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Limitations of safety management system implementation and the transformation of certification audits for marine accident prevention

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ABSTRACT

Despite the widespread implementation of the International Safety Management (ISM) Code, marine accidents driven by navigational errors and organizational failures persist. This study examines the structural limitations of Safety Management System (SMS) implementation, focusing on certification audits as the primary mechanism linking regulatory compliance to operational safety. By analyzing marine accident data, SMS operational characteristics, and recent international regulatory discourses, this paper identifies a critical decoupling between the preventive objectives of the ISM Code and the conformity-oriented nature of current audit practices. The findings indicate that certification audits disproportionately emphasize documentation and procedural compliance, failing to effectively identify and mitigate operational risks—particularly those rooted in human and organizational factors. To bridge this gap, this study proposes a paradigm shift toward risk-based and performance-oriented audit approaches designed to evaluate the substantive effectiveness of SMS. Ultimately, this study contributes to maritime safety governance by demonstrating how the preventive efficacy of the ISM Code can be enhanced through audit transformation without imposing additional administrative burdens.

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KEYWORDS

Safety Management System (SMS); ISM Code; certification audit; risk-based audit; maritime safety governance

Introduction

Background and problem statement

Marine accidents have repeatedly been identified as being predominantly caused by human factors rather than by structural deficiencies or equipment failures of ships (Allianz Global Corporate & Specialty [AGCS], 2019; European Maritime Safety Agency [EMSA], 2024; Hetherington et al., 2006; International Maritime Organization, 2024b; Reason, 1997; Ziarati, 2006). According to analyses of marine accident causation conducted by the International Maritime Organization (IMO), approximately 70–80% of accident causes are directly or indirectly related to human factors. This finding stands in contrast to the continuous strengthening of technical safety standards for ships over recent decades.

Based on this recognition, the IMO acknowledged the limitations of relying solely on technical regulations to ensure ship safety and introduced the International Safety Management (ISM) Code with the objective of preventing accidents through organizational and managerial approaches (International Maritime Organization [IMO], 2018).

The ISM Code institutionalizes Safety Management Systems (SMS) at both company and ship levels, with the ultimate aim of systematically identifying and managing operational risks and preventing accidents arising from human error during ship operations. At present, the ISM Code applies to the majority of merchant ships engaged in international voyages, and from a formal perspective, SMS has become a globally established regulatory framework.

Nevertheless, despite nearly three decades having passed since the introduction of the ISM Code, marine accidents remain a persistent challenge. In particular, it has been repeatedly observed that between 75% and 96% of accidents are attributable to human and organizational factors rather than to structural defects or

equipment deficiencies of ships (AGCS, 2019; Anderson & Kirwan, 2000; EMSA, 2024; Hetherington et al., 2006; Rothblum, 2000; Ziarati, 2006). A synthesis of statistical data on marine accident causation presented by AGCS (2019), EMSA (2024), and Rothblum (2000) is illustrated in Figure 1 below.

The proportion of human and organizational factors among the causes of marine accidents reaches 85.5%, indicating their overwhelming significance. This finding suggests that, alongside ensuring the technical and structural safety of ships, the practical effectiveness of ISM Code certification audits – designed to verify the safety management capabilities of the people and organizations operating ships – constitutes a critical key to reducing marine accidents.

Recent evidence shows that accidents tend to concentrate in areas that should be directly controlled by Safety Management Systems (SMS), such as navigational watchkeeping and the execution of hazardous operations. This pattern reveals a structural gap between formal regulatory compliance and actual safety performance (IMO, 2018, 2023, 2024a, 2024b). It further supports the need for a fundamental re-examination of the effectiveness of the current certification audit framework.

Moreover, the persistence of marine accidents indicates that the problem does not stem from the absence of SMS or from insufficient institutionalization of the system, but rather from the fact that SMS does not function effectively in practice. In other words, the limitations lie at the implementation stage, where structural weaknesses in the operation of safety management systems continue to be exposed.

Research objectives and problem statement

Many previous studies have focused on the structural composition of the ISM Code itself or on its institutional conformity. However, relatively limited scholarly attention has been paid to a critical examination of whether certification audits – the primary mechanism for assessing the implementation of Safety Management Systems (SMS) – effectively fulfill their original purpose of accident prevention, beyond merely verifying procedural compliance (Bhattacharya, 2012; Dekker, 2014; Hollnagel et al., 2011; International Organization for Standardization [ISO], 2018a, 2018b; Kim, 2016; Knapp & Franses, 2009; Lee, 2016; Mok, 2023; Power, 1997; Reason, 1997; Sun & He, 2025).

Against this background, the present study re-examines the effectiveness of SMS from the perspective of marine accident prevention, placing particular emphasis on certification audits as the key mediating mechanism through which SMS is expected to function in practice. To this end, the study addresses the following research questions:

- (1) Why does SMS fail to function as an effective accident prevention tool in actual operational settings?

