Article

Rethinking Marine Tourism Safety in Nusa Penida: A Qualitative Study of Risks and Management Strategies

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Ari Rahman
Department of Environmental Engineering, Faculty of Infrastructure Planning, Universitas Pertamina, Jakarta, Indonesia
ari.rahman@universitaspertamina.ac.id

I Wayan Koko Suryawan
Department of Environmental Engineering, Faculty of Infrastructure Planning, Universitas Pertamina, Jakarta, Indonesia
i.suryawan@universitaspertamina.ac.id

ABSTRACT

Marine tourism in Nusa Penida, Bali, has expanded rapidly over the past decade, attracting large numbers of domestic and international visitors to its renowned dive sites, coral reefs, and coastal landscapes. However, this growth has raised critical safety concerns that threaten both visitor well-being and the sustainability of the destination. This qualitative study draws on an extensive literature review and a structured hypothetical survey framework, designed in August 2024, to examine the systemic challenges in marine tourism safety. Rather than relying on newly collected empirical data, this research synthesizes existing reports, stakeholder commentary, and regulatory reviews to identify ten interrelated categories of risk: weak enforcement, poor infrastructure, unregulated tourism expansion, unsafe operator behavior, limited monitoring, environmental degradation, weather-related risks, lack of safety education, poor incident reporting, and fragmented governance. Through thematic analysis, the study links these issues to feasible and locally adaptive solutions, highlighting the need for integrated zoning, multilingual safety communication, institutional collaboration, and climate-responsive infrastructure. The findings underscore the urgency of developing cross-sectoral, adaptive marine safety governance that aligns tourism growth with environmental resilience and visitor protection. Policy recommendations are proposed for application in other high-risk coastal destinations.

Keywords: Marine Tourism Safety; Coastal Risk Management; Adaptive Governance; Sustainable Tourism; Safety Infrastructure.

ABSTRAK

Pariwisata bahari di Nusa Penida, Bali, mengalami pertumbuhan pesat dalam satu dekade terakhir, menarik ribuan wisatawan domestik maupun mancanegara ke lokasi penyelaman, terumbu karang, dan lanskap pesisir yang ikonik. Namun, perkembangan ini juga memunculkan tantangan serius terkait keselamatan wisatawan dan keberlanjutan destinasi. Studi ini menggunakan pendekatan kualitatif berbasis kajian literatur yang luas dan kerangka survei hipotetik yang disusun pada Agustus 2024. Alih-alih mengandalkan data empiris baru, analisis ini mengintegrasikan temuan studi terdahulu, laporan kebijakan, dan masukan dari para

Corresponding Author
Name : I Wayan Koko Suryawan
Email : i.suryawan@universitaspertamina.ac.id

pemangku kepentingan untuk mengidentifikasi sepuluh kategori risiko keselamatan, yaitu lemahnya penegakan regulasi, infrastruktur keselamatan yang minim, pertumbuhan wisata yang tidak terkendali, praktik operator yang tidak aman, keterbatasan pengawasan, degradasi lingkungan, risiko cuaca ekstrem, kurangnya edukasi keselamatan, lemahnya pelaporan insiden, serta fragmentasi tata kelola. Melalui analisis tematik, studi ini merumuskan solusi adaptif berbasis konteks lokal, seperti zonasi wilayah laut, komunikasi keselamatan multibahasa, kolaborasi kelembagaan, dan infrastruktur tanggap iklim. Hasil penelitian menekankan pentingnya tata kelola keselamatan wisata bahari yang responsif, terintegrasi, dan mendukung keseimbangan antara pertumbuhan wisata dan ketahanan lingkungan. Rekomendasi kebijakan disusun agar dapat diadopsi di kawasan pesisir berisiko tinggi lainnya.

Kata Kunci: Keselamatan Wisata Bahari; Manajemen Risiko Pesisir; Tata Kelola Adaptif; Pariwisata Berkelanjutan; Infrastruktur Keselamatan

1. Introduction

Nusa Penida, located within the Klungkung Regency of Bali, has rapidly emerged as one of Indonesia's premier marine tourism destinations (Darmana & Koerniawan, 2019). Its appeal lies in its stunning coral reef ecosystems, unique species such as the mola-mola (sunfish) and manta rays, and its dramatic coastal landscapes (Hani, Jompa, Nessa, & White, 2019). Activities like snorkeling, diving, sea walking, and boating have become the core attractions, contributing significantly to the local economy and boosting regional tourism revenue (Nabi & Salimullah, 2022; Suryawan, Gunawan, & Lee, 2025; Yusoh et al., 2023). However, alongside this rapid tourism development, serious concerns have surfaced regarding marine safety and the ability of existing governance structures to protect visitors from increasing environmental and operational risks (Wilks, 2021). Several incidents in recent years, including boat collisions with divers, tourists being swept away by waves, and inadequate emergency responses, have highlighted significant safety gaps (Arsha & Sumadi, 2024; Lumanauw, 2020; Septiani & Mahagangga, 2019). Reports point to contributing factors such as poor marine surveillance, the absence of emergency response infrastructure, unclear safety signage, and limited safety education for visitors (Antara, 2025; Suriyani, 2018). These conditions are compounded by fragmented institutional responsibilities, weak enforcement of marine zoning, and a general lack of transparency surrounding past marine accidents and near-miss events.

