Applied Skills and Knowledge Journal (ASK-J)
Vol 1 • No 1 • Dec (2026) • 197–209
e-ISSN: 2838-0541
DOI: 10.68949/askjv01i01a016

The Impact of Bulk Cargo on Ship Stability: Risk Perceptions, Cargo-Control Practices and Lessons for Dry Bulk Operations

Nur Rifa Syahirah Mohd Rosmali[1]*

[1] Faculty of Maritime Studies, Universiti Malaysia Terengganu

* Corresponding author: rifasyahiraz@gmail.com

ARTICLE INFORMATION

Article type: Original Research
Received: 30 December 2025
Revised: 30 August 2026
Accepted: 03 November 2026
Published online: 07 November 2026

ABSTRACT

Bulk-carrier stability may be compromised by cargo shifting, liquefaction or dynamic separation, inappropriate distribution of cargo weight, water ingress and the interaction of hull stresses with sea conditions. This study examines how early-career maritime personnel perceive these hazards and the associated safeguards, drawing on a seven-respondent structured survey supplemented by technical and regulatory evidence. The survey covered knowledge of cargo regulations, company procedures, training, moisture and transportable moisture limit (TML) testing, perceived causes of instability, and voyage monitoring. Five respondents (71.4%) selected cargo shifting as a major concern; four each (57.1%) selected liquefaction and extreme weather. Six (85.7%) reported that moisture and TML testing occurred at every loading operation, and all seven described their companies' procedures as comprehensive. However, three respondents (42.9%) said commercial pressure affected cargo safety, and another three said it sometimes did. Bilge monitoring, temperature monitoring and a mid-voyage can test were each selected by five respondents as useful monitoring approaches. These responses are perceptions from a small, early-career sample and do not establish accident probabilities, actual compliance or the diagnostic reliability of any method. Integrating the survey with the IMSBC Code, intact stability principles and casualty evidence supports a layered safety approach: reliable cargo identification and independent sampling, loading and structural-control verification, safe monitoring at sea, and clear escalation and emergency response. The study identifies training and assurance priorities while distinguishing mandatory controls from technology options requiring further validation.

Keywords: bulk cargo; ship stability; cargo shifting; liquefaction; transportable moisture limit

1. Introduction

Dry bulk carriers transport high volumes of ore, coal, grain and other solid commodities; secure loading depends on both the physical properties of the cargo and the ship's remaining stability and structural strength. The International Maritime Solid Bulk Cargoes (IMSBC) Code addresses cargo-specific hazards, while the International Code on Intact Stability (IS Code) and the Code of Practice for the Safe Loading and Unloading of Bulk Carriers (BLU Code) provide complementary controls for vessel stability and cargo operations (IMO, 1997, 2008, 2023c).

Cargo can shift by sliding, or a moisture-sensitive particulate cargo can lose shear strength as pore-water pressure increases under compaction and ship motion. The more recent IMSBC wording also recognises dynamic separation for appropriate cargoes; these mechanisms must not be reduced to a single generic "free-surface effect." The safety of an intended shipment rests on representative sampling, the correct cargo schedule, verified moisture content relative to a certified transportable moisture limit (TML), and suitable ship and loading arrangements (IMO, 2023b, 2023c).

The casualty record illustrates the consequences. International Association of Dry Cargo Shipowners (INTERCARGO) documented 26 total losses of bulk carriers of at least 10,000 dwt and 104 fatalities during 2013–2022. Seventy deaths (67.3%) were associated with cargo liquefaction, although grounding accounted for the largest number of lost vessels (INTERCARGO, 2023; SAFETY4SEA, 2023). The latest 2016–2025 rolling report records 17 losses and 71 fatalities, of which 37 (52.1%) were attributed to liquefaction; differences between overlapping reporting periods should not be interpreted as an experimentally controlled measure of safety improvement (INTERCARGO, 2026).

Against this background, this article evaluates three related questions: (a) which bulk-cargo stability threats are most salient to surveyed maritime personnel, (b) how survey respondents describe their cargo verification, training and monitoring practices, and (c) what feasible layers of prevention and response follow from the survey and established regulatory guidance. Rather than presenting perceptions as proof of cargo behaviour, the analysis places them alongside authoritative ship-stability and cargo-handling evidence.

2. Technical and Regulatory Background

2.1 Ship Stability, Cargo Distribution and Structural Loading

A vessel's initial transverse stability may be described by the metacentric height $GM = KM - KG$, with $KM = KB + BM$ and $BM = \frac{I}{\nabla}$. In these relationships, G is the centre of gravity, B the centre of buoyancy, M the initial metacentre, K the keel datum, I the second moment of area of the waterplane about the relevant heel axis (m^4), and ∇ the displaced volume (m^3). Thus KB, BM, KM, KG and GM are lengths measured in metres. These equations are small-angle hydrostatic relationships; assessment of actual seagoing stability additionally requires righting-arm (GZ) curves, free-surface corrections, loading condition, downflooding and applicable statutory criteria (Barrass & Derrett, 2012; Biran & López-Pulido, 2014; IMO, 2008).

Figure 1 illustrates the conventional relationships among G, B and the metacentre under an initial heel; the conceptual depiction does not represent a numerical stability assessment of a specific bulk carrier.