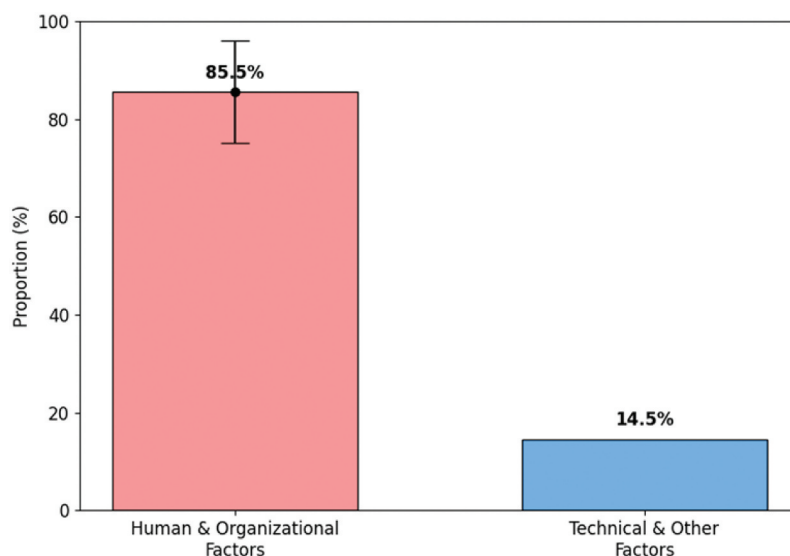


Figure 1. Proportion of human and organizational factors in marine accidents.

- (2) Do these limitations originate from structural deficiencies inherent in SMS itself, or from problems arising at the stages of implementation and certification audits?
- (3) In what direction should the certification audit framework be transformed to enhance marine accident prevention?

The objective of this study is to identify the limitations of the current certification audit system by analyzing recent marine accident cases and the practical operation of SMS, and to propose directions for improving audit frameworks that can make a substantive contribution to marine accident prevention.

While previous studies, including Mok (2023), have identified the structural gap between the preventive intent of the ISM Code and conformity-oriented audit practices, the present study extends the discussion by focusing specifically on the transformation of certification audits as a governance mechanism for marine accident prevention. In particular, this study contributes by linking recent IMO discussions on ISM Code implementation with concrete directions for risk-based, performance-oriented, and accident-triggered audit frameworks, while also addressing issues of responsibility fragmentation arising from the separation of ship ownership and management. Through this approach, the study seeks to move beyond problem identification toward a policy-oriented framework for improving the practical effectiveness of SMS implementation.

Research methodology

This study adopts a qualitative analytical approach to examine the structural limitations of Safety Management System (SMS) implementation and certification audits under the ISM Code framework.

The analysis is based on a comprehensive review of international regulatory documents, academic literature, and marine accident statistics related to the effectiveness of SMS and certification audits. Primary sources include IMO instruments and discussion documents, such as the ISM Code, Resolution A.1188(33), MSC 109/INF.3, MSC 107/17/5, and MSC 110/21, as well as statistical data published by the Korea Maritime Safety Tribunal (KMST). Relevant academic studies on audit systems, human factors, organizational safety, and maritime accident prevention were also examined.

Methodologically, the study combines document analysis and conceptual institutional analysis to identify the gap between the formal conformity-oriented operation of certification audits and their practical effectiveness in marine accident prevention. In addition, recent marine accident trends and operational characteristics of SMS implementation were comparatively reviewed to evaluate the structural limitations of the current audit framework and to explore possible directions for improvement.

Rather than conducting a quantitative causal analysis, this study focuses on identifying structural and functional limitations within the implementation and oversight mechanisms of the ISM Code and on proposing policy-oriented directions for improving audit effectiveness.

Reassessment of the effectiveness of the ISM Code and safety management systems

Background of the ISM Code and its intended functions

The ISM Code was introduced to move beyond traditional regulatory approaches that assessed ship safety primarily on the basis of compliance with design and equipment standards, and to prevent accidents from an organizational and managerial perspective (International Maritime Organization [IMO], 1991; Maritime and Coastguard Agency, 2015). Given that human factors constitute the principal causes of marine accidents, the ISM Code was designed to function as an institutional mechanism that assigns systematic safety management responsibilities to both shipping companies and shipboard personnel involved in ship operations.

The core of the ISM Code lies in requiring companies to establish safety and environmental protection policies, translate them into concrete procedures and responsibility structures, and continuously monitor and improve their implementation. In other words, the ISM Code emphasizes preventive management prior to the occurrence of accidents rather than the attribution of responsibility after accidents have occurred, with the Safety Management System (SMS) positioned as the primary tool to ensure that such preventive management functions effectively in practice (IMO, 2018).

Table 1. Summary of critical perspectives in major literature on ISM Code effectiveness.

