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Integrating Technology, Sustainability, and the Blue Economy to Strengthen Maritime Security and Climate Resilience under Oman's Vision 2040

在阿曼《2040愿景》框架下融合技术、可持续发展与蓝色经济，以加强海上安全与气候韧性

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Abstract:
This paper examines how technological innovation and governance can be incorporated to improve maritime security and climate resilience in the Oman blue economy in accordance with the national Vision 2040 and Sustainable Development Goal 14 (Life Below Water). We utilised a qualitative methodology and interviewed 15 Omani stakeholders in the public, private, and academic sectors, using semi-structured interviews and thematic analysis of the data collection (Braun & Clarke, 2006). The results indicate disaggregated marine information systems that do not allow effective monitoring of illegal fishing, institutional silos between the environmental and fisheries departments and expose the coastal infrastructure to sea-level rise. Stakeholders highlighted the importance of the geospatial technologies (GIS, satellite monitoring) and nature-based

Keywords: Oman Vision 2040; blue economy; maritime security; climate resilience; marine spatial data infrastructure (MSDI); thematic analysis; stakeholder perspectives

关键词：阿曼《2040愿景》；蓝色经济；海上安全；气候韧性；海洋空间数据基础设施；主题分析；利益相关者视角。

solutions (mangrove restoration) to these problems. This paper adds a feasible Marine Spatial Data Infrastructure (MSDI) model to fit in the situation involving Oman with its decentralised governance system, suggesting unified data standards and an inter-ministerial control committee to allow coordinated activity. The work offers a journey of a scalable approach of arid coastal states to balance economic diversification with long-term conservation of the marine.

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摘要：

本研究探讨技术创新与治理模式的整合，以提升阿曼蓝色经济中的海上安全与气候韧性，并与国家《2040愿景》及联合国可持续发展目标14（水下生物）相衔接。采用质性研究方法，我们对来自阿曼公共部门、私营部门及学术界的15位利益相关者进行了半结构化访谈，并运用主题分析法（Braun & Clarke, 2006）对数据进行了分析。研究发现，海洋数据系统碎片化阻碍了非法捕捞的有效监管，环境与渔业部门之间存在制度壁垒，且沿海基础设施面临海平面上升的显著威胁。利益相关者强调地理空间技术（如GIS、卫星监测）与基于自然的解决方案（如红树林修复）在应对这些问题中的关键作用。本研究提出一个适用于阿曼去中心化治理结构的实用型海洋空间数据基础设施框架，建议通过标准化数据协议和跨部门监督委员会来实现协同行动。此项工作为干旱沿海国家协调经济多元化与海洋长期保护提供了一条可扩展的路径。

1. Introduction

The Vision 2040 of Oman is a plan of national route to the diversification of the economy, increasing its global competitiveness, and sustainable development (Oman Vision Implementation Follow-up Unit, 2020). This strategic vision will focus on long-term growth of the maritime industry of the Sultanate, and this growth will be based on the geopolitical location of the country at the junction of the Arabian Sea, the Gulf of Oman, and the Indian Ocean. This theme is in line with the global requirement of the blue economy, which aims at achieving economic benefits by exploiting the ocean resources without affecting its health- a concept that is anchored in the United Nations Sustainable Development Goal 14 (SDG 14: Life Below Water) (United Nations, 2015).

The blue economy is an important opportunity for Oman, which includes renewable energy, maritime logistics, fisheries, and tourism. It is worth noting that the national green hydrogen strategy aims to produce 1.125 million tons per annum by the year 2030, and this will be assisted by an intended increase in renewable energy capacity (Abdel-Gadir & Mohammed, 2024). The development of the port, especially at Duqm and Salalah, is boosting the Omani participation in the international shipping routes. Nevertheless, there are complex challenges to the realisation of a sustainable blue economy. The long coastline of Oman is very susceptible to climatic changes such as a rise in sea level and extreme weather patterns, which can destroy coastal communities and infrastructure (Hereher et al., 2020; Al-Hatrushi et al., 2015). At the same time, the issue of maritime security, like the problem of illegal, unreported, and unregulated (IUU) fishing, threatens the sustainability of resources, regulated by the power (Al-Awadhi et al., 2021).