Addressing tourism safety is not only a matter of protecting visitors but is also closely linked to destination reputation and the long-term sustainability of tourism (Kangai et al., 2024; M. A. Rahman, Amin, Rahman, & Amin, 2025). Destinations perceived as unsafe are less likely to attract repeat visitors or positive word-of-mouth recommendations. Conversely, destinations that invest in reliable safety systems and clear communication tend to rank higher in competitiveness, especially in the international market. This makes the establishment of a comprehensive and evidence-informed safety strategy a critical priority for tourism development in Nusa Penida. Despite these challenges, there remains a limited body of research that systematically examines the marine safety landscape in Nusa Penida from a governance, ecological, and visitor experience perspective. Much of the existing management of marine safety remains reactive and fragmented, with little integration across environmental, tourism, and regulatory systems (Suhardono, Lee, & Suryawan, 2024; Suryawan, Gunawan, & Lee, 2024; Suryawan, Gunawan, et al., 2025; Suryawan, Rahman, et al., 2025). This lack of cohesive planning reflects a broader issue observed in many rapidly growing tourism destinations, where developments often outpace infrastructure and policy readiness. Hence, there is a pressing need to examine the complex interactions between safety perceptions, institutional frameworks, environmental vulnerabilities, and behavioral patterns among tourism operators and visitors.

Existing literature from other island destinations globally suggests that marine safety is best managed through cross-sectoral coordination (Li, 2023; Nisa, 2022; Zhang, Loh, Patchell, & Tsai, 2023). The unique ecological and social context of Nusa Penida demands a locally relevant approach, one that considers the island's marine biodiversity, seasonal weather variability, topographic hazards, and the growing volume of tourism activities (Leatherman, Leatherman, & Rangel-Buitrago, 2024; Suwendri, Mardika, & Pidada, 2021). Factors such as sudden tidal shifts, strong underwater currents, and the proximity of recreational zones to high-risk coastal features like cliffs or reef edges increase the need for structured safety systems. In reviewing key issues across the marine safety landscape in Nusa Penida, several interconnected dimensions emerge. Another significant issue is the lack of a centralized, accessible data system for recording marine safety incidents. Without accurate and transparent records, it becomes difficult to identify high-risk zones, learn from past accidents, or plan targeted interventions. The absence of such data also limits accountability and hinders the development of evidence-based policies. At the governance level, fragmentation among institutions has hindered the development of a unified marine safety strategy. Different agencies often have overlapping or unclear mandates, leading to delays in response and inconsistencies in implementation. Community involvement in safety planning is often minimal, even though local residents and tourism stakeholders possess valuable knowledge and are directly affected by marine incidents. Given these conditions, the need for an integrated, adaptive, and context-sensitive approach to marine safety in Nusa Penida is both timely and critical. Solutions must go beyond the installation of physical infrastructure and include regulatory reforms, education initiatives, participatory planning, and the use of technology for real-time risk communication. Adaptive management offers a promising framework emphasizing learning, flexibility, and inclusive governance as key principles for dealing with uncertainty and complexity in environmental management (A. Rahman et al., 2025; Suhardono, Lee, Thuy Phan, & Suryawan, 2025; Suryawan & Lee, 2025; Yang, Lee, & Suryawan, 2025).

This study aims to critically synthesize the current body of literature, policy frameworks, and documented safety incidents related to marine tourism in Nusa Penida. By doing so, it seeks to identify key risk factors and institutional challenges that contribute to marine safety vulnerabilities in the region. The research integrates regional policy reviews, secondary data, and insights from existing tourism safety programs to construct a holistic understanding of the systemic issues at play. Furthermore, the study proposes a set of adaptive and context-sensitive interventions ranging from improved infrastructure and regulatory enforcement to participatory governance and multilingual safety communication. The findings are intended not only to support the development of more robust marine safety protocols in Nusa Penida but also to inform broader discussions and comparative policy learning across other high-risk island tourism destinations in Indonesia and Southeast Asia that face similar socio-ecological dynamics.

2. Literature Review

Marine tourism is a rapidly growing sector globally, particularly in island and coastal destinations where natural beauty, coral reefs, and recreational water activities offer high appeal. However, this growth is often accompanied by increased safety risks for tourists, environmental degradation, and governance challenges. In the context of Nusa Penida, Bali, an island with both ecological significance and tourism potential, marine safety has become a critical issue, shaped by a complex set of interrelated variables. This literature review adopts a systems thinking approach, which allows for a holistic understanding of how environmental, institutional, social, and infrastructural factors interact to influence safety outcomes. Systems thinking emphasizes the interconnectedness of components within a system and is widely used in analyzing socio-ecological challenges such as coastal management and tourism planning (Glyptou, 2024; Larsen, 2011; McMillan, Birkmann, Tangwanichagapong, & Jamshed, 2022). Applying this lens, marine

safety in Nusa Penida is not seen as a function of isolated incidents or single agencies but as the product of interlinked subsystems involving governance institutions, community behavior, ecological health, physical infrastructure, tourist knowledge, and adaptive capacity.

A growing body of literature has highlighted governance capacity as a foundational determinant of marine safety outcomes. Governance in this context refers not only to formal regulations and institutions but also to informal norms, enforcement practices, and stakeholder coordination. Adaptive marine governance must integrate multi-level institutions and include meaningful participation from local communities (Quimby & Levine, 2021; Simon & Muñoz, 2025). In marine protected areas like Nusa Penida, unclear jurisdiction between provincial and district governments, as seen after the implementation of Indonesia's Law No. 23/2014 on regional governance, has led to institutional fragmentation, delays in regulation enforcement, and limited oversight of safety standards. Infrastructure and safety facilities are also central to marine safety. Studies have demonstrated the importance of installing and maintaining physical safety assets such as lifeguard towers, buoy lines, safety signage, first aid stations, and marked navigation lanes for boats (Wilks, 2021). In small island contexts, these facilities are often absent or underfunded, exacerbating the vulnerability of tourists to accidents (Becken, Mahon, Rennie, & Shakeela, 2014; Scheyvens & and Momsen, 2008). The literature also explores the role of tourist behavior and risk perception. Many marine tourism accidents stem not from natural hazards alone but from uninformed behaviors such as entering unsafe waters, neglecting dive safety procedures (Leatherman et al., 2024), or misunderstanding risk (Eiser et al., 2012).