Researcher (Year)	Analysis Scope & Methodology	Key Critical Findings and Conclusions
Power (1997)	Theoretical study on the “Audit Society”	Identified a tendency for audits to prioritize “rituals of verification” and evidence-gathering over actual safety improvements (formalism).
Knapp and Franses (2009)	Econometric analysis of accident data and ratification	Demonstrated that while the ISM Code initially reduced accidents, its effectiveness has gradually diminished over time.
Bhattacharya (2012)	In-depth interviews with Master’s and field analysis	Analyzed the disconnect where “safety on paper” is prioritized over “safety in practice” due to commercial pressure and administrative burdens.
Lee (2016)	Correlation analysis between SMS and PSC data	Pointed out a low correlation between SMS documentation levels and actual ship safety (deficiencies), questioning the practical effectiveness of implementation.
Mok (2023)	Empirical analysis of accident statistics and SMS audits	Identified a “structural gap” between the preventive intent of the ISM Code and conformity-oriented audit practices as a cause of persistent accidents.

Common problem recognition in previous studies and international discussions

A substantial body of domestic and international research on the effectiveness of the ISM Code commonly indicates that, while a certain level of accident reduction was observed during the initial phase following its introduction, this effect has gradually weakened over time (Knapp & Franses, 2009; Lee, 2016). In particular, although SMS is formally well documented, numerous studies have pointed out that, in actual operational settings, prescribed procedures are frequently omitted or replaced by established practices and informal routines.

Recent studies commissioned by the IMO Secretariat, including the findings presented in MSC 109/INF.3, along with several academic analyses, have identified excessive documentation burdens, insufficient continuous improvement, limitations on the authority of the master, and the formalization of risk assessment as key factors undermining the effectiveness of the ISM Code (IMO, 2024a; Kim, 2016; Mok, 2023). A notable aspect of these findings is that such problems arise not primarily from the provisions of the ISM Code itself, but from the stages of auditing and oversight intended to monitor and promote effective SMS implementation.

These international discussions indicate a shift in the focus of institutional reform toward enhancing effectiveness at the implementation stage while maintaining the normative framework of the ISM Code. This perspective suggests that the limitations of SMS should not be interpreted as a failure of the ISM Code per se, but rather as functional shortcomings of the implementation and audit framework.

The effectiveness of the ISM Code has also been subject to extensive critical examination in the academic literature. In particular, many previous studies have consistently highlighted the problems of formalism and the gap between regulatory requirements and operational practice, arguing that the current system falls short of fully achieving its original objective of accident prevention. A summary of the key critical arguments and analytical findings presented in major prior studies is provided in Table 1 below.

Operational realities of safety management systems and structural problems

Intensification of formalism and bureaucratization

An examination of the operational realities of Safety Management Systems (SMS) indicates a growing tendency for SMS to be perceived not as a management tool for accident prevention, but rather as a formal system aimed at maintaining certification. In many organizations, SMS documentation and procedures have been continuously expanded and accumulated, leading to a situation in which the management of documentation itself becomes an end rather than a means.

In this process, excessive emphasis is placed on checklists and record-keeping, while responsibility for documentation is increasingly concentrated on masters and navigating officers. As a result, the time and attention that should be devoted to actual risk recognition and response are reduced. This dynamic weakens the self-regulatory safety culture originally intended by SMS and instead increases bureaucratic burdens on shipboard personnel (Bhattacharya, 2012; IMO, 2024a; Power, 1997).

The gap between documented procedures and operational practice

Although SMS procedures are designed to encompass a wide range of operational situations, in practice they often fail to align with actual work processes on board ships. This misalignment arises as procedures added

retrospectively in response to specific accidents or audit findings accumulate over time, resulting in procedures that do not reflect the realities of daily operations.

Consequently, seafarers tend to perceive SMS procedures not as practical operational guidance, but as documentation intended primarily for audit purposes, leading to a decline in their substantive use. Moreover, in such environments, it becomes difficult for a no-blame culture or voluntary hazard reporting systems to take root (Dekker, 2014; Reason, 1997). When non-compliance with procedures is perceived as likely to result in audit findings or accountability measures, seafarers are more inclined to conceal risks or rely on informal practices rather than report them. This tendency constitutes a major factor preventing SMS from being internalized as an element of organizational culture and causing it to remain a largely formal framework.

Recent marine accident cases and the limitations of certification audits

Common characteristics identified in accident cases

An analysis of numerous recent marine accidents shows that their immediate causes typically include inadequate watchkeeping, non-compliance with procedures during hazardous operations, and failures in communication. Although such accidents may appear, on the surface, to result from individual judgment errors or negligence, closer examination suggests that they are more appropriately interpreted as outcomes of organizational management failures rather than isolated individual deviations (Hollnagel et al., 2011; Reason, 1997).

In particular, high-risk operations are frequently carried out without the performance of proper risk assessments or with risk assessment reduced to the completion of formal checklists. Moreover, even when masters decide to alter voyages or operations for safety reasons, it is repeatedly observed that sufficient allocation of resources or policy-level support from shore-based organizations is lacking (Bhattacharya, 2012; IMO, 2024a, 2024b). These patterns indicate that SMS fails to control risks proactively and that its accident prevention function does not operate effectively in practice.

