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GOOD PRACTICES FOR TECHNICAL SUPERVISION IN SHIPYARDS TO ENSURE COMPLIANCE AND SAFETY OF MACHINERY AND HULLS

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Abstract: This article analyzes the role of technical supervision in Brazilian shipbuilding and repair, discussing its importance for regulatory compliance, the structural integrity of hulls and machinery systems, and accident prevention in high-risk environments. Based on a qualitative literature review covering national and international academic literature, standards such as NR-34, NORMAM, and IMO conventions, technical documents, dissertations, and institutional reports, the study identifies recurring weaknesses in shipyards, such as informal processes, low standardization, training gaps, and difficulties in integrating engineering, production, safety, and quality. Based on this evidence, a framework of good practices in technical supervision is proposed, consisting of six pillars—standardization and traceability, quality control and metrology, structural integrity and NDT, machinery and commissioning, operational safety, and technical governance—aimed at reducing rework, mitigating critical risks, and increasing the sector's competitiveness. The article also discusses how digitization, Naval Industry 4.0, and technologies such as sensors, electronic traceability, and digital twins expand the scope and complexity of supervision, requiring more structured, risk-based models supported by training and institutional strengthening policies.

Keywords: Shipbuilding, NR 34, technical supervision, occupational safety; Structural integrity.

Introduction

The shipbuilding and repair industry occupies a strategic position in Brazilian economic development, especially due to its relevance to the logistics, water transport, defense, and offshore exploration sectors. However, despite its importance, the sector faces historical challenges related to construction quality, productivity, safety, and operational reliability (LACERDA, 2003). These challenges make technical supervision particularly critical, as it acts as an integrating element between regulatory requirements, process control, and risk mitigation.

Shipbuilding is characterized by the high technical complexity of the processes involved, including the manufacture and assembly of structural modules, large-scale welding, installation of mechanical and electrical systems, as well as activities carried out in high-risk environments, such as confined spaces and areas with the potential for explosive atmospheres (SOARES; SANTOS, 2012). The diversity and simultaneity of these operations make technical supervision an indispensable component to ensure compliance, structural integrity, and occupational safety.

In the Brazilian context, studies indicate that many shipyards—especially small and medium-sized ones—operate with systemic weaknesses related to the informality of processes, insufficient standardization, and a lack of structured management systems (COELHO; ARAÚJO, 2020). These conditions substantially increase the likelihood of manufacturing failures, rework, non-compliance, and accidents, indicating that technical supervision plays a critical role not only in quality assurance but also in the overall efficiency of the shipyard.

The specialized literature shows that, although standards and regulations are widely available, their effectiveness depends on the ability to apply them in practice in the production environment. Regulatory

Standard No. 34 (BRAZIL, 2011) establishes specific guidelines for welding, cargo handling, painting, working at heights, and operations in confined spaces. However, Soares (2012) demonstrates that many accidents do not occur due to the lack of standards, but rather due to workers' poor understanding of risks and the lack of adequate supervision in monitoring tasks.

Regarding structural integrity, studies by Baptista (2018) highlight the sensitivity of the shipbuilding process to dimensional deviations, cumulative manufacturing errors, and misalignment between blocks. This author demonstrates that geometric and metrological accuracy is crucial to ensuring the structural performance of the vessel and that depends on strict supervised control, highlighting that naval welding is a significant source of complexity, presenting risks of internal and surface failures that require continuous inspection and technical decisions based on Non-Destructive Testing (NDT).

From an economic and competitive standpoint, Moura, Botter, and Silva (2010) demonstrate that quality, cost, and reliability are fundamental dimensions for the performance of Brazilian shipyards. Supervision failures—which translate into rework, delays, non-conformities, and reduced vessel life—directly impact the sector's competitiveness. This scenario is even more critical in regions such as the Amazon, where river transport is essential and shipbuilding operates under challenging technical and logistical conditions (SILVA, 2011).

More recently, the introduction of digital technologies, sensors, electronic traceability, automated inspection systems, and digital twins (digital twins, fed with data from sensors on the real object) has expanded the possibilities for modernizing supervision processes (SEIPOLT, 2025). However, the adoption of these technologies requires the strengthening of technical skills and governance structures that enable their effective integration into the productive environment.