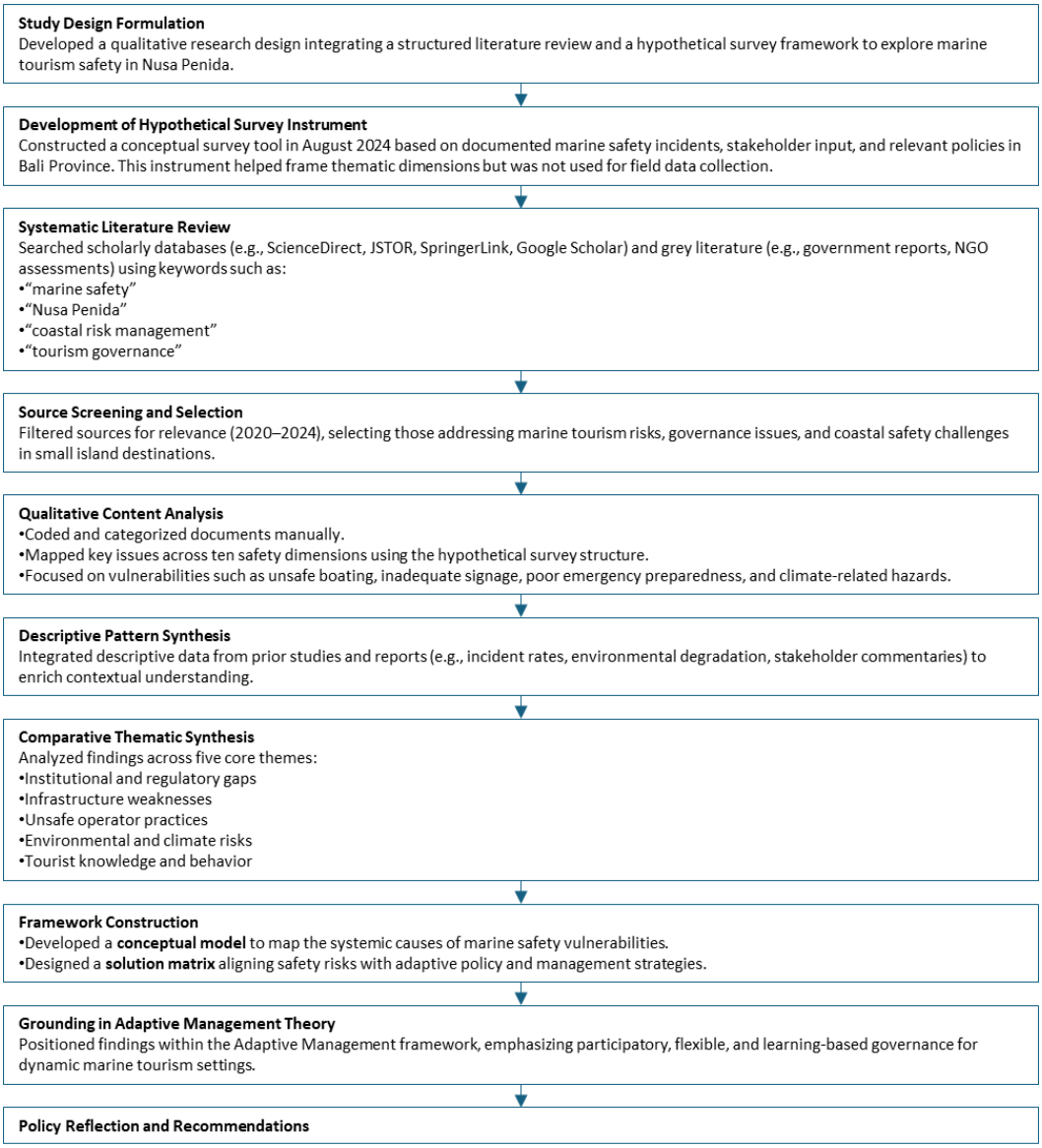
The ecological health of marine ecosystems also directly influences safety outcomes. Coral degradation, for instance, increases physical hazards for divers and snorkelers and may reduce natural wave buffering functions, leading to stronger currents (Nichols, Zinnert, & Young, 2019). Environmental stressors such as pollution, sedimentation, and reef trampling, often intensified by unsustainable tourism practices, create complex feedback loops where environmental degradation compounds safety risks (Suryawan, Suhardono, Nguyen, & Lee, 2025; Sutrisno, Chen, Suryawan, & Lee, 2023). Moreover, disturbances to marine fauna can result in unexpected and potentially dangerous human-wildlife interactions. Coastal tourism destinations are among the most exposed sectors to climate variability (Arabadzhyan et al., 2021; Perch-Nielsen, 2010; Santos-Lacueva, Clavé, & Saladié, 2017), especially islands with limited evacuation routes and a high dependency on marine access. Sudden storms, tidal surges, or underwater currents can arise rapidly and without localized warning systems (Turner et al., 2024). In developing destinations, weather data is not translated into real-time safety alerts accessible to tourists or boat operators. Nusa Penida, with its rugged coastline and unpredictable weather, is especially vulnerable in this regard.

From a data and knowledge systems perspective, the absence of systematic incident reporting or shared databases limits the ability of local agencies to monitor trends or deploy proactive safety interventions. Real-time data collection and transparent dissemination of past accident records can significantly improve risk awareness and guide resource allocation (Damaševičius, Bacanin, & Misra, 2023; Latvakoski, Öörni, Lusikka, & Keränen, 2022). In Nusa Penida, marine accidents are often underreported or addressed informally, making it difficult to track hot spots or learn from previous emergencies. To integrate these dimensions, this study is grounded in the concept of adaptive management (Sofiyah, Ridhosari, Suhardono, Lee, & Suryawan, 2025; Suryawan, Gunawan, et al., 2024; Suryawan & Lee, 2025; Suryawan, Suhardono, et al., 2025), which promotes iterative learning, stakeholder feedback, and flexible institutional arrangements to manage uncertainty in complex systems (Suhardono, Lee, & Suryawan, 2025; Suryawan, Gunawan, et al., 2025; Suryawan & Lee, 2025; Yang et al., 2025). Adaptive management frameworks emphasize the value of local knowledge, scenario planning, monitoring and evaluation, and policy co-creation, especially in settings where top-down governance is limited or fragmented.

