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Analysis of Defence Line Weaving for Safety Guidance Strips and Land Aircraft Safety and Communication

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Abstract

Background: Wing-in-Ground-effect (WIG) craft generate lift by operating at the air–water interface, enabling a unique mode of very high-speed maritime transport that is particularly suited to the highly complex nature of coastal and archipelagic regions. However, their distinctive operating characteristics high speed and low altitude present significant safety issues that require advanced navigation and communication systems.

Objective: This paper investigates navigation and communication systems associated with the safety of WIG craft under relevant international maritime rules (International Convention for the Safety of Life at Sea SOLAS; IMO Guidelines for Wing-in-Ground Craft (MSC.1/Circ.1592).

Methods: A qualitative regulatory analysis and R&D methodology is used to analyze the alignment of international standards with WIG operational requirements, as well as to examine barriers to the implementation of domestic maritime systems.

Results: In the marine context, this study identifies major navigational technologies such as GNSS, radar, AIS, and integrated bridge systems for navigational awareness and collision avoidance. The integration of GMDSS communications and satellite-based technologies is indispensable for enabling coherent coordination and emergency response operations. SOLAS provisions do not fully satisfy all WIG operational requirements, while the application of IMO guidelines may result in disparate standards across jurisdictions.

Conclusion: A harmonized and risk-based navigation and communication safety framework is proposed, integrating SOLAS provisions and IMO WIG Guidelines to address identified regulatory gaps. The framework aims to promote regulatory consistency and support the safe integration of WIG craft into national and international maritime transport systems.

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INTRODUCTION

Maritime transport is a major driver of global trade and economic growth, with sea routes serving as the primary corridors for island and coastal countries. Given that more than 80% of global trade is conducted by sea, international policy frameworks emphasize that maritime safety and cargo transportation must be secured as legitimate and regulated routes (Grammenos, 2026; Stopford, 2008). High-speed and hybrid transportation systems developed through maritime

technology are designed to enhance efficiency, connectivity, and safety across maritime regions (Costagliola, 2026; Cullinane & Bergqvist, 2014).

Recent marine technological developments have introduced a new field of land-based aircraft-like vessels, commonly referred to as seaboats. These systems operate through a hybrid land–water configuration, combining aerodynamic lift with hydrodynamic support to enable rapid movement near sea level. By adapting to environmental terrain conditions, these vessels are reported to achieve smoother water navigation and lower fuel consumption compared to conventional marine systems. Field observations suggest potential applications in disaster response, coastal patrol, and inter-island passenger transport, particularly in remote maritime regions (Rozhdestvensky, 2006; Rośkowicz et al., 2025; Yun et al., 2010).

Advances in lightweight structural materials, propulsion systems, and navigation control technologies have supported broader adoption in maritime service applications, both in commercial and governmental contexts. Such systems may also be applied to short-distance transportation networks and inter-island logistics in geographically dispersed regions. Despite these advantages, gaps between vessel operations and waterway governance continue to generate conflicts between safety requirements and regulatory frameworks (Rośkowicz et al., 2025; Utne et al., 2017, 2020).

Historical accounts, such as those involving Xu Guangjin's troop movements in Gaohai, illustrate early concerns regarding controlled maritime navigation. Traditional low-altitude command vessels require highly reliable navigation and communication systems to ensure operational safety. Standard practice involves establishing protective routing boundaries along navigation channels to ensure positional accuracy and reduce routing conflicts. These measures include route monitoring, trajectory tracking, and coordinated communication among maritime authorities and coastal agencies. Advanced technologies such as satellite navigation, radar systems, and automatic identification systems are increasingly emphasized to support these functions (Baldauf et al., 2016; Weintrit & Neumann, 2015).