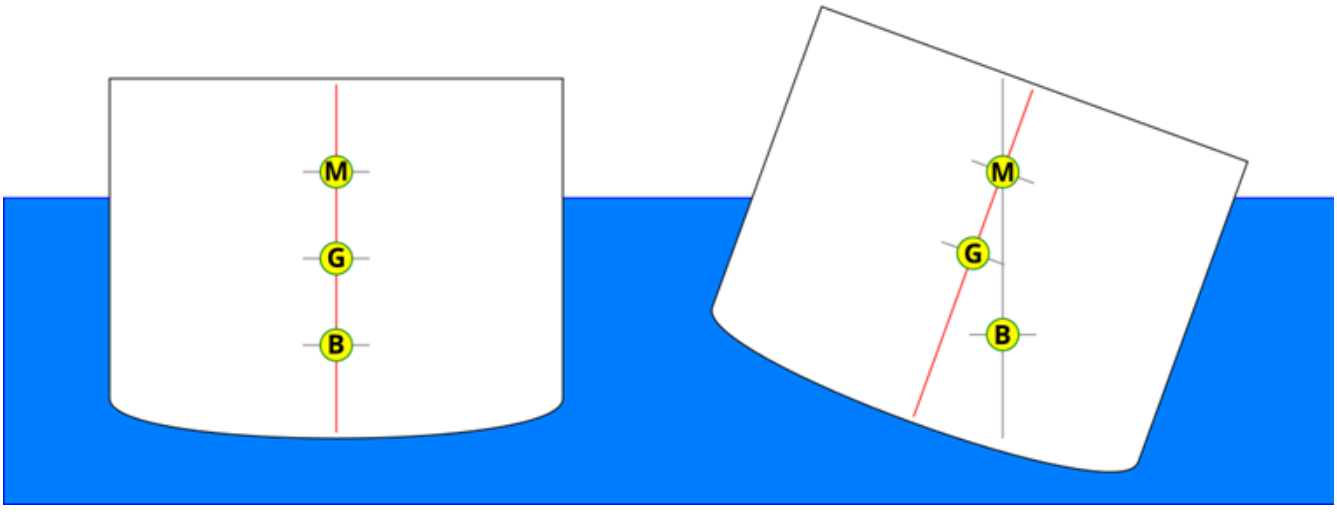


Figure 1. Conceptual relationship of a vessel's centre of gravity, centre of buoyancy and initial righting geometry.

Uneven loading can also generate excessive vertical shear force and hull-girder bending moment. In general terms, sagging is associated with relatively greater loading amidships and hogging with greater support or loading toward the extremities, although the actual sign and magnitude depend on the distribution of weight, buoyancy and waves (Eyres & Bruce, 2012; House, 2024). Figure 2 illustrates these load-induced hull-deflection modes.

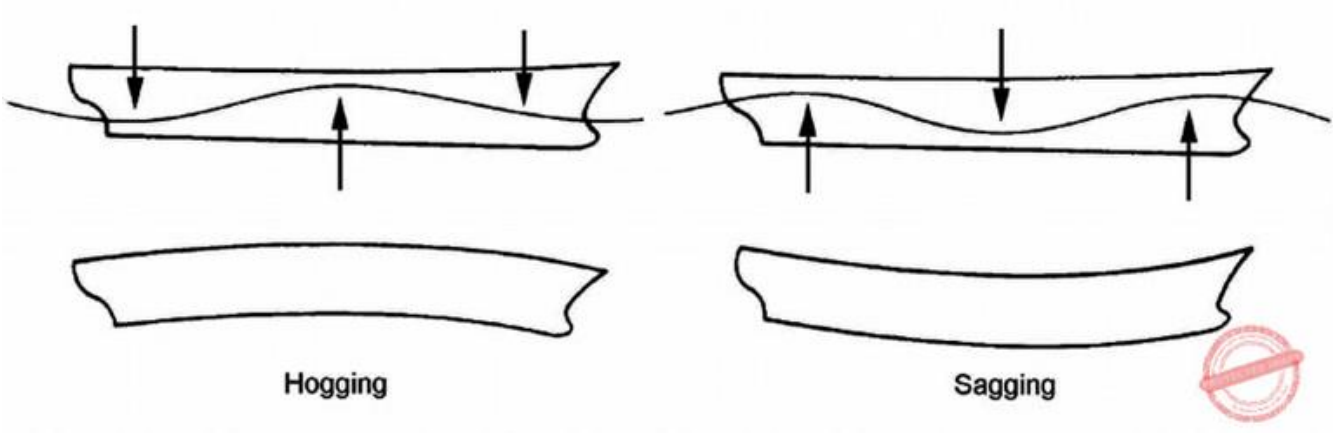


Figure 2. Conceptual hogging and sagging responses of a ship hull under longitudinal load imbalance.

A high initial GM does not, by itself, guarantee safe carriage: rapid rolling may intensify cargo movement or dynamic loads, while a low GM can reduce the margin against heeling. Cargo shift, fluidised cargo movement and excessive structural stresses are distinct hazards that require different engineering controls; they should not be treated as interchangeable outcomes (Barrass & Derrett, 2012; IMO, 2008).

2.2 Cargo Liquefaction, Dynamic Separation and Moisture Control

Group A cargoes in the IMSBC Code are cargoes that may liquefy or undergo dynamic separation. The code generally requires actual moisture content to be below the TML for acceptance, subject to prescribed exceptions for specially constructed or fitted ships. A credible acceptance decision depends on competent-authority-recognised sampling and testing, appropriate test timing, moisture control throughout stockpiling and loading, and signed information supplied to the master (IMO, 2023b, 2023c). The International Group of P&I Clubs (2026) similarly emphasises continued vigilance for nickel ore, including risks associated with variable cargo characteristics and supply arrangements.