3. Method

This study adopts a qualitative research design that integrates a structured literature review with a hypothetical survey framework to explore marine tourism safety in Nusa Penida. Rather than relying on primary data collection, the research draws upon secondary sources such as academic publications, policy documents, incident reports, and NGO assessments published between 2020 and 2024. The goal of this approach is to synthesize existing knowledge, identify systemic gaps, and interpret the underlying causes of safety risks affecting marine tourism. To support thematic organization, a hypothetical survey instrument was developed in August 2024 based on documented incidents, stakeholder commentary, and Bali Province's marine tourism policy frameworks. While not used to gather field data, this framework served as a conceptual lens to guide the analysis and identify ten key dimensions of marine safety. These dimensions were then thematically coded to uncover recurring patterns and governance challenges. The synthesis triangulated findings from various sources to produce evidence-informed recommendations for adaptive and context-sensitive interventions. To support transparency, Figure 1 illustrates the conceptual flow of the research from literature screening and coding to thematic interpretation and policy formulation.

Figure 1. Conceptual flow of the research from literature screening and coding to thematic interpretation and policy formulation



Parallel to the development of the survey instrument, the study undertook a systematic literature review. Academic databases such as ScienceDirect, JSTOR, SpringerLink, and Google Scholar were searched using targeted keywords such as "marine safety," "tourism governance," "Nusa Penida," "coastal risk management," "marine protected area regulation," and "visitor risk perception." In addition, relevant grey literature was sourced, including local government tourism plans, marine zoning guidelines, coral reef monitoring reports, and international safety best practices in similar island tourism destinations. These sources were reviewed with the goal of identifying safety concerns that are already recognized, how they are being addressed (if at all), and what gaps remain in the institutional and policy framework.

Qualitative content analysis was used to organize and interpret the literature. The literature was first screened for relevance, and key documents were then reviewed in full. Themes were coded manually, guided by the indicators and categories established in the survey instrument. Particular attention was paid to areas where tourists are known to be vulnerable to safety risks, such as strong underwater currents, lack of signage at cliff-side viewpoints, inconsistent enforcement of boating regulations, or inadequate emergency preparedness during extreme weather events. The synthesis also examined patterns in marine tourism growth, local institutional capacity, and the influence of seasonal or climate-induced hazards. Descriptive insights from prior empirical studies, including statistical data on accident occurrences, reef degradation, and tourist feedback from previous assessments, were integrated to contextualize the findings. These descriptive patterns were interpreted qualitatively to assess which aspects of marine safety are perceived as deficient or emerging priorities, based on existing documentation. Rather than relying on original inferential analysis, the study leveraged summary statistics, evaluations, and expert opinions found in secondary sources to build an evidence base.

To support critical interpretation, a comparative synthesis was conducted across several themes: regulatory and institutional shortcomings, infrastructural weaknesses, operator practices, ecological risk factors, and tourist awareness levels. These dimensions were then organized into a conceptual model illustrating the systemic causes of marine safety issues (Figure 1) and translated into a practical solution matrix (Table 1), which outlines the causal mechanisms, policy-level interventions, and tourist-adaptable services. This framework was grounded in the Adaptive Management perspective, which promotes learning-based, flexible, and participatory approaches to managing risk in complex and evolving environments like coastal tourism zones. The final methodological step involved a reflective analysis of the policy implications of the findings. Drawing from both the literature review and the interpretive insights generated through the safety framework, the study formulated recommendations for improved zoning, institutional coordination, visitor communication strategies, and the integration of local knowledge and climate adaptation into marine safety planning. These recommendations were not prescriptive but suggestive, aiming to inform ongoing debates around sustainable tourism and marine governance in small island contexts

4. Results

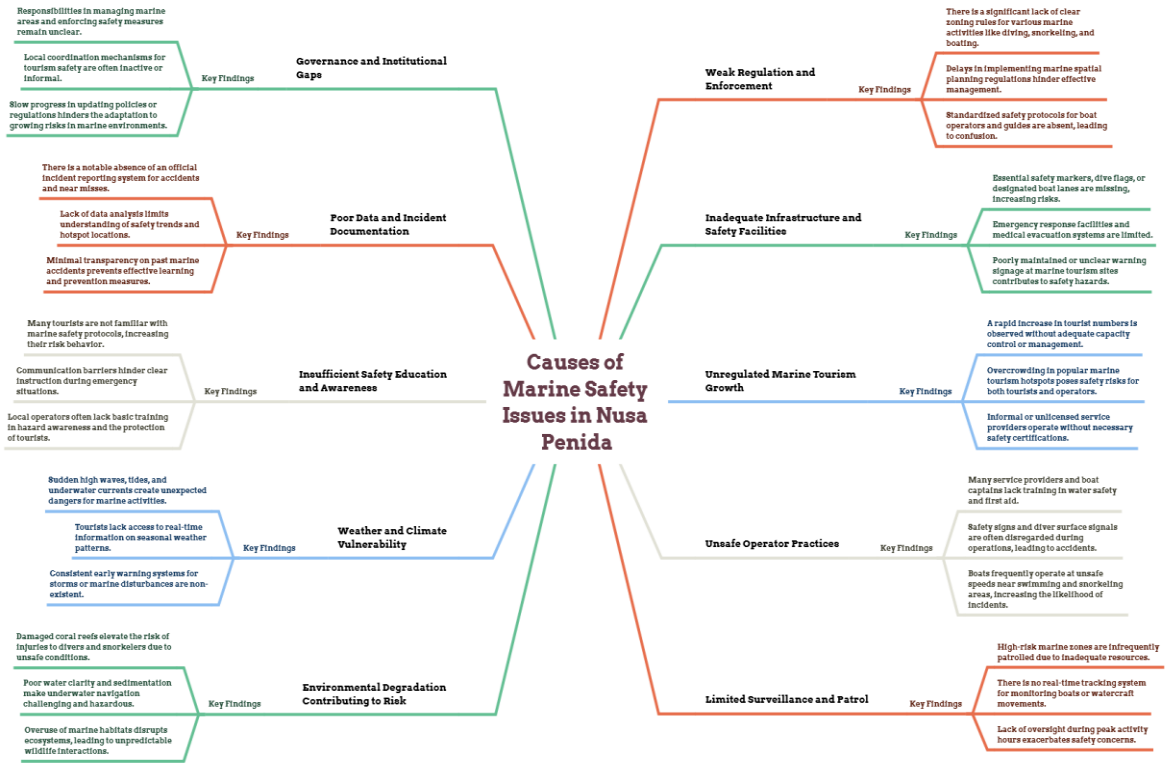
4.1. Causes of Marine Safety Issues in Nusa Penida