According to the *Statistical Yearbook of Marine Accidents 2024* published by the Korea Maritime Safety Tribunal (KMST), the official marine accident investigation body of the Republic of Korea, aggregated accident statistics covering the period from 2020 to 2024 indicate that, as shown in Table 2, approximately 70–85% of representative navigational accidents – such as collisions, contacts, and groundings – are attributable to navigational errors, a subset of operational and human errors (Korea Maritime Safety Tribunal [KMST], 2025). In contrast, accidents involving fire, explosion, and machinery damage show a relatively higher proportion of other causes, including technical failures and management deficiencies, indicating clear differences in causation structures across accident types. These findings suggest that effective marine accident prevention depends less on purely equipment- or technology-centered approaches than on risk perception and decision-making during ship operations, as well as on the substantive implementation of safety management systems that support such processes.

As illustrated in Figure 2, navigational errors account for the majority of collision-, contact-, and grounding-related accidents, whereas non-navigational factors – including technical failures and management deficiencies – predominate in accidents involving fire, explosion, and machinery damage.

Table 2. Causes of marine accidents by accident type (five-year aggregate).

Accident Type	Share of Errors		Key Characteristics
	Navigational	Non-navigational	
Collision	80–85%	15–20%	Inadequate lookout, violation of COLREGs, communication failures
Contact	75–80%	20–25%	Judgment errors during low-speed maneuvering, poor ship handling
Grounding	70–80%	20–30%	Route deviation, misjudgment of depth, tide, or current
Capsizing / Sinking	55–65%	35–45%	Combined effects of poor stability management and navigational decisions
Fire / Explosion	30–40%	60–70%	Equipment failure, inadequate maintenance, management deficiencies
Machinery Damage	25–35%	65–75%	Maintenance failure, insufficient technical management
Overall Average	70–75%	25–30%	Predominance of human and organizational factors

Note: Percentages indicate aggregated ranges based on KMST marine accident statistics covering the period from 2020 to 2024.

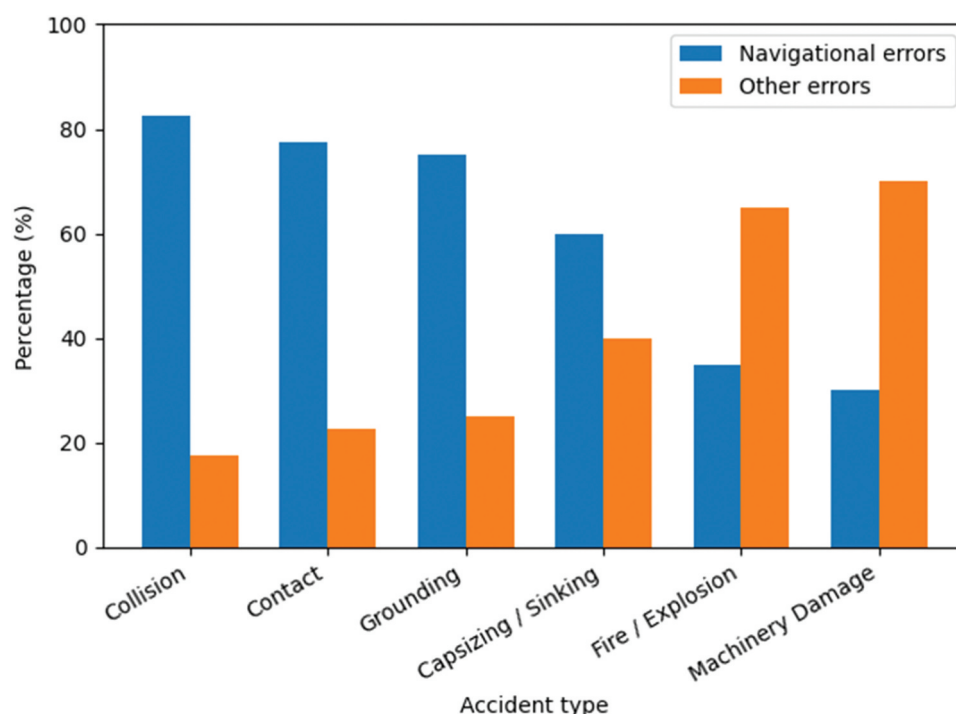


Figure 2. Distribution of navigational and non-navigational causes of marine accidents by accident type (2020–2024 aggregate). *Note:* Values represent midpoints of aggregated percentage ranges based on KMST accident statistics covering the period from 2020 to 2024.

Loss of the preventive function of certification audits

A notable point is that the risk factors underlying these accidents were not identified or managed as priorities during the certification audit processes conducted prior to their occurrence. This suggests that certification audits function less as proactive mechanisms for accident prevention and more as retrospective instruments for verifying conformity with documented procedures and requirements.

In particular, the fact that the non-performance or merely formal execution of risk assessments is not treated as a critical issue during audits, but only problematized after accidents occur, clearly illustrates the limitations of the current audit framework (IMO, 2018, 2024). Under such conditions, certification audits risk degenerating into tools that justify accountability after accidents rather than mechanisms that prevent accidents in advance.

Consequently, recent marine accident cases can be evaluated as revealing the structural limitations of certification audits that fail to substantively verify and promote the effective implementation of Safety Management Systems (SMS), extending beyond issues of individual error.