Thus, the literature review shows that:

- technical supervision is a structural pillar of quality and safety in shipbuilding;
- supervision failures are associated with the main causes of accidents and rework;
- the proper implementation of national and international standards depends directly on the quality of supervision;
- technological modernization requires new integrated, interdisciplinary, and risk-based supervision models.

In view of this, this article aims to analyze technical supervision practices in light of Brazilian literature and to structure a conceptual model capable of guiding shipyards in the adoption of safer, more efficient, and technically robust practices. The following chapter will delve deeper into the state of the art of national research, providing a theoretical basis for the development of the proposed framework.

Methodology

This research is characterized as a qualitative literature review, whose objective is to systematize theoretical knowledge about technical supervision in shipyards, with a focus on Brazilian shipbuilding. The inves-

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tigation adopted critical literature analysis procedures, prioritizing national academic productions, technical documents, dissertations, theses, regulatory standards, and institutional reports.

Works were selected that presented relevant discussions on metrological control, structural integrity, welding, safety, regulatory compliance, and Naval Industry 4.0.

The criteria for selecting sources included thematic relevance, methodological consistency, the recency of publications, and the relevance of the institutions producing the knowledge, including federal universities, classification societies, regulatory agencies, and technological institutes. Dissertations and theses were included due to the technical and detailed nature of their findings, which are often absent in strictly theoretical literature.

Works that did not directly address technical supervision practices, that had limited methodological basis, or that did not correspond to the naval focus adopted were excluded. We chose to prioritize Brazilian references precisely because of regional specificity, local production contexts, and the heterogeneity of shipyard arrangements——factors that are essential for understanding technical supervision in its practical application.

Thus, the methodology adopted allowed us to consolidate evidence on weaknesses in national shipyards, as well as to identify practices and guidelines potentially applicable to the Brazilian context.

Theoretical Framework

- Overview

The Brazilian shipbuilding industry occupies a strategic position in the country's economic, logistical, and geopolitical development. Structured by shipyards distributed along the coast and major river basins, this industry integrates production chains in engineering, metallurgy, energy, and transportation, playing an essential role in national infrastructure. However, this relevance contrasts with historical challenges related to productivity, technical qualification, and industrial modernization, which directly impact the quality of vessels and the competitiveness of the sector.

The productive structure of the Brazilian shipbuilding industry is characterized by a diversified network of shipyards, ranging from large industrial shipyards, medium-sized regional complexes, and hundreds of small units focused on the construction of river vessels, fishing boats, and port support vessels. According to Lacerda (2003), the shipbuilding industry has high potential for productive linkages, integrating sectors such as steelmaking, electromechanics, industrial automation, welding, and engineering services, making it one of the most technology- and skilled labor-intensive industrial activities.

The sector's productive arrangements also have specific regional characteristics. In the Southeast and South, shipyards focused on offshore construction, large vessels, and maritime support ships are concentrated. In the North, especially in the Amazon, small and medium-sized shipyards dedicated to the construction of river vessels, ferries, tugboats, and passenger transport predominate, adapted to unique operating conditions (SILVA, 2011). This structural diversity implies different levels of technological maturi-

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ty and, consequently, different demands for technical supervision.

Studies such as those by Moura, Botter, and Silva (2010) indicate that the competitiveness of shipyards depends on their ability to integrate quality, reliability, and cost, requiring standardized production processes, strict welding control, advanced metrology, and efficient risk management. These factors reinforce the need for supervision practices aligned with international standards, which are still not widely disseminated in the Brazilian sector.

The Brazilian shipbuilding industry faces structural bottlenecks that limit its competitiveness and quality. Among the main ones are:

- Shortage of skilled labor: technical training in areas such as naval welding, NDT, metrology, and commissioning is still insufficient. Studies by Coelho and Araújo (2020) show that many workers learn their jobs empirically, without formal training, which compromises the execution of critical activities and requires greater intervention by technical supervision.
- Dimensional accuracy: the assembly of structural blocks requires rigorous geometric control, since accumulated millimeter errors can cause misalignments, deformations, and structural integrity failures. The absence of systematized procedures and adequate metrological instruments aggravates this problem.
- Welding: Naval welding involves thick plates, complex geometries, and adverse environmental conditions, making it one of the biggest sources of structural failures. Baptista (2018) demonstrates that parameter variability, inconsistent welder qualification, and a lack of efficient inspections result in extensive rework and increased costs.
- Regulatory compliance: compliance with standards such as NR-34, NORMAM-05, SOLAS, and ISM Code requires integration between safety, engineering, and management. According to Soares (2012), many shipyards do not have a formal organizational structure to implement such standards, which leads to inconsistent practices and decisions based on individual experience rather than consolidated processes.