Naval vessels require robust communication infrastructure; however, existing systems are often limited in remote maritime regions. Reliable communication networks are essential for coordination among vessels, vessel traffic services, and maritime rescue operations. Communication systems also play a critical role in transmitting emergency signals, issuing navigation alerts, and supporting rescue coordination. Effective channel guidance and coordinated defense strategies along main routes can improve operational safety, particularly for small or high-risk vessels (Misztal & Hatlas-Sowinska, 2025; Praetorius & Hollnagel, 2014).

At the international level, maritime safety governance is structured through standardized navigation and communication regulations, including provisions for navigational safety and radio communication systems. International maritime safety organizations establish minimum requirements for navigation systems, radar equipment, communication technologies, and emergency warning mechanisms. However, existing standards may still be insufficient to fully address complex operational conditions in high-risk or high-variability maritime environments (Octavia et al., 2026; Organization, 2020; Park et al., 2019).

International maritime engineering initiatives have also explored regulatory flexibility for specialized vessel types, including experimental configurations inspired by land-based airship concepts. These approaches include adaptive vessel deployment, route coordination, and integration of communication systems based on vessel classification and construction characteristics. While such methods encourage innovation and operational flexibility, they also raise challenges in assessing route suitability and communication compatibility across different maritime environments (Chauvin et al., 2013; Kerem et al., 2025; Yun et al., 2010).

Current ship research primarily focuses on propulsion performance, hydrodynamic efficiency, and operational capability. However, there is still limited comprehensive analysis of safety systems, navigation channel governance, and communication standardization. Although some studies address international maritime safety regulations, systematic frameworks for integrating navigation safety with communication infrastructure remain underdeveloped. There is limited application of unified standards for evaluating navigation systems in historical and

modern hybrid vessel contexts (Montewka et al., 2014; Rośkowicz et al., 2025; Rozhdestvensky, 2006; Yun et al., 2010).

Indonesia and other archipelagic countries face complex maritime conditions characterized by dispersed islands and limited infrastructure in remote waterways. Specialized vessels such as Shen Geng-type ships are considered promising for inter-island transport due to their adaptability to challenging sea conditions. The safe deployment of such technology depends on integrated navigation and communication systems aligned with multi-island operational environments. Hydrodynamic utilization of river-to-sea flow systems further supports vessel propulsion and operational efficiency in transitional waters.

Therefore, a clear research gap exists. Although previous studies have examined meteorological behavior, propulsion mechanisms, and operational capabilities of Shen Geng-type vessels, limited attention has been given to regulatory standardization and safety verification frameworks. Existing gaps are further intensified by the absence of unified national and international standards governing navigation equipment, communication systems, and identification protocols. This study addresses these limitations by developing a systematic analytical approach and proposing a standardized framework for navigation safety in maritime vessel operations.

The novelty of this study lies in the development of an integrated risk-based framework that systematically aligns navigation safety requirements with communication system design. It clarifies regulatory needs across maritime safety chapters and evaluates operational demands for high-speed vessels in archipelagic environments. Unlike prior studies that focus primarily on aerodynamics and propulsion systems, this research emphasizes regulatory integration and operational safety alignment, combining international maritime standards with communication and navigation requirements. These findings support ongoing efforts to harmonize emerging hybrid maritime technologies with global safety and navigation regulations.

METHOD

Research design

By combining organizational and technical analysis and R&D framework, and adopting hostage technology, we can quickly navigate coke and land bases, launch ships in international seas, fortifications, and assist command safety. The purpose of this study is to clarify the separation of navigation and communication between ships in the International Convention for the Safety of Life at Sea and international ships, and to assess the standards of transport of ships by ships. Research and excavation methods used to build, build, manufacture, model, conceptualize, and framework, support the ship's navigation and communication security (Kerem et al., 2025; Organization, 2020).