Structural limitations of certification audits and issues of responsibility allocation

Structural limitations of conformity-oriented audit practices

The current certification audit framework for Safety Management Systems (SMS) is based on a conformity-oriented approach that assesses whether the requirements of the ISM Code are met. While this approach contributed, particularly during the early stage of implementation, to the institutionalization of SMS and the establishment of a minimum level of safety management, the gap between audit practices and the original objective of accident prevention has widened over time (Cariou et al., 2007; Knapp & Franses, 2009).

The most significant limitation of conformity-oriented audits lies in their focus on the existence of documents and procedures rather than on the actual magnitude or likelihood of risks. In other words, the primary criterion for audit judgments is whether procedures addressing specific risks are

documented, rather than whether those risks are effectively controlled in practice. As a result, SMS tends to be perceived not as a tool for risk management, but as a documentation system designed to satisfy audit requirements.

Under such a structure, audits face inherent difficulties in identifying and controlling risks proactively. Even when risk assessments are conducted in a merely formal manner or repeatedly reproduce identical content, such deficiencies may not be raised as audit findings as long as documentary requirements are satisfied. Consequently, conformity-oriented audits may contribute to enhancing the formal completeness of SMS, but they are unlikely to translate into substantive outcomes in terms of marine accident prevention.

Outsourcing of risk and ambiguity in responsibility allocation

In the modern shipping industry, the separation of ship ownership and ship management has become increasingly common. Reflecting this reality, the ISM Code defines the “Company” under Part A, paragraph 1.1.2 (Definitions) not only as the shipowner, but also as any organization or person – such as a manager or bareboat charterer – who has assumed responsibility for the operation of the ship from the owner and agreed to take over all duties and responsibilities imposed by the Code. This provision explicitly allows shipowners to legally delegate the establishment and implementation of SMS to third parties.

However, such arrangements inherently carry the risk of obscuring the entity that bears substantive responsibility for safety management. In particular, under structures where ownership and operation are separated, shipowners often retain exclusive control over key resources, such as budget allocation and crew manning, while management companies bear only formal responsibility for SMS implementation. This situation gives rise to what can be described as a “fragmentation of responsibility.”

In practice, the operation and documentation of SMS are frequently handled by ship management companies or designated safety management service providers, whereas critical decision-making authority – such as budget planning, crew allocation, and voyage scheduling – remains with shipowners or operators. Under these conditions, a disconnect emerges between the authority required to control risks and the responsibility for implementing SMS, potentially creating gaps in safety management.

Nevertheless, current certification audits are conducted primarily with respect to the “Company” holding the Document of Compliance (DOC), while the extent of the shipowner’s substantive involvement and fulfillment of responsibility is examined only to a limited degree. As a result, even in contexts where safety management functions are outsourced, the ultimate entity responsible for risk control remains unclear. This ambiguity in responsibility allocation not only complicates the identification of accident causes, but also weakens incentives for proactive management aimed at accident prevention (IMO, 2024b; Lee, 2016).

The paradox of intermediate and additional audits and certificate suspension

Under the certification framework of the ISM Code, the identification of a major non-conformity during intermediate or additional audits may lead to the suspension of the Document of Compliance (DOC) or the Safety Management Certificate (SMC). While this mechanism can function as a powerful means of enforcing SMS implementation, its practical operation reveals several inherent limitations.

In the current certification system, the suspension of a DOC triggers the invalidation of the SMCs of all vessels operated by the company concerned. This structure entails a degree of institutional rigidity, as it fails to adequately reflect differences in risk characteristics among vessel types or the specific operational conditions of individual ships (Mok, 2023). In particular, for hazardous cargo carriers or specialized vessels, the immediate suspension of operations may paradoxically generate secondary risks that threaten the safety of both ships and crews. Nevertheless, the existing framework does not sufficiently incorporate flexible response mechanisms to address such situations.

This sanctions-oriented structure gives rise to what may be described as an “audit paradox,” whereby the identification of major non-conformities is discouraged during the audit process. The pressure associated with the possibility that audit findings may result in immediate operational paralysis not only generates conflict between audit parties, but also creates inappropriate incentives for auditors to conclude audits by identifying minor non-conformities rather than rigorously addressing substantive risk factors (Bhattacharya, 2012; IMO, 2024a). As a consequence, audits risk degenerating into mere “rituals of verification” aimed at

maintaining certification rather than improving safety (Power, 1997), while latent risk factors with high accident potential remain unmanaged.

Trends in international discussions

In recent years, a growing recognition has emerged within the International Maritime Organization (IMO) that certification audits conducted under the ISM Code have not made a substantive contribution to marine accident prevention. Importantly, these discussions do not advocate for an expansion of the normative framework of the ISM Code or the introduction of new regulatory requirements. Instead, they are grounded in the recognition that the effectiveness of existing safety management systems must be enhanced by improving implementation practices and the audit framework that verifies them.

In particular, documents submitted to the Maritime Safety Committee (MSC) have repeatedly pointed out that current certification audits place excessive emphasis on verifying conformity with documented procedures and records. As a result, the actual level of risk control in operational settings, as well as human and organizational factors, are insufficiently reflected in audit outcomes. This problem awareness is closely linked to the reality that marine accidents continue to occur despite the formal implementation of safety management systems.