These bottlenecks show that technical supervision is not only necessary but also a critical tool for risk mitigation and continuous improvement.

The shipbuilding industry is essential to Brazilian logistics, especially in coastal shipping and river transport. In the logistics sector, shipyards produce vessels that are essential for the transport of fuel, solid bulk, containers, and passengers. The expansion of inland navigation, driven by regional integration policies, reinforces this strategic role.

In the field of defense, shipyards are responsible for the construction and maintenance of military vessels, including patrol ships, corvettes, armored boats, and support vessels. The modernization of the Brazilian Navy's fleet depends directly on the technological and productive capacity of these shipyards (BRAZILIAN NAVY, 2003).

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In the energy sector, shipbuilding is closely linked to the offshore industry, especially in oil and gas exploration in the Campos Basin and the pre-salt layer. Platforms, FPSOs (floating production, storage, and offloading units), support vessels, and anchoring systems depend on shipyards specializing in complex structures, high-responsibility welding, and commissioning of critical systems. Studies published in BNDES magazines highlight that the shipbuilding industry has significant economic multiplier effects for the energy and infrastructure sectors (LACERDA, 2003).

These three sectors—logistics, defense, and energy—reinforce the need for reliable vessels, robust systems, and high-quality production processes, factors that are directly influenced by technical supervision.

- Applicable Regulatory Framework

International regulation of shipbuilding has historically been conducted by the International Maritime Organization (IMO) through multilateral conventions. Among the most relevant are:

SOLAS – International Convention for the Safety of Life at Sea: the world's leading reference in vessel safety, defining requirements for structure, stability, fire protection, navigation systems, and hull integrity. In the context of technical supervision, SOLAS imposes strict standards for structural inspection; integrity of watertight compartments; critical mechanical and electrical systems; periodic testing and certification. The application of these requirements reinforces the need for qualified supervisors who understand their translation into shipyard operations.

ISM Code – International Safety Management Code: introduces principles of safety management and pollution prevention, establishing that companies and ships must maintain a Safety Management System (SMS). Technical supervisors play a central role in the practical implementation of safe working procedures; risk analysis; incident investigation; internal compliance audits.

The MARPOL Convention (International Convention for the Prevention of Pollution from Ships) establishes environmental guidelines for the prevention of pollution by oil, harmful liquid substances, waste, atmospheric emissions, and sewage. For shipyards, MARPOL implies direct responsibilities in: r containment systems; tank cleaning procedures; handling of welding and painting waste; periodic environmental inspections.

In addition to the IMO, there are Classification Societies: classification societies establish international technical standards that regulate the construction, modification, and operation of vessels. In Brazil, the main ones are:

ABS – American Bureau of Shipping;

- DNV – Det Norske Veritas;
- LR – Lloyd's Register;
- BV – Bureau Veritas.

These entities publish detailed rules covering: hull structural requirements; welding and NDT parameters; shaft line and propulsion system inspections; alignment tolerances; criteria for material and process certification.

Despite occasional differences, national naval standards are aligned with international standards, mainly represented by NR-34, Maritime Authority Standards

(NORMAM-05, NORMAM-07), and LESTA.

NR-34 — Shipbuilding and Repair: Regulatory Standard No. 34 (BRAZIL, 2011) is the main national instrument for regulating health and safety in shipyards. It establishes specific guidelines for: welding, cutting, and heating; cargo handling; industrial painting; working at heights; confined spaces; and prevention of explosive atmospheres.

Studies such as those by Coelho and Araújo (2020) and Soares and Santos (2012) show that the effectiveness of NR-34 depends directly on technical supervision, especially in the issuance of Work Permits (PT), preliminary risk analyses (APR), and supervision of the execution of activities.

NORMAM-05 — Waterway Work Safety published by the Brazilian Navy, NORMAM-05 establishes requirements for accident prevention in waterway activities, including: vessel inspection; maintenance of machinery systems; risk control in port operations; parameters for commissioning and testing.