Technological innovation is largely regarded as key to finding a way out of these challenges. The use of Geographic Information Systems (GIS), remote sensing, and predictive modelling is also employed in Oman to assess coastal vulnerability and monitor the environment (Al-Hatrushi et al., 2015; Amna & Al-Wardy, 2023). Moreover, natural remedies such as mangrove restoration are also known to have a twofold impact on the areas of protection of the coast and maintenance of the habitats (Al-Afifi, 2018). Nonetheless, scattered information management, institutional divisions, and bureaucratic loopholes are likely to affect the success of these technologies and plans.

The following questions are, therefore, investigated in this study in the framework of the Oman Vision 2040: (1) How are the main stakeholders understanding the role of digital technologies in improving maritime

security and environmental monitoring? (2) Which are the main climate-related threats to the marine ecosystems and blue economy aspirations in Oman? (3) What governance and policy mechanisms should be in place to achieve an integrated, resilient and sustainable future of maritime? This study will be able to offer evidence-based recommendations on how Oman can ensure its blue economy development is in line with maritime security, climate resilience, and long-term marine conservation through the lens of the perspectives of social, business, and scholarly stakeholders.

2. Literature Review

The review brings together the current knowledge in three interrelated spheres that are the focus of this research: the conceptual and operational framework of the blue economy, technological uses to ensure maritime security, and climate resilience measures in coastal areas. The analysis confirms important themes and major gaps in the Omani and regional context, providing grounds for researching the communication of governance, technology, and sustainability in the context of Vision 2040.

2.1 Blue Economy and Sustainable Development: From Global Paradigm to Omani Priorities

The concept of the blue economy has transformed into a niche environmental concept and has become a mainstream paradigm of sustainable development, which proposes economic development to be based on the preservation of ocean resources and the health of marine ecosystems (Vierros y De Fontaubert, 2017). It operationally includes sustainable fisheries, maritime transport, coastal tourism and renewable energy. The fact that Marine Spatial Planning (MSP) is highly recommended as one of the key instruments of governance of this paradigm to allocate the maritime space and reduce the conflict of sectors (Ehler & Douvare, 2009).

Vision 2040 in Oman includes the blue economy squarely as an economic diversification pillar and as an environmental protector (Oman Vision Implementation Follow-up Unit, 2020). First academic literature has started to trace this shift, with strategic emphasis on such areas as green hydrogen and port-led development (Abdel-Gadir & Mohammed, 2024). There is, however, a wide divergence between this top-level policy promise and the fine, workable structures of sectoral integration. An example of this is that MSP principles are acknowledged, yet their implementation to balance emerging offshore renewable projects and sensitive habitats such as coral reefs has not been well explored in the Omani context, though the vulnerability of the regional reef systems is known (Coles & Riegl, 2013; Burt & Bartholomew, 2019). More than that, the social aspect of the blue economy, especially the involvement of the community and the fair distribution of benefits, is frequently overshadowed by references to technology and infrastructure. This knowledge gap is what drives the present study to focus on stakeholder attitudes and governance coordination to ask questions such as how Oman might actualise blue economy ambitions into on-the-ground, integrated implementation to be connected to SDG 14.

2.2 Maritime Security and Technology: Evolving Threats and Digital Solutions

Maritime security in the Gulf region is no longer limited to traditional naval issues, but it includes non-traditional threats everywhere, such as Illegal, Unreported, and Unregulated (IUU) fishing, smuggling and environmental crimes (Bueger & Edwards, 2020). These complications are magnified in enormous sea regions such as the Exclusive Economic Zone (EEZ) of Oman, where enforcement and surveillance become a logistical and economic nightmare.

Technology is being proposed as an enhancer of the volume of maritime domain awareness. The global literature is highly informative regarding the use of Automatic Identification Systems (AIS), satellite remote sensing, and unmanned vehicles in surveillance (Germond, 2015). New studies suggest the possibility of Artificial Intelligence (AI) and machine learning to process big data comprising such systems and detect trends that can indicate illegal actions (Kraska & Park, 2022). The regional powers in the Gulf are heavily investing in these technologies in terms of ensuring security in ports and surveillance of the waterways.