Alongside these concerns, calls for a fundamental shift in the overall approach to the ISM Code framework have continued to gain traction. Norway, through submission MSC 107/17/5, argued that the current ISM Code does not adequately reflect the digitalization of the shipping industry and changes in ship management structures, and proposed a comprehensive review of the relevant guidelines (Norway, 2023). Subsequently, the IMO initiated a comprehensive review process focusing on the practical implementation of the ISM Code, drawing on Norway's proposal for a new work item and the findings of the Secretariat's effectiveness study (MSC 109/INF.3) (IMO, 2024a; Norway, 2023).

In particular, the new work item approved at the 110th session of the Maritime Safety Committee (MSC 110) in 2025 provides a concrete roadmap for advancing these discussions. The work is scheduled to be undertaken by the Sub-Committee on Implementation of IMO Instruments (III) between 2026 and 2027, with completion targeted for 2028. Key review targets include the administrative guidance contained in Resolution A.1188(33) and the company guidance set out in MSC-MEPC.7/Circ.8, reflecting a focus on improving implementation and oversight rather than revising the normative provisions of the ISM Code itself (International Maritime Organization [IMO], 2025).

These international discussion trends are closely aligned with the structural limitations of certification audits identified in this study. Specifically, there is a shared recognition that when certification audits remain confined to conformity-oriented, retrospective verification, safety management systems are likely to function merely as formal frameworks, with limited potential to deliver substantive accident prevention outcomes. In this context, recent IMO discussions suggest the need to transform audit and oversight approaches toward risk-based and implementation-oriented models, while maintaining the existing regulatory framework of the ISM Code.

Interim summary: distortion of audit functions and the disconnection from accident prevention

The combination of conformity-oriented audits, ambiguous allocation of responsibility, and sanctions-centered enforcement mechanisms, as discussed above, has progressively diverted certification audits away from their preventive role in marine accident prevention. Rather than being perceived as processes for identifying risks and promoting improvement, audits are increasingly regarded as procedures for retrospectively confirming regulatory conformity and assigning responsibility.

This perception also influences the behavior of those responsible for SMS implementation. When audits are viewed not as mechanisms that support risk management, but as procedures that may lead to punishment and sanctions, voluntary hazard reporting and proactive improvement activities are inevitably suppressed. This dynamic constitutes a structural factor that prevents SMS from being internalized as an element of organizational culture, confining it instead to a level of formal compliance.

As a result, although the current certification audit system continues to perform a certain role in assessing SMS implementation, its function remains insufficient from the perspective of marine accident prevention.

This limitation does not stem merely from technical shortcomings in audit procedures, but rather indicates the need for a fundamental redefinition of audit objectives and evaluative priorities – specifically, a reassessment of what audits are intended to achieve and which aspects of safety management they should focus on.

Transforming certification audits for marine accident prevention

The need to redefine the function of certification audits

In light of recent international discussions, certification audits need to be redefined as a core management instrument that verifies how Safety Management Systems (SMS) actually operate in practice, rather than merely as procedures for confirming conformity with prescribed requirements. While the current certification audit framework plays a certain role in assessing the formal implementation of SMS, it is difficult to conclude that it sufficiently achieves its original objective of marine accident prevention. This limitation does not arise from the competence of individual auditors or from the detailed operation of audit procedures, but rather from a structural orientation in which certification audits are primarily focused on conformity assessment rather than accident prevention.

To enhance the effectiveness of SMS, certification audits should be redefined not as mechanisms for maintaining certification, but as management tools for proactively identifying and controlling risks. In other words, audits must move beyond verifying whether requirements are satisfied and instead focus on assessing whether risks are actually being managed in practice. Such a functional transformation constitutes a prerequisite for enabling SMS to operate as a system that genuinely ensures operational safety, rather than as a documentation-centered framework.

Importantly, the transformation of certification audits proposed in this study does not necessarily require amendments to the SOLAS Convention itself. Rather, many of the proposed measures – including risk-based audit prioritization, strengthened human-factor-oriented assessments, and accident-triggered follow-up audits – can be implemented through revisions to implementation guidelines, audit methodologies, and oversight practices within the existing ISM framework. In this regard, the proposals presented in this study are consistent with recent IMO discussions emphasizing the effective implementation of the ISM Code and the enhancement of audit effectiveness, rather than the expansion of the Code's normative structure.

Introduction of risk-based audits

The core element of transforming the certification audit framework lies in the adoption of a risk-based approach. Risk-based audits do not examine all elements of ships and organizations at an identical level, but instead concentrate audit resources and attention on areas with a higher likelihood of accidents and greater potential consequences. This approach offers a means of maximizing the preventive function of audits under practical constraints such as limited audit time and personnel (IMO, 2018, 2023).