Brazilian Navy Guidelines: in addition to NORMAM-05, the Ports and Coasts Directorate (DPC) publishes: the Naval Inspector's Manual, NORMAM-07, equipment approval standards, specific instructions for shipbuilding works. These documents reinforce inspection practices, leak testing, safety procedures, and the technical responsibilities of the naval supervisor.

Law No. 9,537, of December 11, 1997 (LESTA) — This law is the legal basis that regulates waterway traffic safety in waters under Brazilian jurisdiction. It defines the duties of the Maritime Authority, represented by the Navy Command, as well as the principles and guidelines that govern inspections, surveys, sanctions, and other procedures aimed at safe navigation. It is an essential regulatory framework to ensure that maritime and river activities occur within the technical and safety standards required by the Brazilian government.

Compliance with these requirements depends on qualified supervisors capable of interpreting multidisciplinary rules and ensuring that each stage of construction follows internationally accepted standards. Despite the existence of robust standards, there are several practical challenges in implementing the regulatory framework:

- Multiplicity and overlap of standards: the coexistence of national standards (NR-34, ABNT), military regulations (NORMAM-05), international conventions (SOLAS, ISM, MARPOL), and classification rules creates interpretative complexity. Supervisors often face difficulties in integrating these standards into coherent operational processes (SOARES, 2012).
- Insufficient training: technical training focused on regulatory interpretation is still limited. Studies in Brazilian shipyards reveal that supervisors often lack advanced skills in NDT, metrology, safety, and regulatory audits (COELHO; ARAÚJO, 2020).
- Organizational culture and informality: several shipyards, especially in the North and Northeast, have a strong culture of informality, with decisions based on empirical experience, without records or structured monitoring. This hin-

ders the documentation required for certifications and audits (SILVA, 2011).

- Failures in integration between engineering, quality, and safety: the literature points out that internal sectors often operate in isolation, without integrated management systems (MOURA; BOTTER; SILVA, 2010). Technical supervision is, therefore, the indispensable link for aligning regulatory requirements with production practices.

These challenges reinforce the need for technical supervision models capable of unifying requirements, standardizing processes, and ensuring traceability.

- Critical Risks in Shipbuilding

Shipbuilding processes involve a high level of technical complexity, which makes the structural integrity of vessels, occupational safety, and operational reliability highly dependent on strict control of procedures and inspections. Deformations, misalignments, cracks, and residual stresses are directly related to metrological insufficiency, lack of standardization, and supervision failures (MOURA; BOTTER; SILVA, 2010). The joining of blocks, when performed with accumulated deviations, can compromise the watertightness and service life of the vessel, requiring rework and increasing industrial costs.

Welding is one of the critical points in this context, as it involves long joints, significant mechanical stresses, and risks of invisible internal flaws, such as inclusions, porosity, or lack of fusion. nd literature emphasize that the detection of non-conformities depends on adequate Non-Destructive Testing performed by qualified professionals and calibrated equipment (BAPTISTA, 2018). In shipyards with low technological maturity, such processes exhibit high variability, reinforcing the role of supervision in defining priorities and acceptance criteria according to ABNT, Petrobras, and classification society standards.

Another relevant dimension involves the risks associated with confined spaces and hazardous atmospheres, such as basements, tanks, and pump rooms. Such environments combine simultaneous risks of flammable gases and oxygen deficiencies with access limitations, which requires continuous monitoring, Work Permits, and permanent prevention in accordance with NR-34 and NORMAM-05. The absence of qualified supervisors is among the main causes of serious accidents in Brazilian shipyards (SOARES; SANTOS, 2012; COELHO; ARAÚJO, 2020).

In addition to the hull structure, mechanical systems—such as shaft lines, piping, and commissioning—also present critical risks, requiring precise alignment, hydrostatic testing, inspections, and integration between engineering and operations. Failures in these systems are among the main causes of leaks and accidents. Finally, human factors—such as insufficient training, poor communication, and a poorly structured organizational culture—are widely documented in the national literature (CORRÊA, 2016; SILVA, 2011). Thus, technical supervision functions simultaneously as a mitigating agent and a point of vulnerability when the organizational environment does not provide adequate support.

- The Role of Technical Supervision

Technical supervision is a structuring element of shipbuilding, as it integrates engineering, quality, and operational safety requirements in highly complex and risky environments. In a sector regulated by different standards, the supervisor acts as a link between design and execution, ensuring that technical criteria are correctly applied and that critical operations are carried out safely (SOARES; SANTOS, 2012). In shipyards with low maturity, supervision often functions as the only effective mechanism for immediate control (COELHO; ARAÚJO, 2020).