A “can test” can help indicate suspicious flow behaviour but is not an alternative to laboratory determination of moisture content or TML. Under section 8.4 of the IMSBC Code, a sample that does not display free moisture following the check may nonetheless exceed its TML. A failed can test warrants immediate precautions and laboratory confirmation; it must not become the basis for acceptance merely because the test was repeated onboard (IMO, 2023c).

Bauxite offers an instructive example of evolving classification and understanding. Following the loss of Bulk Jupiter in 2015, IMO warned of the hazards of moisture-sensitive bauxite shipments, highlighting how cargo grading and particle-size distribution affect transportability (IMO, 2015). The IMSBC Code Amendment 07-23 became mandatory on 1 January 2025, and Amendment 08-25 may be used voluntarily from 1 January 2026 before entering into force on 1 January 2027 (IMO, 2023a, 2025; MCA, 2024, 2026).

2.3 Loading, Trimming and Voyage Precautions

The BLU Code links a ship–terminal loading plan, communication, maximum permissible loading rates, hull stress monitoring and correction of unexpected conditions. Loading at high rates without a verified sequence can cause local load concentration, large shear forces or bending moments, even where transverse GM appears satisfactory (IMO, 1997; House, 2024). Regular cargo-space, bilge and other condition checks can assist situational awareness, but hold entry and sampling must remain subject to enclosed-space safety and heavy-weather restrictions. Terminal procedures and company guidance cannot supersede the master’s obligation to question unsuitable or unverifiable cargo documentation.

3. Methods

3.1 Design and Participants

This descriptive, cross-sectional study used a structured bilingual questionnaire administered digitally to seven maritime respondents. All seven selected the 18–35 years age bracket and indicated fewer than five years of experience. Three identified as Third Officers and four as other positions. The respondent group was a small, non-random convenience or purposive sample; no probability-based selection, population denominator or

sample-size justification can be established from the reported information. Findings are therefore presented as the distribution of answers among these seven individuals, not as statistically representative estimates of maritime professional attitudes.

3.2 Questionnaire and Analytical Framework

The questionnaire combined categorical choices, five-point self-ratings and multiple-response selections in five areas: professional background; awareness and regulations; stability risk factors; monitoring and experience; and practical recommendations. Percentages were recalculated from integer counts using $100 \times n/7$. For multi-select questions, a respondent could choose more than one option, so category percentages may sum beyond 100%. The severity ordering contained a separate researcher-reported rating grid, but the number of raters and scoring aggregation were not documented; those values are labelled descriptive judgement scores rather than inferred group means.

Figure 3 presents the analytical sequence used to connect survey responses with engineering and regulatory safeguards. It distinguishes the descriptive questionnaire component from the technical interpretation and does not imply that a shipboard experiment or simulator validation was performed.



Figure 3. Research-process framework used to organise problem identification, questionnaire evidence and recommendations.

A conventional qualitative risk matrix was described, with risk treated as an ordered function of likelihood and severity. The available questionnaire does not provide accident frequencies, calibrated severity categories, or exposure denominators. Consequently, no quantified risk score or actual accident likelihood can be estimated; the illustrative matrix in Figure 4 is retained as a screening concept only.

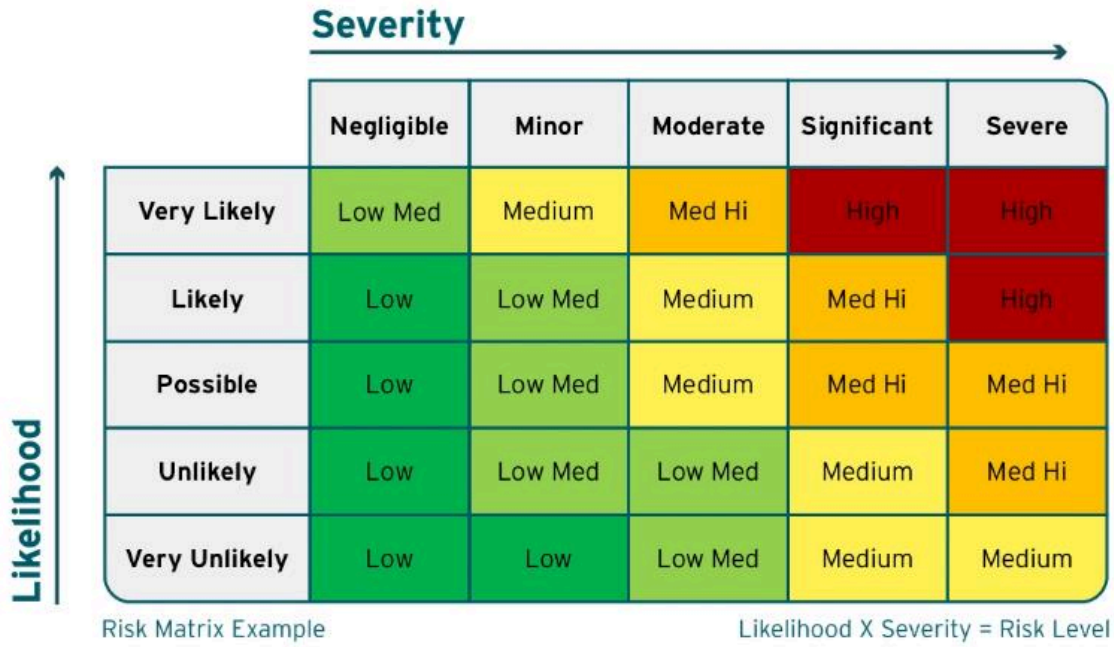


Figure 4. Illustrative qualitative risk-matrix concept; no case-specific probability calibration is claimed.