Nevertheless, there remains a literature gap in terms of the implementation realities in the mid-sized coastal states like Oman. Technological potential is usually determined independent of institutional, financial, and human capacity requirements of sustainable uptake (M. S. Islam, 2024). Very few studies are available on the application of technologies like GIS and AIS in monitoring the fisheries or controlling the pollution by the Omani authorities, and the obstacles that hinder their effective utilisation. This paper fills this gap by focusing on the case of technological capabilities and limitations reported by stakeholders and offering a ground-level perspective of the interface between the digital tools and maritime security activities in Oman.

2.3 Climate Resilience in Coastal Zones: Assessing Risk and Deploying Solutions

The coastal areas of the Arabian Peninsula, including Oman, are known to be one of the most susceptible regions to the effects of climate change, which is mainly sea-level rise, rising sea surface temperature, and intensified cyclonic activity (Hereher et al., 2020). The concentrations of the exposure have been measured through scientific evaluation based on geospatial models, with the proximity of the Al Batinah and Al Wusta coasts (lying close to the sea) being found vulnerable to a high risk (Al-Hatrushi et al., 2015). The

ecological and socioeconomic impact, such as habitat loss and intrusion of saline water, infrastructure damage, etc., is devastating (Al-Awadhi et al., 2021).

The literature gives two parallel, yet mostly unrelated, ways of adaptation. The first one is technology- and engineering-related, which entails hardened infrastructure, deep early-warning systems, and climate modelling (Etri et al., 2023). The second market is the idea of Ecosystem-based Adaptation (EbA), which suggests using nature-based solutions such as the restoration of mangrove and coral reefs to offer the benefits of natural coastal defences and biodiversity (Al-Afifi, 2018; Primavera, 2018).

The outstanding gap is the incorporation of these strategies in the governance of nations. Although the vulnerability of the body in the physical form or pilot restoration initiatives has been recorded, there has not been an adequate examination into the systematisation of mainstreaming climate adaptation into marine spatial planning, fisheries policy, or port development in Oman. The lack of connection between climate risk information in the hands of environmental agencies and the planning process of economic authorities is a major issue. This paper directly fills this gap by examining the perceptions of the stakeholders regarding the risks of climate change and their favoured adaptation methods, which sheds light on the opportunities and challenges in building a consistent, holistic climate resilience framework for the Omani blue economy.

3. Conceptual Framework

The framework the study is based on is an integrative one that places governance, technology, and climate resilience as inseparable pillars that are vital in the realisation of a secure and sustainable blue economy within the framework of Oman Vision 2040 (Oman Vision Implementation Follow-up Unit, 2020). The framework (Figure 1) not only enumerates such components but also presents how they have to work in harmony in order to meet the targets of SDG 14 (Life Below Water).

- **Pillar 1: Governance Reforms and Built-in planning.** The pillar of governance is to govern effectively. It requires a shift towards the integration of marine spatial planning (MSP). According to the available literature, MSP is an essential process of overcoming spatial conflicts and economic use versus conservation (Ehler & Douvere, 2009). In the case of Oman, such a pillar entails the enactment of interoperable data-sharing protocols and cross-agency coordination mechanisms- a gap that is evidently seen in the stakeholder analysis.
- **The second pillar is Technological Innovation to achieve Security and Sustainability**. This pillar covers the implementation of digital solutions to improve maritime domain awareness and environmental surveillance. It deals with technologies of Geographic Information System (GIS), satellite remote sensing, Artificial Intelligence (AI)-assisted surveillance, and IoT sensor networks. The framework argues that the technologies do not represent the goals; rather, they facilitate open, data-driven decision-making in the pillar of governance. This depends on the address of the capacity limitations identified in this research.
- **Pilar 3: Hybrid Adaptation to Climate Resilience**. This pillar responds to the need to adjust to the effects of climate change, including sea-level rise and ocean warming, which puts pressure on coastal properties and ecosystems (Hereher et al., 2020). The framework encourages an intermediate solution based on the strategic integration of technology-enhanced early-warning systems with ecosystem-based adaptation (EbA) plans, which include the restoration of mangroves and coral reefs (Al-Afifi, 2018).
- **Synergies and Feedback Loops:** The main idea of the framework is that these pillars feed each other. As an example, Governance Reforms (e.g., amended zoning laws) need to be informed by data on Technological Innovation (e.g., GIS maps of coastal erosion), which in turn necessitate and finance Climate Resilience efforts (e.g., specific mangrove restoration efforts). On the other hand, Pillar 3 nature-based solutions are successful when monitored and managed with the help of Pillars 1 and 2. This becomes a continuous loop of feedback that is required in adaptive management.