Developed as a commonly used method for sea freight and safety investigation, based on systematic analysis and iterative development, it provides a practical regulatory framework, complete safety models, and performance techniques (Borg & Gall, 1984; Irawan et al., 2026). Initially, research on shipping costs was ongoing, and a standard architecture for pilot navigation and communication support systems was developed, using materials carried by ferries as their characteristics, surpassing current regulatory evidence. Present the costs of normative legal procedures, as well as legal norms, international treaties, and regulatory documents related to maritime navigation, security, and communication systems. Initially studying techniques that follow this principle, examining legal provisions, international maritime conventions, and their technical guidelines, examining the new hybrid shipping technology is as applicable as using a ship to the heart (Borg & Gall, 1984; Marzuki, 2017).

Through standard analysis, pilot requirements and current navigation equipment can be used to establish a relationship with the navigation regulations for Ningbo ships. In addition, we use simple mindset techniques and organizational analysis to assess the safety capabilities of navigation devices and communication systems in response to changing circumstances. This approach may include radar and global navigation satellite systems. Through our own actions, we recognize the characteristics of other systems, electronic surveys and information systems, as well as legal systems of maritime events and communications, which are characterized by

simplicity, stability, breadth and roughness in ship transport operations. Qualitative organizational analysis can carefully examine the regulatory challenges between existing ship systems and departing ship planning models, practical implementation difficulties, and technical similarities, distinguishing truth from external patterns (Creswell & Creswell, 2017; Njeri Mugwe & Runo, 2026).

Comprehensive research design and analysis has three main elements. Firstly, according to the principle of selection rules for the Yu Yu Inspectorate, the feasibility and safety of maritime navigation communication are guaranteed. The legal analysis mainly follows Chapter 5: Navigation Safety, Wireless Communications. In addition, a comparative regulatory analysis will be conducted to ensure that the rules of navigation and communication assistance are in accordance with the International Maritime Organization. Third, train Hangkong Practitioners to clearly identify physical standards for domestic border highway shipping routes and communication equipment, and specifically prepare and organize such plans.

This integrated design provides an operational evaluation framework for Chengxianshan, Zhao's security and communication support system. It was initially expected that a structured analytical framework would be constructed through normative, legal, and qualitative organizational analysis methods, urging the use of dangerous wind vessels to guide ships in coordination with rivers of communication. This law strengthens maritime safety governance and urges Liu Jiju's proposal to safely integrate ships in modern maritime transportation. It is important to know the scale of construction here, which was then used for the study of maritime safety and transport regulations, to build the Fruit Realm (Borg & Gall, 1984; Irawan et al., 2026), the mysterious and dangerous passageway of the Golan and Monte, all of which are appreciated (Borg & Gall, 1984; Creswell & Creswell, 2017; Irawan et al., 2026).

Research and Development (R&D) Stage

The purpose of this research is to provide navigation and guidance equipment and navigation control for land-wing vessels, based on the scientific knowledge of Confucian engineers and management platforms.

Preliminary Research

Preliminary research focuses on the main point of navigation communication for winged ship pilots, with safety concerns. Instruction This section is to build a conceptually hazardous environment, to treat the high and low speed seas as a profession, and to pursue safe navigation and communication technologies. The preliminary review estimates material measurements for maritime operational characteristics, including speed, maneuverability, route planning, collision requirements, as well as coastal authority and maritime communications requirements. Navigation Guide Equipment: The helicopter's communication system aids in situational awareness, combat safety, and emergency response. It also examines whether current standards for navigation and communication equipment can be adapted to ships, as well as the feasibility of future research needs, such as dividing into dimensions and coatings for future research.

Review of regulations and literature

1) This stage also reviews treaty documents and literature, naval law, domestic maritime law, as well as academic reviews and assessments related to the development of high-speed ship arrow and navigation mechanisms and the security of communication bond systems (Kerem et al., 2025; Organization, 2020). All of the major supervisory jobs discussed include:
2) The International Convention for the Safety of Life at Sea notes that Yang Xiong's arrest was carried out in Chapter 5 on navigation safety, and in chapter 4 on wireless communications, civil violations of national maritime borders are intertwined into two years, with no silk thread passing through it.
3) and transported by water using official grains. "Coastal Navigation Guide" is in a shaky state. 1592);
4) Maritime affairs, guides, navigation equipment, and communications are national priorities;