4. Results

4.1 Respondent Profile and Awareness

Table 1 summarises the respondent composition and core knowledge self-ratings. Four respondents selected level 4 or 5 for knowledge of the IMSBC Code and SOLAS, while three selected level 3. The sample is concentrated in an early-career demographic, which limits the range of operational experience represented.

Table 1. Respondent profile and reported knowledge of bulk cargo safety requirements (n = 7).

Measure	Reported category	Count	Percentage
Age	18–35 years	7	100.0%
Experience	Less than five years	7	100.0%
Position	Third Officer	3	42.9%
Position	Other positions	4	57.1%
Regulatory knowledge	Level 3	3	42.9%
Regulatory knowledge	Level 4	3	42.9%
Regulatory knowledge	Level 5	1	14.3%

Table 2 presents the reported frequency of company procedures, stability training and moisture/TML checks. All seven respondents selected “Yes, very comprehensive” for their organisations’ high-risk cargo procedures. Four reported monthly training, while six reported pre-loading moisture/TML testing at every operation. These are self-reports; they do not independently establish compliance or the adequacy of any laboratory process.

Table 2. Reported cargo-safety procedures, training frequency and moisture/TML testing practices (n = 7).

Practice	Response	Count	Percentage
Company SOP	Very comprehensive	7	100.0%
Training	Monthly	4	57.1%
Training	Every three months	1	14.3%
Training	Every six months	1	14.3%

Practice	Response	Count	Percentage
Training	Once yearly	1	14.3%
Moisture/TML checks	Every loading	6	85.7%
Moisture/TML checks	Often	1	14.3%

Figure 5 consolidates several operational indicators without repeating a series of single-category pie charts. Knowledge at level 4–5 and the reported practices are distinguished from the one respondent who had witnessed a relevant cargo-shifting or liquefaction incident.

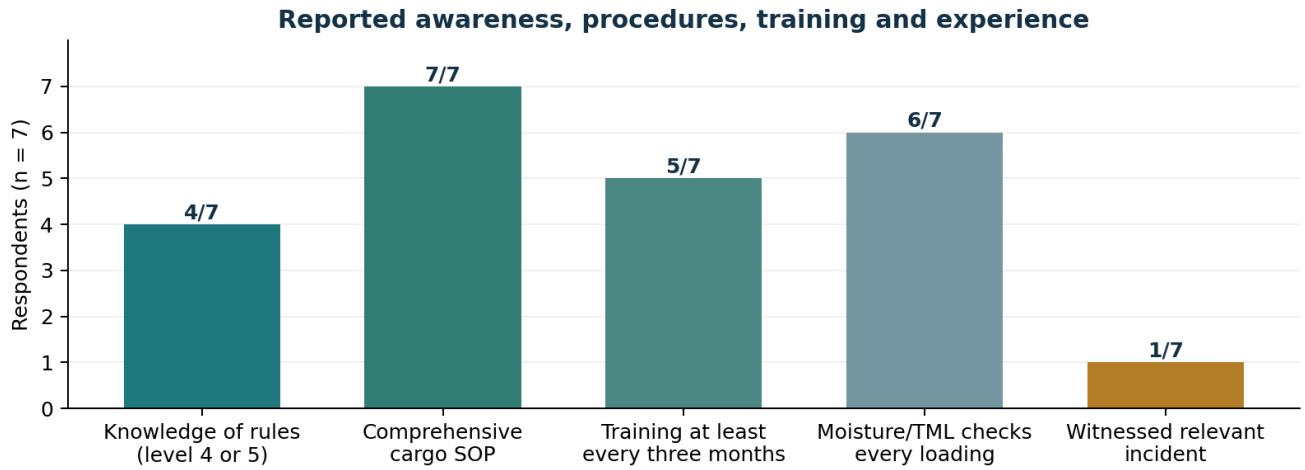


Figure 5. Respondent counts for selected awareness, procedural, training, testing and incident-experience indicators (n = 7).

4.2 Perceived Instability Hazards

Participants were asked to select all factors that, in their view, often contribute to loss of stability in bulk carriers. As reported in Table 3, cargo shifting received five selections, liquefaction and extreme weather four each, and poor weight distribution and water ingress three each. Zero respondents selected structural failure or inaccurate cargo declarations in this particular multiple-response item. Those zero counts do not show that these hazards are absent in practice or irrelevant under the IMSBC Code.

Table 3. Factors perceived to contribute to bulk-carrier instability (multiple selections permitted; n = 7).

Stability factor	Responses	Percentage
Cargo shifting	5	71.4%
Cargo liquefaction	4	57.1%
Extreme weather	4	57.1%
Poor weight distribution	3	42.9%
Water ingress	3	42.9%
Structural failure	0	0.0%
Inaccurate cargo declaration	0	0.0%

Figure 6 shows the same multi-select result in a count-based horizontal chart, allowing differences of one respondent to remain visible rather than suggesting undue numerical precision.