Figure 2 illustrates a comprehensive conceptual framework outlining the underlying causes of marine safety issues in Nusa Penida, one of Indonesia's fastest-growing coastal tourism destinations. With its striking seascapes, rich biodiversity, and increasing appeal to both domestic and international tourists, Nusa Penida has witnessed a rapid escalation in marine-based tourism activities such as snorkeling, diving, sea walking, and boat excursions. However, this growth has not been accompanied by proportionate development in safety infrastructure, regulatory oversight, or environmental management, resulting in heightened risks for both visitors and the marine ecosystem. The figure categorizes these safety challenges into ten interrelated dimensions. Each dimension contributes to a layered understanding of how institutional weaknesses,

environmental degradation, socio-economic dynamics, and tourism pressures collectively shape the safety landscape. The purpose of this framework is not only to diagnose the current vulnerabilities but also to inform responsive, evidence-based strategies for improving marine tourism safety in Nusa Penida.

One of the foremost causes is the weakness of regulations and the enforcement system. The lack of clearly defined zoning for marine tourism activities, such as diving, snorkeling, or boating, has led to unregulated overlaps between user groups. Delays in the implementation of marine spatial planning laws, compounded by limited inter-agency coordination, have contributed to this problem. There are also no standardized safety protocols required for boat captains or diving operators, which significantly increases the margin of human error. Enforcement mechanisms are underdeveloped or poorly executed, and the absence of penalties for violations means there is little deterrence for unsafe practices. These regulatory gaps leave tourists vulnerable and reduce the capacity for preventive action. Inadequate safety infrastructure and support facilities further aggravate the risks. Many high-traffic tourist areas, including famous snorkel and dive sites, lack essential physical safety installations such as warning signs, dive flags, lifeguard posts, first aid stations, or evacuation pathways. Mooring points and boat anchoring systems are often improvised or of poor quality, leading to frequent damage to coral reefs and underwater hazards. Even where signage exists, it may be unclear, weather-damaged, or not available in multiple languages. These deficiencies in basic infrastructure hinder the ability to manage visitor flow and respond promptly during emergencies.

Figure 2. A comprehensive conceptual framework outlining the underlying causes of marine safety issues in Nusa Penida



Tourism in Nusa Penida has grown far faster than the institutional ability to manage it. The explosion of marine tourism has led to congestion at popular underwater attractions, with dozens of boats, swimmers, and divers occupying the same narrow zones. There is currently no visitor quota or time slot management system in place, creating high-density conditions that reduce visibility, crowd safety margins, and increase the likelihood of vessel collisions or physical injuries. Moreover, informal and unregistered tour operators, who may not adhere to minimum

safety standards, contribute to unsafe experiences for unaware tourists. A related issue is the unsafe practices of marine operators. Tour guides, dive instructors, and boat crews are often hired with limited formal training in water safety, rescue protocols, or first aid. Pre-activity safety briefings are frequently skipped or conducted superficially. Cases have been documented where boats operate at excessive speeds near swimmers, and diving flags or surface markers are ignored. In extreme cases, divers have been injured or killed due to such negligence. Additionally, overloading vessels beyond their licensed capacity is a common practice, driven by the economic incentive to maximize profit per trip, further compromising passenger safety. Routine surveillance and patrolling are limited or nonexistent in many critical marine zones. Budgetary constraints, lack of trained personnel, and minimal investment in monitoring technologies such as GPS tracking or underwater surveillance leave authorities unable to supervise activity in real time. Patrols are infrequent, typically conducted only once a month, and during peak tourist hours, there is often no official presence to enforce safety regulations or assist in emergencies. Environmental factors also play a role in exacerbating marine safety risks. Coral reefs have been degraded due to anchoring, trampling, and pollution, increasing the likelihood of injury for divers and swimmers. Poor water clarity caused by sedimentation, as well as unpredictable interactions with displaced marine animals, create additional hazards. Certain areas have witnessed fish feeding behaviors promoted by tour operators that distort natural ecosystems, increasing aggressive animal encounters or navigational confusion for snorkelers.

4.2. Classification of Multidimensional Causes Behind Marine Safety Issues in Nusa Penida

Table 1 offers a detailed classification of the multidimensional causes behind marine safety issues in Nusa Penida, while also proposing comprehensive solutions and adaptive services that can be implemented to improve the safety and experience of tourists. The ten categories that encompass the regulatory, infrastructural, operational, environmental, and institutional dimensions of marine safety, each of which presents unique challenges and corresponding opportunities for intervention. The first category, weak regulation and enforcement, highlights governance failures such as the absence of zoning for marine activities like diving, snorkeling, and boating. This regulatory vacuum has created overlapping jurisdictions and confusion among authorities, leading to the ineffective implementation of safety protocols. The proposed solutions emphasize establishing clear marine spatial planning and introducing standardized standard operating procedures (SOPs) for tour operators. These measures must be reinforced through clearer role distribution among agencies and strict enforcement mechanisms. To support tourists directly, adaptive services such as safety information through QR codes, multilingual safety videos during onboarding, and tourist maps indicating designated safe zones are essential for bridging the communication gap and promoting responsible behavior.