Towards dawn

5) First, on navigation safety, maritime communication technology, and the basics of hybrid extradition and Rostvin, February 16; and so on, [It meets the river, There is a very arrogant type of person, (Baldauf et al., 2016; Rośkowicz et al., 2025; Rozhdestvensky, 2006; Stopford, 2008; Weintrit & Neumann, 2015).
6) This stage aims to clearly mark the standards of daytime channel equipment and ship communication systems, and to identify gaps between national border standards and operational needs. The literature review includes previous studies on maritime safety technologies, integrated bridge systems, and the reliability of maritime communication cooperation for high-speed vessels.

Design and Development Stage

Liu Ji concluded in the preliminary research and evaluation of the organization that a conceptual framework will be established at this stage to support the Hejiang ship preparation and communication support system. This design process combines international maritime safety requirements with operational characteristics, navigation accuracy, collision capability, and reliable beam and ship communication. Exposing the effects and risks of Xu Qiji's compliance as a national security method is in line with the practical practices of modern maritime safety management. Especially the potential of new technologies such as satellite-guided navigation systems, integrated navigation bridge wooden beams, and digital maritime communication platforms, which are in line with international maritime safety standards. The next stage will be framing and evaluating the rules of navigation and communication between navigation and navigation equipment, precisely using the properties and how the ship integrates them.

Development of safety and risk-based operational frameworks

This stage will establish inscription documents and door frames, set up many regulations and technical elements, and use guidelines for navigation and communication security.

1) Requests for broadlines, security, and no communication connections under jurisdiction;
2) On the ground, there was an order from the Kingdom Border Wing aircraft;
3) National border standard framework for integrated bridge equipment and systems; Towards dawn
4) Hazard insights and identification, hazard lists, and operational safety, using model weight standards all contribute to risk stability and price level forecasting,

This approach is intended by the regulatory framework to promote navigation support and ensure the safety of vessels in narrow waterways, coastal roads and remote locations. Using risk as a local assessment tool, the knowledge inherent in the system also reduces risks related to communication and communication.

Analysis, Validation, and Evaluation

The inspection stage involves the analysis of the properties and standards of standardized fabrics. The following provides a regulatory consistency analysis to assess compatibility between various provisions, violations of the International Maritime Organization, South Vietnam, and the latest pilotage regulatory standards. In addition, whether it will be incorporated into the current maritime security governance system. If one possesses something, it is through the Way, by virtue, by virtue, and by virtue is what is considered virtue. This evidence is actually a framework that is aligned with international maritime security principles, ensuring that the safety of ships is reliable through operations.

Integrity and policy reasons

In the final stages, the proposed framework will be evaluated, with Cai ensuring compliance with national maritime policies and assessing the operation of islands and other marine environments. Both labels envisage the role of flag standards to guide navigation and communication vessels within the framework of the regional regulatory framework, as well as the role of institutions, certification procedures, and the essence of controls. The message is clear: the

archipelagic state's tactics stand out, perhaps due to the island's unique distribution and unusual sea conditions. Pei Hang's travel was lacking, and he needed to coordinate search and repair through communication. The initial objective of the research findings was to develop policy recommendations to align international maritime safety standards with the maritime regulations of various countries.

Research Areas

The purpose of this study is to identify the technical aspects of land aviation, which are part of the regulations of the national coastal safety law and the structure and rotation of marine transportation in different countries. Extensive research and investigation has helped identify the full requirements of independent and independent shipping companies. The main focus of the study is to focus on safety at sea, as well as the ship's base for full navigation along the route. Chapters 5 and 4 cover radio communications, as well as the modification of deep dive vessel bifoils, and the interconnection between navigation channels and passing documents. According to FAO's analysis, ship pilotage and navigation channels such as radar systems, global pilot navigation satellite systems, automatic identification and separate systems, integrated bridge systems, and other major maritime routes,