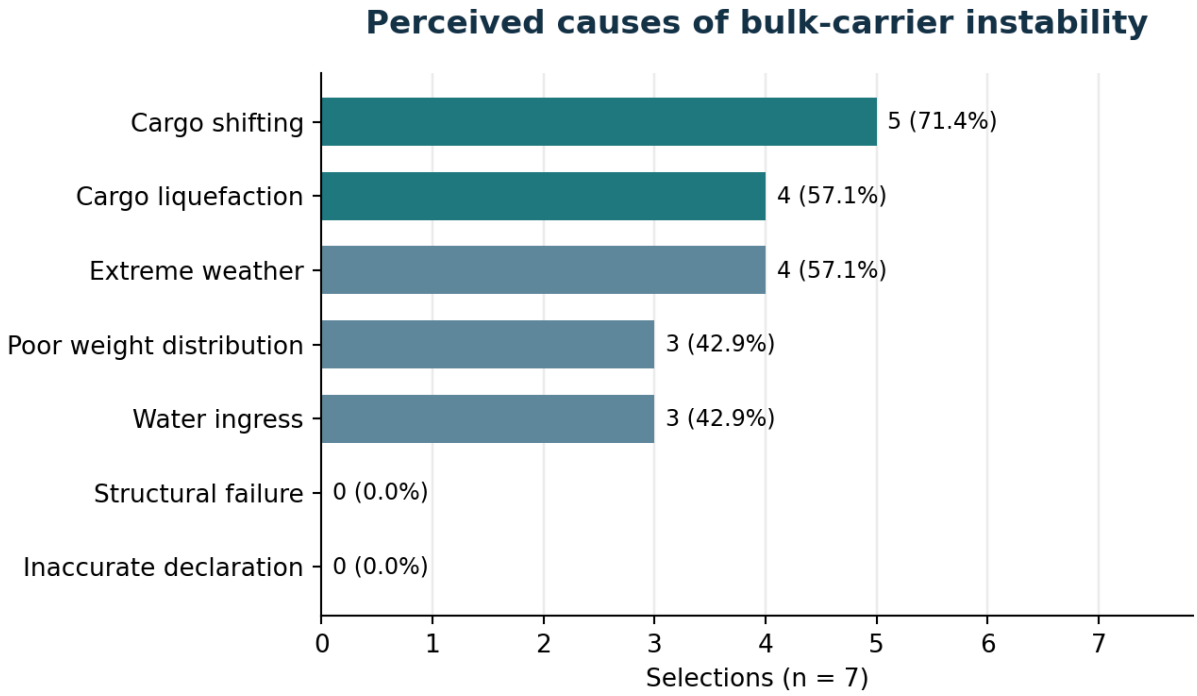


Figure 6. Relative frequency of selected cargo-related stability factors; percentages are based on seven respondents and do not sum to 100%.

The study also presented a separate severity grid assigning five to cargo shifting; four to liquefaction, poor weight distribution and water ingress; three to structural failure; and two to inaccurate cargo declaration and extreme weather. Because the scoring process was not shown, Table 4 reports the placements as an author-developed prioritisation framework, not a statistical ranking established from individual survey records.

Table 4. Descriptive severity placements retained from the research ranking framework (not respondent mean scores).

Factor	Illustrative severity placement (1–5)	Interpretation
Cargo shifting	5	Highest placement
Cargo liquefaction	4	High placement
Poor weight distribution	4	High placement
Water ingress	4	High placement
Structural failure	3	Intermediate placement
Inaccurate cargo declaration	2	Lower placement in reported grid only
Extreme weather	2	Lower placement in reported grid only

The low placement for inaccurate cargo declaration is particularly important to interpret carefully: shipping Group A cargo without compliant moisture/TML certification can have catastrophic consequences despite the absence of survey selections. A conceptual safety scale should not override the requirements of the IMSBC Code (IMO, 2023c; International Group of P&I Clubs, 2026).

4.3 Commercial Pressure and Cargo Specification

When asked whether cargo that does not meet specifications is a major contributor to accidents, four respondents agreed, one was unsure and two disagreed. In a separate item, three answered that commercial pressure causes safety measures to be neglected, three answered “sometimes,” and one answered “no.” Table 5 summarises these response distributions. The apparent contrast between high reported procedural coverage and concern about schedule pressure suggests a useful line of enquiry for further audits, but no causal connection can be estimated from the available responses.

Table 5. Perceived cargo-specification and commercial-pressure issues (n = 7).

Survey statement	Answer	Count	Percentage
Nonconforming cargo can cause accidents	Agree	4	57.1%
	Unsure	1	14.3%
	Disagree	2	28.6%
Commercial pressure can reduce cargo safety	Yes	3	42.9%
	Sometimes	3	42.9%
	No	1	14.3%

4.4 Monitoring Preferences and Incident Experience

Table 6 records the monitoring approaches selected as most effective during lengthy voyages. Bilge sounding/monitoring, temperature monitoring and the "mid-voyage can test" each received five selections, while visual inspection and digital moisture sensors received four each. The question allowed multiple responses, and these preferences do not demonstrate the sensitivity or technical validity of the chosen tools. One respondent (14.3%) reported experience or witness of a relevant incident, while six did not.

Table 6. Selected voyage cargo-condition monitoring methods (multiple responses permitted; n = 7).

Method selected	Responses	Percentage
Bilge sounding/monitoring	5	71.4%
Temperature monitoring	5	71.4%
Mid-voyage can test (opinion only)	5	71.4%
Physical visual inspection	4	57.1%
Digital moisture sensors	4	57.1%
Other	1	14.3%
CCTV monitoring	0	0.0%

Figure 7 visualises the response counts. The "can test" entry is explicitly a preference recorded in the survey, not an endorsed substitute for certified moisture/TML testing or a routine instruction for handling bulk cargo at sea.