The second dimension points to the inadequacy of infrastructure and safety facilities, a major barrier in delivering real-time safety assurance for marine tourism participants. The lack of visible markers, such as dive flags or floating lanes, insufficient emergency access points, and the absence of lifeguard stations compromise the safety of tourists during emergencies. Furthermore, the poor quality of anchoring systems near coral reefs increases environmental risks and accident probability. Solutions require both hardware and planning approaches such as the installation of lifeguard towers, infrastructure upgrades, and the development of emergency evacuation plans. These initiatives should be accompanied by adaptable tourist services like emergency contact maps, real-time safety info boards, and visual markers showing where assistance is available. Unregulated marine tourism growth forms the third area of concern. The explosive rise in visitor numbers without corresponding controls has led to overcrowding in popular snorkel and dive zones. The absence of visitor limits and the presence of informal, unlicensed operators worsen the scenario. Policy responses must aim to establish capacity management mechanisms such as quota systems and formal licensing frameworks. Tourist-responsive services such as mobile reservation

platforms indicating visitor loads, early bird access options, and visual crowd-density indicators can help redistribute tourist flows more evenly, preventing overuse of vulnerable marine areas.

Table 1. Classification Of The Multidimensional Causes Behind Marine Safety Issues

Category	Causes	Solutions	Adaptable Services for Tourists
Weak Regulation and Enforcement	– Lack of zoning for diving/snorkeling/boating – Delays in marine spatial planning – No safety protocols for operators – Inability to enforce penalties – Confusion in agency responsibilities	– Establish marine spatial planning and zoning – Standardize operator safety SOPs – Clarify jurisdiction and roles – Introduce strict enforcement mechanisms	– Tourist maps showing safe zones – QR-code access to safety info in multiple languages – Safety videos during ticketing or onboarding
Inadequate Infrastructure and Safety Facilities	– No dive flags or boat lanes – Lack of emergency response points – Incomplete warning signage – No lifeguard stations – Poor anchoring systems	– Install floating safety markers and lifeguard towers – Develop emergency access and evacuation plans – Improve marine infrastructure maintenance	– On-site safety info boards – Tourist access to safety kits or emergency contacts – Maps showing lifeguard stations and safe swim zones
Unregulated Marine Tourism Growth	– Overcrowding in popular sites – Rapid tourism increase – No visitor capacity limit – Informal operators lacking licenses	– Implement visitor quota systems – Introduce licensing requirements – Develop crowd management systems	– Reservation apps showing site capacity – Crowd-level indicators for tour selection – Early bird or off-peak access options
Unsafe Operator Practices	– Untrained captains and guides – Ignoring diver signals – High-speed boating in swim zones – No pre-activity briefing – Boat overcapacity	– Mandatory safety certification – Routine audits of operator compliance – Pre-tour safety orientation required	– Safety briefings in tourist's native languages – Printed checklists on boats – Rated operator system (stars based on safety record)
Limited Surveillance and Patrol	– Rare marine patrols – Low safety resource availability – No real-time tracking – Weak oversight in peak seasons	– Increase frequency of marine patrols – Use boat tracking technology – Allocate budget for surveillance systems	– Tourist alert system for patrol zones – Real-time info boards on marine traffic – Volunteer tourism options to support patrol
Environmental Degradation Contributing to Risk	– Coral breakage and injury hazards – Poor underwater visibility – Habitat disruption affecting marine animals – Overuse of fragile reefs	– Enforce environmental protection rules – Monitor reef conditions and limit access when needed – Educate about sustainable behavior	– Eco-friendly marine activity guides – Distribute reef-safe sunscreen – Signage promoting "look but don't touch" principles
Weather and Climate Vulnerability	– Sudden waves or currents – No real-time weather updates – No early warning system	– Integrate climate data into marine planning – Install weather alert boards at ports – Coordinate seasonal closures when necessary	– Weather advisory in booking systems – Emergency shelters and storm response plans – Tourist briefings during monsoon season
Insufficient Safety Education and Awareness	– Tourists unaware of marine risks – Language barriers – No ongoing safety campaigns – Local operators lack safety education	– Launch multi-language safety campaigns – Regular training for operators and crew – Develop clear visual safety materials	– Distribute welcome safety brochures – Install interactive kiosks with safety tutorials – Include safety quizzes in guided tours

Category	Causes	Solutions	Adaptable Services for Tourists
Poor Data and Incident Documentation	– No reporting system – No access to incident history – Inability to track trends – No safety dashboards	– Create marine safety reporting platform – Analyze hotspot incidents – Share findings for preventive actions	– Tourist access to public safety data – Display recent incident info at major sites – Mobile app for real-time tourist feedback
Governance and Institutional Gaps	– Undefined safety leadership – Weak coordination – Low integration with tourism planning – Outdated marine safety policies	– Designate a central coordinating body – Establish multi-stakeholder working groups – Update policies to match current risk realities	– One-stop information center at tourist harbors – Coordinated messaging from all marine service providers – Tourist hotline for emergencies and complaints

The fourth category outlines unsafe operator practices, including the operation of boats at high speeds within swim zones, failure to conduct pre-activity briefings, and non-compliance with diver safety signals. Many tour operators still lack mandatory training in safety and first aid, resulting in inadequate responses during marine emergencies. Solutions call for rigorous certification systems and continuous compliance monitoring through audits. On the user-facing side, safety briefings delivered in multiple languages, checklists on boats, and a rated operator system based on safety performance would enhance the reliability and accountability of services. Limited surveillance and patrols are another pressing concern in ensuring tourist protection. Patrols are sporadic, especially during peak seasons, due to resource constraints and a lack of real-time vessel tracking systems. This limits the authorities' ability to respond to incidents quickly or enforce rules. Strengthening surveillance by deploying boat tracking systems, allocating consistent patrol budgets, and using community-based support, such as volunteer tourism patrols, would help close these monitoring gaps. Interactive alert systems that inform tourists of patrol coverage areas and provide safety warnings are essential tools to support these initiatives.