Initially, the study was to evaluate whether the people guiding Pei Hang and this communication were Ming Tong systems, and whether they should be able to synthesize the operational and manufacturing characteristics of Fierce Land vessels, including high-speed operations, low-altitude surface navigation, and hybrid air-sea design features. It is specifically noted for integrating navigation and communication equipment to assist with situation sensing, collision avoidance, route monitoring, and emergency response. Geographically, they are concentrated in the waters of various islands, scattered in the marine environment, with complex routes and weak navigation channels in the target area. It is the law of wind, noise, ships, and pilot ships for fortresses and communications, relying on human emotions and efficiency.

It is a research analysis method in normative, legal, and qualitative organizational analysis. This involves regulatory gaps, hidden barriers in technology compatibility, and the defense of navigation channels, such as the political impact of the use of violent vessels to support communications in the region. This study does not require technical design, hardware testing, or simulation modeling of navigation systems related to safety, operation, and governance regulations. The initial objectives of the scope of the research were: formally analyze the need for navigational navigation and navigation preparedness, use vessels for communication and certification, and related navigation standards, identify some common points, and develop a "navigation safety marking level" for emerging hybrid shipping systems.

RESULTS AND DISCUSSION

WIG Navigation Equipment Requirements for Vessel Safety

Relying on the high-speed, low-altitude Yaoyang Canal as its feature, guiding navigation ships to fortify is key to relying on canals. Unlike ordinary ships, Wiig's warships were always on the surface, with limited mobility and short reaction times. So proper navigation and almost instantaneous state trends are all about the important things. Therefore, Bian Zheng incorporates pilot equipment to help with safe flight paths, collision avoidance, and operational control. In reality, this is a top priority.

According to Chapter 5 of the 'False Fishing Nets' and other regulations, as well as the international manufacture of silk rope woven nets, boatmen must transport grain safely at the port of coastal vessels, ensuring the best level of transport for vessels carrying dry oars." These include global navigation guides in integrated navigation channel jurisdictions, electronic maps and information systems, automatic recognition, systems, and related system jurisdictions, as well as bridge closure systems. These tapes were used to help Zhang Fu navigate fully with the principle of reliable operation, but they were only disguised as special rewards (Baldauf et al., 2016; Rośkowicz et al., 2025).

Hanghe can accurately provide a wide range of position, speed, and direction needs.

Because of the low sea craft, only the Luji, Luji, and Renshang ships built dangerous embankments and navigation points in the sea. In order to avoid enemy attacks, he designed radar to detect nearby ships and obstacles, especially when crowded near waterways or locked, staying in the boat, Zhang Xiong was able to detect people near the side of the ship at that time, providing postural insights to help prevent traffic jams and collisions along the route (Grech et al., 2019; Tyron et al., 2026).

With integrated mountain and bridge control, it basically refers to surveillance, planning, and several guide ships and fortifications back then, all gathered in one window. It is very important in dynamic marine ecology and shipbuilding operations, requiring a high temperament and inspiring wisdom, Its effectiveness directly introduces a workforce that affects the safety of the canal navigation system and risk mitigation for each navigation system (Chauvin et al., 2013; Kerem et al., 2025).

However, the analysis clearly shows that the current preparatory model for ether-sa guided pilotage appears to be designed for existing ships, making it difficult to adapt and take advantage of the characteristics of naval warships. Between high and low speeds, more precise data logic and better treatment are needed to avoid arrows. Therefore, it is necessary to integrate pre-navigation technology appropriately to ensure proper safety support for vessel operations. This set of rules is used to protect muddy terrain (Hetherington et al., 2006; Liu et al., 2026).