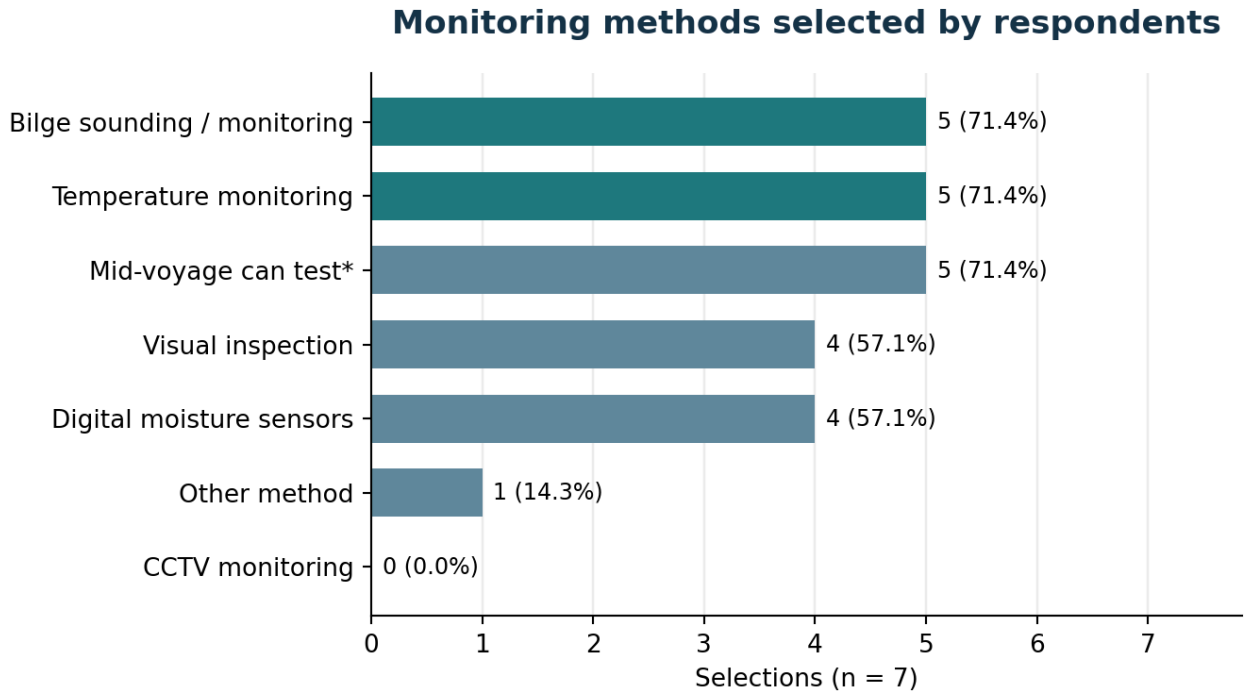


Figure 7. Survey selections for methods perceived to be useful for monitoring bulk cargo at sea (n = 7).

5. Discussion

5.1 Interpreting Cargo Shifting and Liquefaction

The respondents' emphasis on cargo shifting and liquefaction is consistent with internationally recognised hazards, although the questionnaire records perceptions rather than observed occurrence frequencies. In a shift by sliding, poorly trimmed or uneven cargo may move across the hold. For moisture-sensitive fine cargo, repeated compaction can increase inter-particle pore pressure and reduce shear strength, potentially permitting progressive movement. Both events may cause a substantial heeling moment and reduce effective stability, but their detection and prevention require different measures (IMO, 2023c; Biran & López-Pulido, 2014).

Industry accident evidence must be interpreted at a larger scale than this seven-person survey. INTERCARGO's 2013–2022 review identified 70 deaths associated with liquefaction, while the 2014–2023 and 2015–2024 reports continued to highlight liquefaction as a leading life-loss mechanism (INTERCARGO, 2023, 2024, 2025). The 2026 report also distinguishes liquefaction casualties from other forms of cargo shift and flooding. Because reporting periods overlap, the casualty figures provide context but are not independent data points to be pooled.

5.2 The Cargo Documentation–Verification Interface

A striking finding is that none of the seven respondents selected inaccurate declarations in the multiple-response question, although four agreed that out-of-specification cargo contributes to accidents. This can arise from questionnaire framing, differing interpretations of documentation and the small sample; it should not be treated as proof that declarations are unimportant. The IMSBC Code's testing regime makes representative sampling, accurate moisture records, TML certification and a reliable shipper–terminal–ship interface critical safety barriers (IMO, 2023c, 2023c; MCA, 2024).

The survey's high reported frequency of testing is encouraging as a description of practice but does not confirm whether tests were cargo-specific, representative, timely or performed by suitably recognised laboratories. Guidance from North of England P&I Association (n.d.) stresses that suspicious wetness should prompt suspension and further investigation. The international guidance on the transport of nickel ore likewise stresses practical supervision of cargo selection and loading conditions (International Group of P&I Clubs, 2026).

5.3 Monitoring and the Limits of Onboard Tests

Bilge sounding, temperature monitoring and visual assessment are supplementary situational-awareness measures, not a method for demonstrating that every parcel of cargo remained under its TML. They may detect water accumulation, warming or changed cargo appearance, but there is no evidence in this dataset of their diagnostic accuracy or their suitability for all types of cargo. The three different safety functions—testing before loading, monitoring during the voyage and responding to developing signs—should be kept analytically and operationally separate.

The interest in a mid-voyage can test is noteworthy precisely because it may reflect misunderstanding of its intended screening role. A passing result cannot assure safe moisture content; tests that require unsafe access to a cargo space during adverse conditions may introduce new risks. Digital sensors could eventually improve monitoring, but installation, calibration, spatial coverage, material compatibility and alarm thresholds must be validated before operational reliance is placed on their readings (IMO, 2023c).