For risk-based audits to function effectively, risk assessment must be repositioned as a central component of SMS. Rather than merely confirming the existence of risk assessment procedures, audits should incorporate substantive criteria such as the quality of hazard identification processes, the rationality of risk evaluation, and the implementation of measures based on assessment results. In particular, differentiated audit approaches – such as shortened audit intervals or expanded audit scopes – are required for high-risk vessels, including hazardous cargo carriers, aged ships, and vessels with accident histories.

The core contribution of this study lies in proposing a transformation of certification audits from procedures focused on verifying procedural conformity toward a system that evaluates actual risk management capabilities. The key differences between the existing conformity-oriented audit framework and the risk-based and performance-oriented audit approach proposed in this study are summarized in Table 3 below.

Institutionalizing accident-triggered follow-up audits

The current certification audit framework operates primarily through periodic audits, while audits conducted after accidents tend to function as retrospective inspections. Under such a structure,

Table 3. Comparison between current conformity-based audit and proposed risk/Performance-based audit.

Category	Current Audit (Conformity-based)	Proposed Audit (Risk/Performance-based)
Primary Objective	Verification of compliance with regulations and procedures	Verification of risk identification and control effectiveness
Audit Focus	Documented records and checklists	Substantive risk assessment and field implementation
Resource Allocation	Uniform time allocation across all audit elements	Concentration of resources on high-risk areas and vulnerable ships
Auditor's Role	Verifier of administrative conformity	Evaluator of actual safety performance and culture
Audit Outcome	Confirmation of "Safety on Paper"	Verification of "Safety in Practice"

Table 4. Comparison between marine casualty Investigation and triggered audit.

Category	Marine Casualty Investigation	Triggered Audit
Primary Objective	Identifying proximate causes and determining legal/technical liability	Verifying systemic defense mechanisms and organizational resilience
Analysis Level	Micro-level (e.g., human error, equipment failure)	Macro-level (e.g., resource allocation, adequacy of risk assessment)
Core Question	"What happened?"	"How did the system fail?"
Utilization of Results	Accident reporting and recommendations for institutional improvement	Decisions on certificate (SMC/DOC) validity and mandatory system improvements

lessons derived from accidents are not systematically fed back into improvements of Safety Management Systems (SMS). Accordingly, there is a need to institutionalize an accident-triggered audit framework in which follow-up audits are automatically initiated in the event of serious marine accidents.

Accident-triggered follow-up audits should focus not only on the direct causes of accidents, but also on the organizational and managerial factors that allowed such accidents to occur. In particular, these audits should comprehensively examine the adequacy of risk assessments, the effectiveness of procedural implementation, decision-making processes of masters and crew, and the support mechanisms provided by shore-based organizations. Through this approach, accident causation can be prevented from being reduced to individual error and instead be translated into systemic improvements of SMS as a whole.

Although accident-triggered audits and conventional marine casualty investigations originate from the same triggering event – namely, an accident – they should be clearly differentiated in terms of their objectives and analytical levels. While marine casualty investigations primarily adopt a micro-level, retrospective approach aimed at identifying accident causes and determining technical and legal responsibilities, accident-triggered audits should treat accidents as indicators of systemic failure within SMS and adopt a macro-level, preventive approach focused on reassessing organizational resilience.

The fundamental distinction between the two mechanisms lies in the direction of the questions they ask. Marine casualty investigations focus on "what happened?" and "who is at fault?," whereas accident-triggered audits seek to answer questions such as "why did our safety management system fail to identify this risk in advance?" and "how were existing defensive barriers undermined?" (Reason, 1997). Consequently, while accident investigations often culminate in recommendations for institutional improvement, accident-triggered audits possess stronger enforcement capacity in that their outcomes are directly linked to the continued validity of certificates (SMC/DOC), thereby compelling substantive system recovery and improvement. A comparative summary of these two mechanisms is presented in Table 4 below.

Strengthening human-factor-oriented audit frameworks

Given that a substantial proportion of marine accidents originate from human factors, certification audits need to substantially strengthen their focus on the evaluation of human elements. However, assessments of human factors are unlikely to achieve meaningful effectiveness if they remain confined to verifying training records or qualification certificates alone (Dekker, 2014; Hollnagel et al., 2011).

Human-factor-oriented audits should be expanded to encompass non-technical competencies such as seafarers' understanding of procedures, risk perception capabilities, communication practices, and teamwork. In addition, audits should indirectly assess whether SMS has been internalized as an element of organizational culture by examining factors such as the extent to which seafarers actively participate in risk

assessment processes and how hazard reports are handled within the organization. This implies a necessary shift in audit orientation from documentation-centered assessments toward people-centered evaluations.

Establishing audit structures that clarify responsibility allocation

The transformation of certification audit frameworks is closely linked to the redefinition of responsibility structures. Even in contexts where safety management functions are outsourced, ultimate responsibility for ship safety should reside with the shipowner or the entity exercising substantive operational control. Accordingly, audits should evolve beyond formal verification of the DOC holder and instead focus on verifying where the authority and resources necessary for effective risk control actually reside.

To this end, audit processes should examine the level of shipowner involvement, budgetary support mechanisms, and decision-making processes related to crew allocation, in order to assess the substantive fulfillment of responsibility for SMS implementation. This approach should not be understood as a means of assigning blame, but rather as a prerequisite for ensuring the effectiveness of risk control.