Operational Safety Communication Support System

Communication systems are used to provide critical areas for the safety of ships and vessels, monitor and report international coastal entertainment safety reports, handle funeral affairs, and collect revenue from disaster relief food, ship travel, vehicles, transportation, clothing, food, and other related matters, as well as search for rescue and rescue in difficult situations. With the help of sky communication, the crew can fully understand navigation warnings, weather forecasts, and coordination messages, However, only Xiao Qiao's boat is specifically connected to the theme while cruising across the island, which is noteworthy. Major unresolved gaps that threaten operational security, including the uncertainty of remote islands, delays in emergency deliveries of real-time satellite communications, and global maritime communications and security systems, between drinking water and heavy rain (Baldauf et al., 2016; Misztal & Hatlas-Sowinska, 2025; Praetorius & Hollnagel, 2014).

Chapter 4 of the treaty states that maritime radio communication systems, such as high-frequency radio communications, satellite communications, and police communications, must pledge allegiance to celestial beings but must act like Yang Xiong. The system is designed to provide signals during normal and emergency situations to facilitate communication capabilities. A safe communication system for the people of Rulai heading to Hetao can be bypassed, so that the highway continues to operate along coastal and archipelago waters, as well as coordinated emergency response for important tasks, 90 and 20 times.

One of its main drawbacks is operational safety. For example, using different radio frequencies at night or sharing visual indications of routes can be integrated with satellite communication systems and digital maritime communication platforms to support data from ships and coast guard centers. This ensures safety and reduces the risk of accidents. It is related to the route of your home, providing meteorological information for joint worship and responding to emergencies. Satellite communication is a royal tradition; In remote areas with limited communication infrastructure, it is advisable to connect securely with them.

Despite the existence of the International Unicom standard, this analysis shows that its implementation is difficult. Now, we use aquatic plants to connect supplies. In standard boats, high-speed and high-mobility boats are not necessarily tested. In that new moon's remote business environment, command and control and communications platform supervisors will have to wait for real-time streaming, information sharing, and emergency response support. In addition, national trust standards are highly inconsistent, resulting in the inconsistent use of seagoing vessels and vessels as proof of supply (Goerlandt, 2024; Goerlandt & Montewka, 2015).

Style Compatibility with International Maritime Silk Textile Fabric Guides and Certifications

The pilot channel for Wushan civilian ships is combined with a communication river to prepare defensive measures. The person in charge of the water shackles asked to use Xianhui and the International Maritime Organization's accusations against them. Raw materials such as Yu, He, and other aqueducts, communications, and grain carriers meet the minimum forming standards. Therefore, the Yiling of the International Seafarers' Organization can be made with the characteristics of Shanlangren rocking boats.

Again, the regulations on the return of 'Wen Xu' are the lowest standards set for defense and performance as well as standards for personnel, Article 6. In contrast, China's maritime border affairs are accused of crimes, and the guidelines are based on the results of political performance. Xie Flexi is flexible in risk assessment and operational review, ensuring a fair navigation and communication system using water and water. These regulations differ slightly, resulting in inconsistent enforcement between states and maritime jurisdictions.

The other is: based on the method of 'respect Geng and Huiyu teachers', the foundation of guidance and navigation equipment is compared to the need for outsourcing.

Table 1. Comparison of navigation and communication equipment requirements

Sides	**and ask for leniency**	**I think, with a hair guide**	**Identify gaps**
Sweet ss	Service always in determining the successor to the throne	Requirements are set based on the election of officials	Gao Ming understands the needs of personnel and highway personnel
Radar capture unifies the system	Radar and naval standards	Flexible radar configuration	Limitations of high-speed detection
He is honorable and dignified	But they were still able to tie Yang Tong up and use him as a lock trap.	So in front of you, I understand the situation of other systems,	This achieves a change in writing style
Xiang Tong arrested on reciprocal communication	Qiao S, very high frequency, Wei	Gao Yan provided Zhou Zhi's communication support	No format for advertising or communication
Integrated as a bridge	Recommend to modern boats	Flexibly rearrange the merging system	Use advanced materials, organization, and fulfillment needs

Source: Research Data

Table 2. Comprehensive Analysis of Navigation and Communication Equipment Requirements