5.4 Loading, Hull Strength and Human Factors

Vessel equilibrium is influenced by both transverse stability and longitudinal stresses. Cargo allocation among holds, ballast planning, loading and discharging sequences, and instantaneous hull-girder stresses must be monitored against the approved loading instrument. The BLU Code supports a coordinated loading plan and a clear exchange of information between master and terminal; the 2008 IS Code provides a separate framework for assessing intact stability (IMO, 1997, 2008). Structural deformation or loss of strength should not be inferred from the present survey because no actual vessel loading cases or hull-stress computations were available.

The finding that six of seven respondents said commercial pressure affected safety at least sometimes suggests that procedural effectiveness may depend on the authority to delay operations, reassess uncertain documents, and secure independent review without schedule penalties. This is a practical management issue rather than evidence of systematic non-compliance by any particular company. Regular training should emphasise a questioning attitude, traceable records, ship–shore communication and a documented stop-loading pathway (House, 2024; IMO, 1997).

6. A Layered Cargo-Stability Safety Framework

Figure 8 sets out a four-stage safeguard framework arising from the survey themes, cargo-handling guidance and stability theory. The framework is proposed for training and quality assurance rather than validated as a predictive risk model.

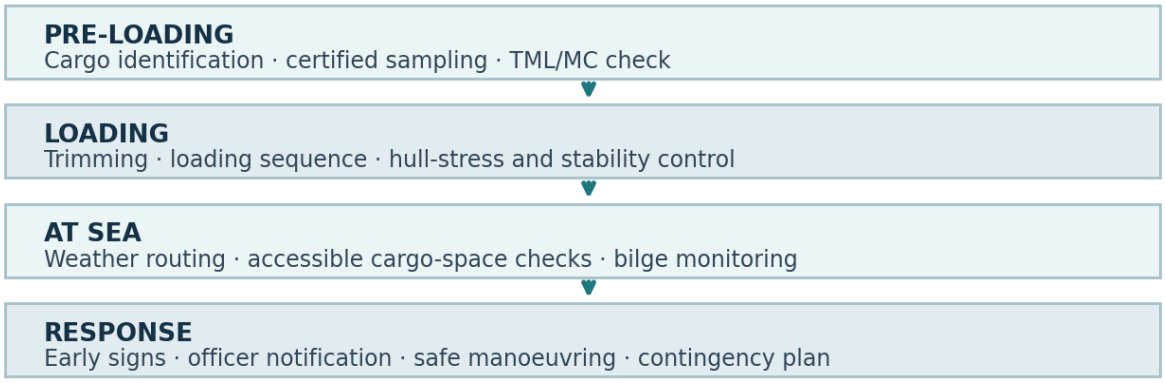


Figure 8. Proposed layered controls for managing cargo-related instability from acceptance and loading to voyage monitoring and response.

Table 7 translates the conceptual stages into accountable operational actions and distinguishes required acceptance controls from optional enhancements. The detailed actions should be adjusted to the applicable cargo schedule, vessel stability booklet, loading instrument and operator procedures.

Table 7. Proposed cargo-stability assurance actions by operational stage.

Stage	Principal assurance task	Evidence / decision trigger

Stage	Principal assurance task	Evidence / decision trigger
Cargo acceptance	Identify IMSBC cargo group; verify shipper details, sampling, laboratory moisture and TML	Certificates, cargo schedule, independent concerns, stop-loading decision
Loading and trimming	Check loading plan, stowage, ship–terminal agreement, stability and hull-girder limits	Approved loading instrument, hold plan, loading sequence, terminal communications
Voyage monitoring	Inspect safely, track bilges and relevant cargo indications, monitor ship heel and motion	Trend logs; abnormal water, list, cargo movement or temperature as applicable
Emergency response	Escalate concerns to master and company, follow approved contingency advice, minimise exposure	Documented decision-making, protective measures, port/refuge coordination
Training and assurance	Scenario-based training; verify adequacy of sampling and stop-work authority	Audit trails, exercises, lessons learned and independent review

7. Limitations and Future Work

The principal limitation is the very small and homogeneous respondent group ($n = 7$; all early-career). No population-representative sampling, individual response file, transcript-level qualitative material, repeated scoring or independent validity evidence was available. Descriptive percentages represent exact counts of respondent selections; hypothesis testing, inferential claims and broad rank generalisation would be inappropriate. Because the study was not designed to compare ship types or trade routes and did not inspect cargo samples or vessel records, it cannot establish whether the preferred monitoring methods reduce actual casualties.

The researcher-produced severity grid gives a useful educational ordering but lacks a reproducible scoring protocol. Future studies should recruit masters, chief officers, port surveyors, shippers and terminal supervisors; differentiate cargo groups and ships; collect item-level survey data and operational records; evaluate standardisation of cargo tests, ship–shore information quality and stop-loading decisions; and, if feasible, assess monitoring technologies against actual laboratory and sensor performance. Ethics and participant-consent documentation also require confirmation before public submission.

8. Conclusion

The small survey places cargo shifting, liquefaction and heavy-weather influences at the centre of respondents' bulk-carrier stability concerns. It also identifies frequent reported cargo-safety procedures and pre-loading moisture/TML testing, alongside concern about commercial pressure and strong interest in voyage monitoring. These findings are most useful as targeted training and assurance priorities, rather than as evidence of accident prevalence or the reliability of specific monitoring devices. The regulatory and casualty evidence shows that safe bulk-cargo carriage depends on the combined assurance of cargo suitability, representative testing and certification, correct loading and structural checks, condition monitoring, disciplined ship–shore communication and well-rehearsed responses. A layered approach is therefore more defensible than reliance on any single procedure, visual test, sensor or numerical severity ranking.