Environmental degradation contributing to risk comprises the sixth category and focuses on hazards such as coral breakage, poor visibility underwater, and habitat disruption caused by the overuse of fragile reefs. These ecological stresses not only threaten biodiversity but also endanger tourists, especially divers and snorkelers. Interventions must enforce marine conservation rules, monitor reef conditions in real-time, and regulate tourist access during ecologically sensitive periods. Educational tools such as eco-friendly marine activity guides, signs promoting "look but don't touch" ethics, and the use of reef-safe sunscreen would promote environmentally conscious behavior among tourists while enhancing overall safety.

Weather and climate vulnerability are also significant contributors to marine incidents in Nusa Penida. Sudden waves, strong currents, and a lack of climate-informed early warning systems put tourists at significant risk. Integrating climate forecasts into tourism management, using portside alert boards, and enforcing seasonal closures during high-risk weather periods are critical for minimizing casualties. Tourists can also be better protected through advisory notices integrated into booking systems and briefings during high-risk periods like the monsoon season. Another key dimension is the insufficient level of safety education and awareness among tourists and operators. Many visitors are unfamiliar with marine safety procedures, and language barriers further compound communication failures. In addition, local operators often do not receive structured safety training or updates. Solutions include launching multilingual campaigns, creating simplified safety guides, and conducting operator training programs. Tourist-facing educational tools such as interactive safety kiosks, welcome brochures with infographics, and engaging safety quizzes embedded in guided tours can significantly raise awareness and preparedness.

The ninth category emphasizes the lack of reliable data and incident documentation. Currently, there is no official system to track or analyze accidents, making it difficult to detect patterns or high-risk zones. Introducing a marine safety reporting platform and conducting routine analysis of hotspot incidents would allow better planning and prevention. Making safety data transparent to tourists through mobile apps and info boards would also build trust and enable informed decision-making. Finally, governance and institutional gaps represent structural weaknesses such as poor coordination between agencies, the absence of a dedicated safety authority, and outdated regulations that do not align with the rapidly evolving tourism landscape. Solutions in this area include designating a central body to coordinate marine safety, creating stakeholder groups to harmonize actions, and updating existing policies. Providing tourists with a one-stop safety information desk, centralized complaint mechanisms, and coordinated communication across service providers ensures that policy reforms translate into practical improvements on the ground.

5. Discussion

The findings of this study on marine safety issues in Nusa Penida underscore the urgent need for a comprehensive, cross-sectoral policy response that integrates safety, sustainability, and community-based tourism development. The policy implications extend beyond isolated interventions and demand systemic improvements in governance, infrastructure, operator practices, environmental stewardship, and visitor education. At its core, the study reveals that marine safety is not merely a matter of emergency response but a broader issue of public administration, spatial planning, and inclusive stakeholder engagement. As Nusa Penida continues to grow as a prominent marine tourism destination, policy frameworks must evolve to proactively manage safety risks while preserving ecological integrity and enhancing the visitor experience. One of the most immediate policy implications is the need to establish and enforce a clear marine spatial planning framework (Stelzenmüller et al., 2021; Zaucha & Kreiner, 2021). The lack of designated zones for snorkeling, diving, boating, and other water-based activities has created overlapping uses and increased the risk of accidents. Marine zoning policies must be developed based on ecological sensitivity, tourist density, and stakeholder needs (Papageorgiou, 2016; Skiniti et al., 2024; Tsilimigkas & Rempis, 2021). These policies should be supported by enforceable regulations that define usage boundaries, permitted activities, and operational hours for various zones. Such zoning must also be integrated into broader tourism development plans and climate resilience strategies to ensure long-term sustainability (Dube, Nhamo, Chikodzi, & Chapungu, 2023; Suryawan, Suhardono, & Lee, 2024; Teena Jayakumar & Sarkar, 2024).

Furthermore, the study highlights the importance of strengthening institutional coordination. The current fragmentation of authority and responsibilities among different levels of government and agencies results in weak enforcement, conflicting mandates, and policy inertia. A coordinated institutional structure with clearly defined leadership for marine safety should be established, either through a designated task force or an inter-agency coordinating body. This entity would be responsible for aligning marine safety policy with environmental, tourism, and transportation regulations, as well as facilitating consistent implementation across districts and departments. It should also be equipped with the legal mandate and financial resources necessary to lead proactive safety planning, emergency preparedness, and community engagement.

Another key implication is the need to integrate safety protocols and certification systems into the licensing process for tourism operators. Currently, many boat operators and tour guides operate informally without standardized training in water safety (Bell, Howland, Mangione, & Senier, 2000). Policymakers should require mandatory certification programs for all marine tourism providers, including regular refresher courses and compliance audits. These training modules must include local environmental knowledge, marine conservation awareness, and culturally appropriate guest interaction. Such programs not only enhance safety but also build

local capacity, increase employment standards, and professionalize the tourism sector. Infrastructural investment is also a critical area in which policy must focus. The lack of lifeguard stations, emergency signage, safe anchoring systems, and designated entry/exit points for marine activities places both tourists and natural resources at risk. Public infrastructure spending should prioritize the construction of safety-related facilities, such as lifeguard towers, floating buoys, and accessible emergency kits at key beaches and dive sites. These investments should be guided by a vulnerability assessment that identifies high-risk zones based on user density, historical incident data, and environmental sensitivity. Moreover, public-private partnerships can be leveraged to co-fund infrastructure upgrades and maintenance, especially where tourism operators are direct beneficiaries of improved safety systems.