The adoption of risk-based inspection (RBI) has been discussed as an alternative for prioritizing inspections and optimizing resources. In this model, the decision on what to inspect depends on the criticality of the joint, module, or system, and not just on the production routine. Baptista (2018) notes that prioritizing critical areas reduces structural failures and increases vessel reliability. Thus, RBI represents a methodological approach aligned with technological trends and international recommendations.

Among the essential duties of supervision are: structural quality control, inspections and NDT, operational safety, document traceability, and integration with engineering and commissioning. These activities are not simple oversight, but a set of technical decisions aimed at preventing non-compliance and accidents. The supervisor evaluates acceptance criteria, interprets non-destructive tests, and coordinates critical procedures, which requires specific training in welding, metrology, classification standards, and industrial safety (MOURA; BOTTER; SILVA, 2010).

Despite its strategic role, supervision faces barriers related to organizational culture, poor communication, and lack of ongoing training. Informal practices, lack of records, empirical decisions, role overload, and poor regulatory integration significantly reduce the effectiveness of supervision, especially in shipyards in the Amazon region (SILVA, 2011). Thus, the advancement of technical supervision depends on the consolidation of organizational processes, investments in training, and the adoption of more structured inspection models, in line with international standards.

Discussion

- Proposed Framework of Good Practices in Technical Supervision

Based on an analysis of the national literature, applicable standards, and challenges characteristic of Brazilian shipyards, an integrated technical supervision framework composed of six structural pillars is proposed. The model seeks to consolidate operational, managerial, and regulatory practices into a coherent system capable of raising standards of quality, safety, and traceability. Each pillar responds to a specific set of risks identified in the previous chapters and is aligned with the recommendations of research by Baptista (2018), Soares and Santos (2012), among others.

Pillar 1 - Standardization and Traceability: process standardization and document traceability form the basis of any efficient supervision system. Studies indicate that the lack of standardization is one of the main causes of quality variability in Brazilian shipyards (MOURA; BOTTER; SILVA, 2010).

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(a) WPS/PQR and welder qualification: the adoption of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) ensures that welded joints meet regulatory and structural requirements. According to Baptista (2018), the variability of welding parameters is the source of most of the defects detected by NDT.

(b) Material control: traceability of plates, profiles, electrodes, gases, and consumables reduces the risk of mechanical and chemical incompatibility.

(c) Document traceability: documents such as inspection reports, material certificates, revised drawings, and commissioning records must be integrated into an electronic control system, in accordance with practices recommended by the naval industry 4.0.

This pillar ensures consistency between engineering, production, and inspection activities, reducing rework and strengthening regulatory compliance.

Pillar 2 - Quality Control and Metrology: the structural quality of the hull depends fundamentally on metrological control. Misalignments and distortions accumulated during manufacturing result in structural failures and increased costs.

(a) Dimensional accuracy: the use of instruments such as theodolites, laser trackers, and large measuring equipment allows for compliance with the tolerances established by classification societies.

(b) Module alignment: modular construction requires strict control of interfaces, avoiding excessive stresses and assembly failures.

(c) Geometric control: control of thermal deformations, common in the naval welding process, requires continuous monitoring and preventive procedures defined by supervision.

This pillar promotes construction reliability and prevents structural failures that are difficult to correct.

Pillar 3 - Structural Integrity and NDT: the structural integrity of the ship depends on systematic inspections and the correct application of Non-Destructive Testing (NDT). Internal faults that are not visible are responsible for most of the non-conformities detected in sea trials. In addition, structural problems can take years to come to light.

(a) Acceptance criteria: must comply with ABNT standards, international standards, and classification rules. Inconsistent criteria result in unnecessary rework or undetected failures.

(b) Prioritization of critical joints: Baptista (2018) demonstrates that joints in areas of high structural stress—such as longitudinal reinforcements, intersections, and machine bases—should undergo more rigorous inspections.

(c) Staggered inspections: supervision should adopt progressive inspections:

- before welding (fit-up inspection),
- during the process (interpass inspection),
- after welding (visual, LP, MT),
- volumetric inspections (UT/RT) according to criticality.