Acknowledgements

The author acknowledge the Faculty of Maritime Studies, Universiti Malaysia Terengganu, and the contributions of maritime stakeholders who participated in the research. Appreciation is also extended to those who supported the study.

Funding

No external funding received for this study.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the author used OpenAI's ChatGPT to assist with manuscript structuring, language refinement, and improving the clarity and readability of the text. All AI-assisted content was critically reviewed, verified, and edited by the author. The author takes full responsibility for the accuracy, integrity, originality, and final content of the published work.

Conflict of Interest

Not applicable.

Author Contributions

Nur Rifa Syahirah Mohd Rosmali contributed to the conceptualization of the research and reviewing and editing the manuscript.

Data Availability Statement

Individual-level questionnaire records are not available in the present manuscript.

Ethics Statement

Formal ethics approval and consent documentation must be confirmed by the authors and institution before submission.

References

Barrass, C. B., & Derrett, D. R. (2012). Ship stability for masters and mates (7th ed.). Butterworth-Heinemann. https://shop.elsevier.com/books/ship-stability-for-masters-and-mates/barrass/978-0-08-097093-6

Biran, A. B., & López-Pulido, R. (2014). Ship hydrostatics and stability (2nd ed.). Butterworth-Heinemann. https://www.sciencedirect.com/book/monograph/9780080982878/ship-hydrostatics-and-stability

Eyres, D. J., & Bruce, G. J. (2012). Ship construction (7th ed.). Butterworth-Heinemann. https://catalogue.bnf.fr/ark:/12148/cb446283278

House, D. J. (2024). Cargo work: For maritime operations (9th ed.). Routledge. https://doi.org/10.4324/9781003407706

International Association of Dry Cargo Shipowners. (2023). Bulk carrier casualty report 2013–2022. https://www.intercargo.org/wp-content/uploads/2023/07/INTERCARGO-Bulk-Carrier-Casualty-Report_2023.pdf

International Association of Dry Cargo Shipowners. (2024). Bulk carrier casualty report 2014–2023. https://www.intercargo.org/wp-content/uploads/2024/05/INTERCARGO-Bulk-Carrier-Casualty-Report_2024_FINAL.pdf

International Association of Dry Cargo Shipowners. (2025). Bulk carrier casualty report 2015–2024. https://www.intercargo.org/wp-content/uploads/2025/03/INTERCARGO-Bulk-Carrier-Casualty-Report_2025-Pages.pdf

International Association of Dry Cargo Shipowners. (2026). Bulk carrier casualty report 2016–2025. https://www.intercargo.org/publications/bulk-carrier-casualty-report-2026/

International Group of P&I Clubs. (2026, June 22). Safe carriage of nickel ore cargoes in the South-Western Pacific Ocean. https://www.igpandi.org/article/safe-carriage-of-nickel-ore-cargoes-in-the-south-western-pacific-ocean/

International Maritime Organization. (1997). Code of practice for the safe loading and unloading of bulk carriers (Resolution A.862(20)). https://www.imo.org/en/ourwork/safety/pages/blu-code-and-blu-manual.aspx

International Maritime Organization. (2008). Adoption of the international code on intact stability, 2008 (Resolution MSC.267(85)). https://wwwcdn.imo.org/localresources/en/KnowledgeCentre

International Maritime Organization. (2015, September 18). IMO warns on bauxite liquefaction dangers. https://www.imo.org/en/mediacentre/pressbriefings/pages/38-bauxite-ccc.aspx

International Maritime Organization. (2023a). Amendments to the International Maritime Solid Bulk Cargoes (IMSBC) Code (Resolution MSC.539(107)). https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions

International Maritime Organization. (2023b). Guidelines for developing and approving procedures for sampling, testing and controlling the moisture content for solid bulk cargoes which may liquefy or undergo dynamic separation (MSC.1/Circ.1454/Rev.2). https://rise.odessa.ua/texts/MSC1_Circ1454e.php3

International Maritime Organization. (2023c). International Maritime Solid Bulk Cargoes Code and supplement (2023 ed.). https://doi.org/10.62454/KL260E

International Maritime Organization. (2025). Amendments to the International Maritime Solid Bulk Cargoes (IMSBC) Code (Resolution MSC.575(110); Amendment 08-25). https://imo-epublications.org/content/collections/maritime-safety/i

Maritime and Coastguard Agency. (2024, December 4). MIN 715 (M): Cargoes—Amendments to the IMSBC Code (07-23) and IMDG Code (42-24). https://www.gov.uk/government/publications/min-715-m-cargoes-amendments-to-the-imsbc-code-07-23-and-imdg-code-42-24

Maritime and Coastguard Agency. (2026). MIN 730 (M): Carriage of cargoes—Amendments to mandatory international instruments 2026. https://www.gov.uk/government/publications/min-730-m-carriage-of-cargoes-amendments-to-mandatory-international-instruments-2026

SAFETY4SEA. (2023). Bulk carrier casualty report 2013–2022. https://safety4sea.com/bulk-carrier-casualty-report-2013-2022/

© 2026 The Author(s). This article is licensed under a
Creative Commons Attribution 4.0 International License (CC BY 4.0).