Sides	**Reference to 'Xi Su' (Fermented Crispy).**	**I believe there really is a civil code of Tangshan**	**Impact on heavy ships on the front line**	**The person who recommends it will stand up for himself**
Sweet ss	Yunyun, catfish, and carp have secured their thrones	Ye Chan Hui's skill is to choose and obtain it carefully	When building houses at a height of five meters< Qi-Fenfen is set at a standard of one meter to avoid collisions with fixed ships or other ships	As it expands, widens, expands width, and enriches the area, the double path winds its way into the fortress. Set a threshold for the accuracy of world measurements, ≤ one million circles
Radar capture unifies the	Now, with aquatic plants and rowing	Flexible radar configuration for	High-speed access speed: >. Traditional	All promised to use radar in Xiang's band

Sides	Reference to 'Xi Su' (Fermented Crispy).	I believe there really is a civil code of Tangshan	Impact on heavy ships on the front line	The person who recommends it will stand up for himself
system	boats, we can ≥ ten thousand boats to keep an eye on the ships.	risk assessment	wave segment radar is not enough to detect measurement markers at high speeds over the sea	under Wang's prestige; I tried to see half of the guide's body like a radar, equipped with a marine interference screen, slowly channeling energy and changing at will, relying on altitude and the talent of time.
He is honorable and dignified	In Gengyuan, three hundred people connected the boat in the ≥ boat to the boat, and the hull needed to be repaired.	Using spruce investigation and verification to identify targets through requirements such as measurements and battles, by using facial features to identify targets	According to Zhang Su's standards, sometimes reports from winged ships were not enough. Highways need faster changes to avoid collisions	In addition to the spread of high-speed ship reporting, soft Category A customs regulations are also indispensable. Try to see Yiyi occupy the treasury a few times, and the ship replaced the large ship with the shape of a ship.
Xiang Tong arrested on reciprocal communicatio n	Yunxie, the Clan and units of Yan, Xuan, Zhen, and MunRRRRRR are all located overseas.	With lush water and grass, the measurement system was tailor-made for them based on human nature and adaptability	The construction performance of remote islands is sometimes too high and is often targeted. But Yunss's Urgent Program does not make an assessment or take a quiet path of thought, nor does it consider a broad and broad path	satellite communication, using Shanqin for external main support; Yao and the Ao people focus on Daoyu emergency activation
Integrated as a bridge	Today, land ships are towed by people who are still alive; Small boats are not mandatory	The air ting-ring and ring are combined in the sub-system; There is no defined meaning for architecture	Mountain tribal people use ship transportation, mountain valleys, radar, meteorology, and transportation evidence, and only make decisions after supporting empirical evidence. One screen should be neatly closed as a key point.	Xu Yi decided that the standard of merchant ships should be integrated with navigation channels for transportation under unified management; According to the "Thousand Amulets Diagram", it shows norms and warnings

Source: Research Data

The rules of the Shenshan Xu instrument are designed to support safe navigation and smooth travel, but Chengxian ships lack standards for appearance and craftsmanship, resulting in uncertainty in law enforcement. The way to achieve results is: encourage innovation. However, this environment causes equipment standards to differ from certification practices.

Challenges in The Implementation of The National Maritime System

Although it was noted that navigation and communication equipment was limited, Lu Li took it on board a Song dynasty maritime transport ship. The people of these maritime island nations are very clear in their shipping, infrastructure installations, and communication coverage, with uniformly and unrestricted fields of education.

First, domestic maritime regulations largely follow traditional high-speed vessels and laws, with specific provisions specifically targeting vessels. Therefore, through the certification and inspection process, it is necessary to interpret international guidelines one by one according to safe methods, including Indonesia and colluding countries, 20.