This model directly informs the investigation of the study, as it informs the interview questions in order to investigate the experience of the stakeholders between and within these pillars. It then gives a framework on how to analyse the results, identify points of synergies and where disconnections, including fragmentation of data or policy gaps, exist to make progress towards the integrated vision of the Oman blue economy.

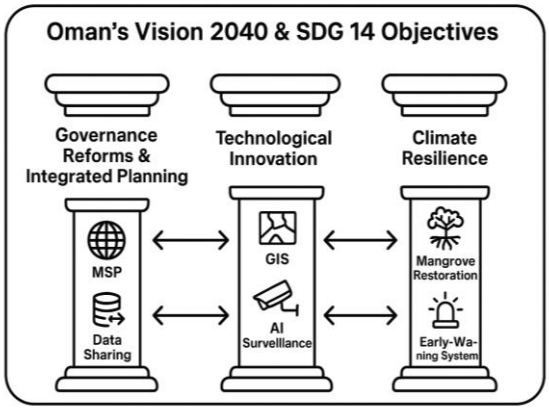

Figure 1.Conceptual Framework for an Integrated Blue Economy under Oman's Vision 2040

4. Methodology

This qualitative research design was used in order to develop the sensitive views of the critical actors in the maritime industry of Oman. A semi-structured interview methodology was chosen to be able to explore the views of stakeholders deeply and still have the focus on the research themes: the adoption of technologies, climate resilience, and the coordination of governance in the blue economy.

4.1 Participant Selection and Data Collection

The purposive sampling was employed to select the participants, enabling them to present the pillars of the central institutions of Oman's maritime governance and economy. The final sample was based on 15 people, who were divided in the following way to represent the policy-driven and multi-sectoral character of the implementation of Vision 2040:

- Public Sector (n=9): The authorities representing the ministries and authorities in charge of fisheries, environment, transport, hydrography, spatial data, and energy (see Table 1).
- Private Sector (n=4): The representatives of the companies that deal with maritime logistics, petroleum development and fisheries.
- Academic Sector (n=2): scholars of Sultan Qaboos University who have a background in the field of marine science and environmental management.

The interviews were done in September-December 2024 and lasted 30-45 minutes. A semi-structured interview guide with open-ended questions was employed, covering: (1) the perception of existing maritime security and environmental monitoring systems; (2) the observed effects of climate change and response to the same; (3) the perception of institutional coordination and obstacles to the implementation of blue economy objectives. All interviews were done either in Arabic or English, according to participants' preference, audio-taped with their consent and transcribed word-for-word and analysed later.

Table 1 Study Participant Distribution

No.	Business Sector	Institutions	Number Of Interviews
1	Public	Ministry of Agricultural Wealth, Fisheries and Water Resources	2
		Oman National Hydrographic Office (ONHO)	1
		Environmental Authority	2
		Ministry of Transport, Communications and Information Technology	1
		National Survey and Geospatial Information Authority	1
		National Centre for Statistics and Information	1
		Ministry of Energy and Minerals	1
		Civil Aviation Authority	1
2	Private	Arab Maritime Aids Company (AMNAS)	1
		Petroleum Development Oman	2
		OQ Company (OQ)	1
		Fisheries Development Oman Company (SAOC)	1
		Asyad Group	1
3	Academic	Sultan Qaboos University	2
4	Total		15

4.2. Thematic Data Analysis

Reflexive thematic analysis was used to analyse the interview transcripts, and the information was analysed according to the six-phase approach set by Braun and Clarke (2006). The reason why this method was selected is that it is flexible and it is appropriate in identifying, analysing and reporting patterns of a qualitative dataset. NVivo 12 software was used to handle data and codes in the process of the analysis.