Strengthening oversight and cooperation between governments and certification bodies

Finally, transforming the certification audit framework necessitates a redefinition of roles between governments and certification bodies. To ensure the quality and consistency of audits conducted by certification bodies, substantive oversight and evaluation at the governmental level are essential. Such oversight is not intended to undermine the autonomy of certification bodies, but rather to secure the credibility and reliability of audit outcomes.

Mechanisms such as the operation of regular consultative forums between governments and certification bodies, the sharing of criteria for identifying major non-conformities, and the joint review of audit cases can contribute to strengthening the preventive function of audits. In addition, continuous training and competency assessment of auditors are necessary to create conditions under which risk-based audits can be applied consistently in practice.

The findings of this study are expected to provide practical implications for administrations, recognized organizations (ROs), and policymakers seeking to enhance the accident prevention function of the ISM Code without increasing regulatory complexity.

Conclusions

The transformation of certification audits proposed in this study is aligned with recent discussions led by the International Maritime Organization (IMO) on strengthening the effective implementation of the ISM Code, and may be regarded as a realistic alternative for enhancing marine accident prevention without expanding the existing regulatory framework.

This study re-examined the effectiveness of Safety Management Systems (SMS) from the perspective of marine accident prevention and sought to locate their limitations not in structural deficiencies inherent in SMS itself, but in the functional limitations of certification audits that are intended to verify and promote effective implementation. The ISM Code was introduced to address the predominant causes of marine accidents – namely human factors and organizational management failures – and its normative intent and institutional structure remain valid. However, as demonstrated in this study, SMS has failed to function as a substantive accident prevention tool in operational settings, largely because certification audits have been conducted with an excessive focus on formal conformity rather than on practical effectiveness.

As confirmed through the analysis of recent marine accident cases, many accidents are closely associated with structural problems in SMS implementation, such as the absence or superficial execution of risk assessments, formalistic compliance with procedures, and insufficient organizational support for the exercise of the master's authority, rather than being reducible to individual error. Nevertheless, these risk factors are not adequately identified or managed during certification audits conducted prior to accidents, and tend to be recognized only after accidents have occurred. This pattern indicates that the current certification audit framework remains confined to a retrospective verification of conformity rather than fulfilling a preventive function.

Furthermore, within the modern shipping industry – where ship ownership and management are increasingly separated – the outsourcing of safety management functions has contributed to ambiguity in responsibility allocation, a problem that certification audits have not sufficiently addressed. Audit practices centered on the holder of the Document of Compliance (DOC) face inherent limitations in verifying where substantive authority and responsibility for risk control actually reside, thereby undermining the effective implementation of SMS.

Based on the findings, this study argues that a fundamental transformation of the certification audit framework is required to enhance marine accident prevention. Specifically, such transformation should include the adoption of risk-based audits, the institutionalization of accident-triggered follow-up audits, the strengthening of human-factor-oriented audit frameworks, the establishment of audit structures that clarify responsibility allocation, and the substantive enhancement of oversight and cooperation between governments and certification bodies. These measures collectively represent a redefinition of certification audits from instruments for maintaining certification into core management tools for proactively controlling risks and ensuring the effective operation of SMS.

In conclusion, marine accident prevention cannot be achieved through the introduction of new regulations or the accumulation of additional SMS documentation alone. Rather, the key lies in redefining the role of certification audits so that they can substantively verify how existing safety management systems operate in practice and actively promote improvement. When certification audits are transformed into mechanisms that question risk, clarify responsibility, and verify implementation, SMS can move beyond formal compliance and function as an effective instrument for marine accident prevention.

In this regard, the transformation of certification audits proposed in this study does not emphasize further normative expansion, but instead resonates with recent IMO discussions that highlight risk-based approaches and substantive implementation, thereby offering meaningful direction for future revisions of relevant guidelines and oversight practices.

In this respect, the present study contributes not only to the diagnosis of the structural limitations of SMS implementation identified in previous studies, but also to the development of a policy-oriented framework for transforming certification audits in line with recent IMO governance discussions.

Nevertheless, the implementation of the reforms proposed in this study may face several practical challenges. The adoption of risk-based and performance-oriented audit frameworks would require additional auditor training, institutional adaptation, and closer coordination among administrations, recognized organizations (ROs), and shipping companies. In addition, differences in regulatory capacity and operational environments among flag States may create difficulties in achieving internationally harmonized audit practices. These challenges suggest that the transformation of certification audits should be approached gradually through phased implementation, guideline development, and continued international discussion within the IMO framework.

Furthermore, this study primarily adopts a qualitative and institutional analytical approach. Future research may therefore contribute by conducting empirical evaluations of audit effectiveness, comparative analyses among flag States and recognized organizations, and case studies examining the practical operation of risk-based audit models.

Author contributions

CRedit: **Inchul Kim:** Conceptualization, Data curation, Resources, Supervision, Writing – original draft, Writing – review & editing; **Sang-il Lee:** Conceptualization, Formal analysis, Investigation.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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