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This pillar strengthens structural safety and reduces the risk of service failures.

Pillar 4 - Machinery, Auxiliary Systems, and Commissioning: machinery systems determine much of a vessel's operational safety and energy efficiency.

(a) Functional tests: supervisors must ensure that pumps, valves, generators, engines, and hydraulic systems are tested in accordance with regulatory procedures and class rules.

(b) Performance curves: The performance of pumps, compressors, and engines must be compared to curves provided by manufacturers. Discrepancies indicate assembly failures or technical problems.

(c) Vibration and alignment: errors in shaft line alignment or rotational imbalances result in excessive vibration, premature fatigue, and coupling failures. These risks are widely documented by modern naval engineering.

Proper commissioning is only possible when conducted by supervisors with multidisciplinary knowledge.

Pillar 5 - Operational Safety: occupational safety is an integral part of naval supervision. Soares and Santos (2012) show that most accidents in Brazilian shipyards result from failures in safety controls.

(a) Work Permits (WP): NR-34 stipulates that critical activities—welding, painting, cutting, working at height, and in confined spaces—can only be carried out under supervised WP (BRAZIL, 2011).

(b) LOTO (Lockout/Tagout): lockout and tagout procedures are essential during maintenance of machinery and electrical systems.

(c) APR – Preliminary Risk Analysis: Coelho and Araújo (2020) emphasize that poorly designed APRs are a source of operational failures and accidents.

(d) Prevention culture: supervision is responsible for promoting safe behavior, correcting deviations, and ensuring the correct use of PPE, ventilation, atmospheric monitoring, and area isolation.

This pillar reduces immediate risks to workers' lives and improves operational reliability.

Pillar 6 - Governance and Technical Responsibility: supervision maturity depends simultaneously on processes, people, and governance. The literature points out that Brazilian shipyards lack robust organizational systems (SILVA, 2011).

(a) Role of the responsible engineer: responsible for validating technical documents; communicating critical decisions; providing technical responses for inspections and reports; ensuring regulatory compliance.

(b) Critical checklists: adoption of standardized checklists for structural assembly; functional tests; NDT inspections; operational safety.

(c) Lessons learned: studies such as those by Moura, Botter, and Silva (2010) reinforce that systematizing lessons learned reduces the repetition of failures, improves internal processes, and strengthens technical culture.

This pillar integrates the others and supports continuous improvement, establishing a governance cycle aligned with the contemporary naval industry.

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Final considerations

Technical supervision in Brazilian shipyards is not only a specific control function, but a structuring axis for construction quality, the structural integrity of hulls and machinery systems, and occupational safety in high-risk environments.

The literature review showed that recurring weaknesses—such as informal processes, low standardization, training gaps, and difficulties in integrating engineering, production, safety, and quality—are directly associated with rework, non-compliance, accidents, and loss of competitiveness. In this scenario, technical supervision emerges as the main mechanism for translating the regulatory framework (NR-34, NORMAM, SOLAS, ISM, MARPOL, and classification rules) into consistent and traceable operational routines.

The proposed framework of good practices, structured around six pillars—standardization and traceability, quality control and metrology, structural integrity and NDT, machinery and commissioning, operational safety, and technical governance—provides a conceptual and operational basis for guiding shipyards in organizing their supervision systems. By articulating metrological control, risk-based inspections, document management, a culture of prevention, and technical responsibility, the model seeks to reduce variability, mitigate critical risks, and support more robust technical decisions. It is, therefore, a contribution that addresses both the reality of small and medium-sized shipyards and the requirements of shipyards focused on the offshore industry, allowing for gradual adaptations according to the level of organizational and technological maturity.

Finally, the results point to the need for public policies, training programs, and technological modernization initiatives to consider technical supervision as a strategic vector for the transformation of the Brazilian shipbuilding industry. The incorporation of technologies associated with Shipbuilding Industry 4.0, such as sensors, electronic traceability, digital quality systems, and digital twins, tends to broaden the scope and complexity of supervision, requiring more structured, interdisciplinary, and risk-based models. Future studies may deepen the empirical application of the framework in different types of shipyards, evaluate performance indicators associated with its implementation, and explore mechanisms for cooperation between academia, industry, the Brazilian Navy, and classification societies, in order to consolidate a continuous agenda for improving compliance and safety in machinery and hulls.

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