The process was as follows:

1. **Familiarisation**: Rereading the complete transcripts after taking a first reading.
2. **Code Generation**: They were inductively created on the basis of the data (e.g., frustration with data sharing) and deductively on the basis of the research questions (e.g., tech barriers, climate impacts).
3. **Theme Development**: The codes were piled into candidate themes (e.g., Hybrid Tech-Nature Solutions, Institutional Silos, etc.) and collated.
4. **Theme Review**: Themes were discussed and improved by comparing them with the coded extracts and the whole dataset to determine that they constituted a significant pattern.
5. **Theme Definition and Naming**: The main idea of every theme was well determined,

and final names were made (see Section 5).

6. **Reporting**: The analysis was prepared in writing, accompanied by colourful and unidentified quotes from the interviews.

A subset of three transcripts was independently coded by a second researcher in order to increase the rigour of the analyses. The level of intercoder reliability was determined by finding the Cohen Kappa coefficient, which was significant ($\kappa = 0.81$) (McHugh, 2012). All conflicts in coding were resolved by discussing them among the researchers and revising the codebook and thematic structure.

4.3. Ethical Compliance

This research was carried out in compliance with the ethical standards that were offered in the Declaration of Helsinki, and formal ethical permission was granted by the College of Arts and Social Science of Sultan Qaboos University. The Head of the College of Arts and Social Science has sent a letter of approval, stating that the research design followed the university guidelines on academic integrity and the ethical treatment of human participants.

- Informed Consent: Before the interview, all subjects were provided with the departmental approval letter and a participant information sheet through email. Informed consent was obtained electronically by signing; the participants agreed to participate, and their informed consent has been taken with the full understanding of the purpose of the study. They were under no obligation, as participation was voluntary, confidentiality was ensured, and they could withdraw without any penalty at any time.
- Confidentiality: In order to safeguard the privacy of the participants in the study, all personal and institutional identifiers were deleted in the transcripts of the interviews when they were being transcribed. The respondents in this article have been referred to by the non-identifiable position code (e.g., Public Sector Official 3, Private Sector Expert 1).
- Data Security Data is stored in a password-protected and encrypted server in Sultan Qaboos University containing all research materials, such as audio recordings, consent forms, anonymised transcripts, etc. It can only be accessed by the research team. All data will be stored within a period of five years as per the standard research data management procedures and then safely eliminated.

4.4. Positionality and Rigour

Being the researchers who are located at Sultan Qaboos University, we also assume the role of interested, active members of the national life in Oman. We entered the study with a view to coming up with constructive evidence-based informative ideas in a bid to aid policy-making. As a way of assuring reliability, we used several measures, including spending extended time in the policy environment, triangulation of views in three different areas, peer debriefing in the analysis, and keeping a reflexive journal, which was meant to record the analytical choices and possible biases that we made during the study.

5. Results and Discussion

In this section, the major findings of 15 stakeholder interviews are given and synthesised within four emergent themes. These findings have been incorporated into the discussion and combined with the confirmed literature to examine their implications for Vision 2040 and SDG 14 of Oman.

5.1. The theme 1: Data Fragmentation as a Systemic Barrier to Integration

One of the prevailing outcomes was the overall problem of fragmented systems in marine data. Data collection was said to be siloed in individual agencies by the stakeholders in the sectors. One of the officials in the public sector pointed out that we have excellent bathymetric data on navigation, but that is not linked to the environmental database tracking the health of coral. They are separate worlds." The fisheries industry representative followed, saying, "We can track the vessels, but it is not a straightforward process to provide such data in real-time to the Coast Guard and have them enforced.