Environmental degradation also emerged as a driver of marine accidents, particularly in coral-rich areas. Coral breakage decreased underwater visibility, and the disruption of marine life increases the unpredictability and hazards of marine excursions (Leatherman et al., 2024; Lowe & Grengs, 2018). Policies should integrate environmental monitoring systems into marine tourism management. For example, reef health assessments and underwater carrying capacity evaluations can inform visitor restrictions or site closures during sensitive periods. Regulatory frameworks should also prohibit damaging activities such as fish feeding, inappropriate anchoring, or coral trampling. Education campaigns must be designed to encourage tourists to adopt low-impact behavior and to reinforce the notion that marine conservation is inseparable from safety. Tourist education and information dissemination represent another essential area for policy enhancement. Tourists often arrive with little knowledge of local marine conditions or safety procedures. Therefore, safety awareness should begin at the point of ticket purchase or pre-trip orientation and continue throughout the visitor journey. Policies should mandate that licensed operators provide safety briefings in multiple languages, using standardized formats and culturally sensitive messaging. In parallel, tourist hubs such as ports, harbors, and hotels should be equipped with interactive kiosks, safety brochures, and real-time alert systems. This not only increases visitor preparedness but also reduces the burden on emergency responders.

Data collection and information systems must also be addressed through policy reform. The absence of an integrated incident reporting platform, lack of historical safety data, and inability to analyze risk trends have hampered evidence-based policymaking. A centralized data management system should be developed to document marine safety incidents, near-misses, and environmental conditions in real time. This platform should be accessible to relevant government agencies, academic institutions, and tourism associations, enabling continuous learning and strategic planning. Furthermore, a public-facing component of the platform could provide tourists with updated safety information and allow them to receive feedback or complaints, thus fostering transparency and accountability. Climate vulnerability, including sudden changes in tides, waves, or currents, presents another policy frontier (Elliott, Cutts, & Trono, 2014; Filho et al., 2021; Glavovic, 2014). With climate change intensifying the unpredictability of marine conditions, safety policies must integrate climate science and adaptive management principles (Creighton, Hobday, Lockwood, & Pecl, 2016; Miller et al., 2010; Tobey et al., 2010; Trebilco et al., 2022). This could include the installation of weather alert systems at ports, the scheduled closure of high-risk areas during monsoon seasons, and the development of emergency evacuation protocols. Climate-sensitive planning would not only mitigate risks but also ensure that marine tourism remains viable under changing environmental conditions.

6. Policy Recommendations

This study highlights critical safety risks associated with marine tourism in Nusa Penida through a qualitative synthesis approach. Although no primary field data were collected, the analysis, based on a comprehensive literature review and policy document assessment, reveals several actionable gaps and priority areas for intervention. The research underscores the urgency of

implementing adaptive governance strategies, formalizing safety protocols, enhancing enforcement of marine zoning regulations, and investing in multilingual communication tools to improve tourist safety awareness. To address these issues, the study proposes the formation of a multi-stakeholder safety board for marine tourism, which would involve local community representatives, tourism operators, and government agencies working collaboratively. This board would be responsible for setting safety guidelines, reviewing incidents, and coordinating emergency responses. Furthermore, guide certification and water safety training should be made mandatory, in alignment with national standards set by the Ministry of Tourism, to ensure professionalism and preparedness among frontline tourism personnel.

Marine zoning maps should be updated with real-time monitoring features and integrated into digital platforms to improve navigation safety, particularly for diving areas and boat transportation routes. These efforts must be complemented by the development of mobile-based safety briefing systems, including QR codes and tablets on tour boats, to provide multilingual safety information to both domestic and international tourists. Moreover, climate-resilient planning must be integrated into route design and site development, considering the increasing frequency of extreme weather and ecological sensitivity in coastal areas. A key insight from this research is that the behavior of individual operators cannot be separated from the broader governance environment. As such, safety management should be framed not only as a regulatory task but also as a participatory process that actively includes stakeholders in policy-making and implementation. Future research should focus on validating these proposed strategies through field-based studies, particularly those examining community perceptions, tourist satisfaction, and the actual impacts of incidents on marine tourism experiences.

7. Conclusions

This study provides a comprehensive qualitative synthesis of the multidimensional factors contributing to marine safety risks in Nusa Penida, integrating insights from a structured survey framework and an extensive literature review. Through this approach, the research has demonstrated that safety challenges in the region are not merely technical or operational in nature, but are deeply rooted in systemic governance gaps, limited infrastructure, inadequate enforcement, environmental degradation, and fragmented stakeholder coordination. The study highlights that while marine tourism in Nusa Penida continues to grow rapidly, bringing economic opportunities and international attention, it remains vulnerable to safety-related incidents that can undermine its long-term sustainability. The lack of standardized safety protocols, insufficient emergency facilities, weak patrol systems, and limited safety education among both tourists and operators collectively contribute to a fragile safety ecosystem. In addition, the pressures of overcrowding, climate-induced hazards, and environmental stress on coral reefs further compound the risks faced by marine visitors. By examining safety indicators such as the availability of lifeguards, emergency contact systems, tour operator training, safety briefings, and warning systems, the study has identified critical priority areas for improvement. The analysis suggests that tourists' perception of safety is strongly shaped not only by visible infrastructure and communication but also by the reliability of local institutions and the transparency of safety practices. Notably, the lack of real-time information, weak integration of climate data into marine management, and absence of multilingual safety materials remain key barriers to achieving a safe and inclusive marine tourism experience.

8. Conflicts of Interest

The author(s) declare no conflict of interest

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