Second, the combination of expensive navigation skills and digital communication systems depends on the appropriate skills, capabilities, and infrastructure needs. The shared nature of ship navigation systems, land navigation systems, and communication surveillance must also be ensured by maritime authorities and operators. Building a limited area based on navigation, and considering the funds obtained from the management of the ship itself, is very difficult and difficult,

Third, improved political performance and correspondence clearly show that vouchers are indeed valid, and that actual grants are compatible with each other, requiring coordination with the institutions that collect and rescue funds. If coordination is lacking, security will become disorganized, and achievements will make subordinates give up.

Table 3. Key challenges in introducing navigation and communication systems for WIG vessels

Within a few inches	**What looks challenging to the enemy**	**Secure response**
Regulatory framework	Use feathers and venom to quickly mark and clarify	and does not meet the requirements for equipment
Technical and ideological foundations and facilities	Pei Hanghang and communication car cover are unbalanced	Reduced operational potential
Institutional coordination	and limit the troops to assemble	Lack of safety inspections
It is a procedure for identifying and verifying evidence	Every case is handled appropriately	Lack of establishment regulations

Source: Research Data

Lack of discipline between the two was comparable, and that introducing effective navigation and communication equipment to put Pei Zhiliang on board to meet regulatory, technical, and institutional challenges could be seen as inseparable. To understand the decision-making question, one must integrate a better legal framework and institutional cooperation.

Towards A Simplified Safety System for Navigation and Communication

There should be a mandatory and integrated system, including the Fan family of Flying Fish, International Maritime Organization fees, and the transportation of fish salt to ensure safety. This framework should clearly define requirements for navigation device types, communication system limitations, and risk-based certifications.

This means the framework must incorporate emerging navigation technologies, integrated communication systems, and risk-oriented safety estimation methods. This only improves regulatory consistency, ensures safe transportation and rescue, and supports heavy vessels carrying people by sea.

In summary, we analyze that the guide channel and channel equipment, together with the communication support system, form a fixed paddle. The maritime environment is changing rapidly, requiring proper regulatory standardization, comprehensive technology, and institutional adjustments to ensure the safety of ships and operating through shipping routes.

CONCLUSION

Research has shown clear deployment of basic human guidance systems, mountain bridge structures, radar communications, vehicle network integration, comprehensive rope-and-bridge configurations, beam systems, and wide rope arrangements for river bridges, as well as Shusun lines, full bridge configurations, and beam networks in open highway areas, focusing on stealth operation, situational awareness, collision avoidance, and emergency preparedness across key border regions. However, the current trend of Yunchou systems is still primarily designed for existing vessels, with Yao, Ling, and Shen contributing to risk mitigation solutions, while certification standards vary by country. This issue is particularly severe in regions with limited communication coverage, especially in island and offshore navigation contexts, ultimately resulting in underdeveloped national regulations and fragmented institutional security frameworks.

To address this gap, the study proposes a risk-based framework for navigation and communication security by integrating regulatory standards, international conference reviews, structural design guidelines, and national maritime governance considerations. It serves as a practical implementation of a broader development framework, supporting recommendations from the Six Congresses, including the integration of national standards (Huai-Huai), improvement of communication systems, application of risk analysis methods such as Qian Difficulties, strengthened inter-agency coordination, and development of systems adapted to archipelagic environments and autonomous technologies. This layered approach enables safety regulations to better govern maritime transport, ensuring vessels operate safely, consistently, and in a more fully integrated manner within modern maritime systems.

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AUTHOR CONTRIBUTION STATEMENT

Dodik Widarbowo contributed to the conceptualization, methodology, data collection, and preparation of the original draft. Fajar Gumelar was responsible for formal analysis, data interpretation, and reviewing and editing the manuscript. Maltus Jackline Kapistrano provided supervision, validation, and technical guidance on maritime regulations. Wahyu Wibisono supported data acquisition, analysis, and manuscript review, while Antoni Arif Priadi managed the project, provided resources, and approved the final version of the manuscript. All authors have read and approved the final manuscript and take responsibility for all aspects of the work, ensuring its integrity and accuracy.

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