Discussion: This observation is a direct reflection of an important implementation gap within the otherwise progressive context of the Vision of 2040 in Oman (Oman Vision Implementation Follow-up Unit, 2020). The policy interprets a system of integrated governance, whereas the practical situation here is one of institutional silos. Such fragmentation hinders the comprehensive maritime domain awareness needed for effective security and environmental management (Germond, 2015). The request by the stakeholders to have an integrated platform is reflected by the world literature on Marine Spatial Data Infrastructure (MSDI) that pinpoints the interoperability and data-sharing protocols as the building blocks of ecosystem-based management (Ehler & Douvere, 2009). We therefore base our findings on the theoretical concept of governance on the local administrative realities of Oman and emphasise that technological solutions cannot prevail without a parallel procedural and policy change.

5.2. *Theme 2: The Potential and the Capacity Limits of Technology and On-the-Ground*

Geospatial and digital technologies have the potential to revolutionise the world, and this is undisputed by the stakeholders. GIS, satellite AIS, and drone surveillance were mentioned as the key to illegal

fishing and coastline dynamic monitoring. We can even have a feel of where the mangrove patches are dying through the satellite shots, and it is on this basis that our restoration programs are being based, said an environmental officer. This optimism was, however, checked with large capacity constraints. One of the representatives of the private sector emphasised, "The pattern recognition AI software in vessel traffic exists, but we do not have specialists to operate the software and analyse the results.

Discussion: A fine addition to the literature on technology and maritime security is this tension between its potential and capacity. As AI and remote sensing are frequently discussed as a solution (Kraska & Park, 2022), our results with Oman show the critical last-mile issues of adoption. This does not only involve the economic expenses, but also a lack of specialised technical skills, as pointed out by M. S. Islam (2024). The stakeholder lens highlights that the digital transformation that must be successful with the vision of 2040 needs to lay equal emphasis on the development of human capital as well as the development of sustainable technical support systems beyond the procurement of technologies on an ad hoc basis.

5.3. Theme 3: Climate Vulnerabilities and Demand for Hybrid Solutions.

Interview responses showed worrying concern about the effects of climate, especially the rise in sea level that would endanger low-lying infrastructures and salty intrusion into aquifers in coastal areas. According to one of the academic experts, models reveal that in decades the most significant areas of the Al Batinah coast will become regularly flooded. Stakeholders, in turn, did not demand one-way solutions but proposed a combination of methods that can be termed a hybrid approach. They highlighted the integration of the so-called grey infrastructure (e.g., early-warning systems) and the so-called green nature-based solutions. The rehabilitation of mangroves was not an environmental initiative but an affordable coastal defence measure, as explained by a planner.

Discussion: The results confirm and place scientific evaluations of the high physical vulnerability of Oman in the area (Hereher et al., 2020; Al-Hatrushi et al., 2015). More to the point, they demonstrate a consensus among stakeholders towards the Ecosystem-based Adaptation (EbA). The use of mangrove restoration is supported by the local studies that have shown its ecological and protective properties (Al-Afifi, 2018; Primavera, 2018). The contribution of our study is that EbA is not viewed by Omani practitioners as a substitute, but it is a complement to technological and engineering interventions that are inevitable. This gives a high locally based mandate to the policy makers to institutionalise the hybrid adaptation strategies in the national climate action plans.

Theme 4: Proposed MSDI Framework as a Governance Nexus.

When formulating solutions to the challenges identified, the stakeholders were brought to the point of a coordinated data governance mechanism. This paper suggests a customised Marine Spatial Data Infrastructure (MSDI) of Oman, based on its contributions. The findings are its core components, which include: (1) a central, interoperable geospatial data portal; (2) legally binding data-sharing protocols among key ministries and (3) a cross-sectoral oversight committee to create alignment and conflict resolution.

Discussion: The most important conceptual addition to this research is the offered MSDI framework. It fills the gaps that were established in Themes 1-3 with a practical model of governance. It goes beyond the general concept of MSDI (Ehler & Douvre, 2009) to institutional arrangements that are applicable to the context of Oman, where the administration is decentralised. Vision 2040 calls to integrate digital technologies (Theme 2), climate data (Theme 3), and policy coordination (Theme 1), which is operationalised by this framework and enables a nexus around which the three aforementioned themes can revolve. It provides a scalable approach on how arid coastal states can shift from fragmented management to an integrated ocean governance to achieve SDG 14 targets.

