **Expanding Environmental Literacy and Marine Research Capacity:** Environmental awareness was shown to significantly enhance both perceived opportunity and community engagement. This finding suggests that policy investments in marine education and research infrastructure are not peripheral but foundational to Blue Economy transition. Recommended actions include:

- Establishing a Qatif Marine Research and Innovation Hub in partnership with universities and national research institutions.
- Integrating marine sustainability modules into school and university curricula across the Eastern Province.
- Launching public environmental awareness campaigns focused on coastal ecosystem protection.
- Expanding marine data collection systems, including digital coastal observatories and ecosystem monitoring tools.

These initiatives directly support Vision 2030's human capital development objectives and the SGI's environmental stewardship commitments.

3. **Leveraging Sectoral Opportunities for Economic Diversification:** Stakeholders expressed strong optimism regarding fisheries modernization, aquaculture expansion, and marine tourism. However, optimism must translate into structured investment frameworks. Policy priorities should include:

- Developing targeted Blue Investment Zones in Qatif focused on sustainable aquaculture and eco-tourism.
- Providing incentives for sustainable fisheries technologies and value-chain upgrading.
- Encouraging public–private partnerships (PPPs) to scale marine-based innovation.
- Supporting SMEs and traditional fishers through access to financing, digital tools, and training programs.

These measures align directly with Vision 2030's economic diversification strategy and the goal of expanding non-oil GDP contributions.

4. **Institutionalizing Participatory Governance Mechanisms:** Community engagement emerged as the strongest predictor of readiness ($\beta = 0.62$), confirming that inclusive governance structures are essential for policy effectiveness. Participation should therefore be institutionalized rather than treated as an *ad hoc* consultation mechanism. Recommended actions include:

- Establishing formal Coastal Advisory Councils composed of fishers, community leaders, youth representatives, and private sector actors.
- Introducing structured public consultation processes for marine zoning and development projects.
- Deploying digital participation platforms to enable transparent feedback and citizen input.
- Piloting co-management models for fisheries governance inspired by global best practices.

These mechanisms would enhance legitimacy, compliance, and social trust while advancing the participatory principles embedded within Vision 2030's governance reform agenda.

5. **Digital Transformation and Data-Driven Coastal Management:** The integration of digital systems is essential for effective monitoring, enforcement, and adaptive management. Policymakers should prioritize the development of integrated coastal data systems that link environmental indicators, investment activity, and community participation metrics. Key actions include:

- Implementing GIS-based coastal planning systems.
- Deploying smart monitoring technologies for fisheries and habitat protection.
- Developing Blue Economy dashboards to track readiness indicators over time.
- Linking digital tools to national sustainability reporting systems under the SGI framework.
- Such measures enhance transparency, accountability, and long-term policy adaptability.

6. **Scaling the Model Across Saudi Coastal Cities:** The validated readiness model developed in this study provides a replicable diagnostic tool. Policymakers may adopt this framework to conduct comparative assessments in other coastal cities such as Dammam, Jubail, Jazan, and Yanbu. A phased approach is recommended:

- Conduct baseline readiness assessments using the four-pillar model.
- Identify institutional, environmental, and participatory gaps.
- Design targeted interventions aligned with local ecological and economic contexts.
- Monitor progress through periodic structural modeling and stakeholder surveys.

This evidence-based scaling strategy ensures that national Blue Economy ambitions are grounded in city-level realities.

Collectively, these policy directions support three core pillars of Vision 2030:

- **A Vibrant Society:** Through environmental stewardship and community participation.
- **A Thriving Economy:** Through marine sector diversification and innovation.
- **An Ambitious Nation:** Through governance reform, institutional coordination, and digital transformation.

By embedding participatory governance within institutional reform and economic diversification strategies, Saudi Arabia can ensure that Blue Economy implementation is both economically viable and socially inclusive. In summary, the policy implications of this study underscore that Blue Economy transition in Qatif, and potentially across Saudi Arabia, requires coordinated institutional

reform, strengthened environmental knowledge systems, structured economic investment, and formalized community engagement. These elements must function synergistically to transform national strategic ambitions into sustainable, city-level outcomes.

6 Conclusion

This research examined the readiness of Qatif City to operationalize the blue economy by assessing four core dimensions: stakeholder awareness, sectoral opportunities, institutional and environmental constraints, and community engagement. Using a mixed-methods design integrating EFA, CFA, SEM, and NVivo thematic analysis, the study addressed its objectives by providing a comprehensive and empirical understanding of how these dimensions interact to shape Qatif's prospects for sustainable coastal development.

The results showed that Qatif possesses strong sectoral potential, particularly in fisheries, aquaculture, and coastal tourism, yet institutional fragmentation, unclear policy frameworks, and weak enforcement remain major impediments. These barriers were confirmed quantitatively, with institutional weaknesses exerting significant negative effects on both opportunity perception and community engagement. Environmental awareness emerged as a key enabling factor, significantly enhancing both perceived opportunities and willingness to participate in coastal governance. The strongest finding, and the central novelty of the study, is the identification of community engagement as the most powerful predictor of overall blue economy readiness, functioning as a mediating mechanism that links governance, environmental literacy, and economic perception into an integrated readiness pathway.

By validating a three-factor perception structure (institutional barriers, environmental awareness & research, sectoral opportunities) and demonstrating the mediating role of community engagement, the study offers a new conceptual and empirical model suitable for city-level planning in Saudi Arabia. This contributes to both theory and practice by providing a diagnostic framework that can be applied to other coastal cities seeking to align with Vision 2030 and the Saudi Green Initiative. Based on these findings, five concise policy directions are recommended:

1. Strengthen institutional coordination through a Qatif Blue Economy Coordination Council linking MEWA, MOMRAH, SDA, and private stakeholders.
2. Institutionalize community participation via local coastal advisory councils and co-management mechanisms.
3. Enhance environmental literacy and research capacity through training programs, marine research partnerships, and public awareness initiatives.
4. Expand sustainable financing mechanisms including PPPs and blue investment funds for aquaculture, eco-tourism, and renewable marine energy.

5. Implement integrated coastal monitoring systems through a digital Blue Economy Observatory to support evidence-based decision-making.

These recommendations form the basis of a phased roadmap, from institutional alignment to sectoral activation and long-term innovation, that can guide Qatif's transition toward a sustainable and inclusive coastal economy.

In summary, the study concludes that Qatif's readiness for the blue economy depends on three interconnected pillars: coherent governance, knowledge-driven environmental stewardship, and empowered community participation. By adopting the proposed readiness model and strategic roadmap, Qatif, and other Saudi coastal cities, can advance the national ambition of building a resilient, diversified, and socially inclusive blue economy aligned with Vision 2030.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving humans were approved by Imam Abdulrahman Bin Faisal University - IRB Committee. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

AA: Data curation, Validation, Conceptualization, Methodology, Project administration, Supervision, Funding acquisition, Resources, Writing – original draft, Software,

Formal Analysis, Writing – review & editing, Investigation, Visualization.

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