6. Conclusion

This paper has analysed the interests of stakeholders in adopting technology, sustainability, and governance as a means of enhancing the maritime security and climate resilience of the blue economy in Oman according to the Vision 2040. The research has identified chronic institutional and operational barriers through thematic analysis of the interviews with 15 stakeholders working in major sectors. Fragmentation of marine data systems, limitations of capacity to implement advanced technologies, and integrated climate adaptation strategies became the key challenges.

The results validate the fact that although the strategic vision of Oman is sound, the execution of the same needs a more coordinated governance system. The MSDI proposal of stakeholder-derived Marine Spatial Data Infrastructure that is proposed below provides a viable tool for dealing with the problem of data fragmentation by setting up interoperability standards and required sharing protocols among ministries. At the same time, the focus on hybrid solutions is to combine geospatial technologies with nature-based interventions, which offers a moderate balance for improving maritime security by creating ecological resilience.

To conclude, the blue economy aspirations of the Vision 2040 will heavily rely on the ability to close the divide between the policy ambition and integration into operations. One relevant example that other arid coastal states can learn from is to improve cross-sectoral

coordination, invest in technical capacity, and formalise climate adaptation as part of maritime planning to improve maritime security and protect their coastal ecosystems, which is achievable in Oman.

7. Policy Recommendations

According to the results of this paper, the following recommendations can be made to improve the application of technology, sustainability, and security in the blue economy governance in Oman:

- Create a Cross-Sectoral Maritime Data Governance Council. In order to solve the problem of data fragmentation, we would suggest establishing a high-level council under the chairmanship of a senior official (e.g., of the Supreme Council for Planning) that would be represented by the Environment Authority, the Ministry of Agriculture, Fisheries and Water Resources, the Ministry of Transport, Communications and Information Technology, and the National Survey Authority. This council shall be required to come up with and implement uniform data protocols and manage the gradual progress of the suggested national MSDI.
- Introduction of a Blue Tech Capacity Build Program. To generate an appropriate balance between the technological potential and the practical skills on the ground, a special training program must be developed in collaboration with Sultan Qaboos University and the technical colleges. This program must aim at developing local capacity in GIS, remote sensing data interpretation and maritime surveillance equipment so that it becomes sustainable even after procurement.
- Introduce Hybrid Adaptation to National Spatial Planning Guidelines. The Ministry of Housing and Urban Planning, through the Environment Authority, ought to revise the coastal development regulations to demand Climate Vulnerability and Risk Assessments. Such guidelines must give priority and encourage nature-based solutions (e.g. mangrove and coral reef restoration) as part of approving infrastructure projects, so that climate resilience permeates economic development.

Author Contributions

Nuha Hamed Al Subhi: Conceptualisation, Methodology, Investigation, Formal Analysis, Data Curation, Writing – Original Draft, Visualisation, Project Administration, Writing – Review & Editing.
Mohammed Nasser Al Suqri: Supervision.
All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

This research was carried out as per the provisions of the Declaration of Helsinki and formally approved by the College of Arts and Social Science in Sultan Qaboos University. The ethical approval was received through an official letter from the Head of the College of Arts and Social Science. Informed consent of all the participants was obtained electronically before participation.

Informed Consent Statement

All the subjects in the study were informed about the consent. Permission to have the anonymised publication of aggregated findings was contained in written informed consent.

Data Availability Statement

All qualitative data (interview transcripts) obtained and analysed in the present study are not made public to ensure participant confidentiality, implemented in the informed consent procedure and in relation to the Personal Data Protection Law by the Royal Decree 6/2022 in Oman. The thematic data that underpin the findings reported are in the form of aggregated data, which can be made available by the respective author on a reasonable request.

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Conflicts of Interest

The authors state that they have no conflicts of interest. These funders were not involved in designing the study; in the data collection, data analysis, or interpreting the data; in writing up the manuscript or deciding whether to publish the results.

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