Applied Skills and Knowledge Journal (ASK-J)
Vol 1 • No 1 • Dec (2026) • 220–229
e-ISSN: 2838-0541
DOI: 10.68949/askjv01i01a018

Risk Assessment of Towage Operations at Penang Port: A Hazid-Based Survey and Priority Analysis

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ARTICLE INFORMATION

Article type: Original Research
Received: 06 January 2026
Revised: 19 August 2026
Accepted: 07 November 2026
Published online: 09 November 2026

ABSTRACT

Harbour towage involves simultaneous navigational, environmental, mechanical and human-factor hazards, particularly when tugs and towed vessels manoeuvre in confined waters. This study examines perceived risks associated with towing operations at Penang Port using hazard identification (HAZID) and a semi-quantitative likelihood–severity matrix. Ten maritime stakeholders supplied ratings for five hazard categories, yielding 50 paired likelihood and severity evaluations. Risk scores were calculated as the product of the two ordinal ratings and summarised descriptively. Navigational hazards received the highest mean score (16.6), followed by weather conditions (15.7), equipment failure (13.6), crew error (11.6) and communication failure (11.3). These results identify respondents' relative priorities; they are not observed frequencies or validated incident probabilities. The study integrates a focused review of formal safety assessment, towage-specific incidents and applicable safety-management principles to propose targeted controls covering passage planning, weather assessment, equipment assurance, communication, crew competence and emergency response. Because incident exposure, tow configuration, observational records and risk-acceptance thresholds were not available for independent assessment, the proposed measures are presented as risk-management priorities requiring site-specific verification. This approach provides a transparent basis for further towage-safety evaluation at Penang Port while preserving the distinction between expert judgments and demonstrated operational effectiveness.

Keywords: harbour towage; HAZID; tugboat operations; risk matrix; maritime safety

1. Introduction

Tug-and-barge and ship-assist operations are essential to port throughput, yet combine close-quarters vessel interaction, towline loading, restricted manoeuvring space and variable weather with complex inter-organisational communication. Port authorities and towage operators therefore need arrangements for identifying credible hazards, allocating controls and responding to changes in operational conditions. A towage risk assessment undertaken for Belfast Harbour illustrates the relevance of collision, contact, grounding, and human and equipment safeguards in structured port risk management (Belfast Harbour Commissioners, 2018). A comparative study of routine ship towage identified operational competence, weather, tug suitability, work processes, safety management and navigational risk assessment as interconnected factors (Singh & Raju, 2016; Kamis et al., 2026).

At Penang Port, towing activities take place in the context of commercial vessel traffic, port infrastructure and navigational constraints. Port-specific notices and operating arrangements provide a regulatory and operational backdrop, but their existence does not establish the effectiveness of individual safety controls (Penang Port Commission, 2026). International guidance recommends that harbour towage be addressed through locally developed risk assessments, documented procedures, stakeholder consultation and contingency plans (Department for Transport, 2025; MCA, 2025).

The broader field of maritime risk analysis cautions against treating risk estimates as independent of assumptions, available evidence and assessor judgment. Goerlandt and Montewka (2015) emphasised the need to make uncertainty and risk-model limitations transparent, while Aven (2016) highlighted the conceptual distinction between knowledge, uncertainty and decision support. The present study therefore treats a risk matrix as an ordinal prioritisation aid rather than an accident-frequency prediction model.

The objectives are to (a) identify perceived hazards linked to Penang Port towing operations, (b) compare their ratings using a consistent HAZID-informed scoring method and (c) propose practical risk-control options for further operational evaluation. These objectives do not assume that particular interventions have already been implemented or that their effectiveness has been measured.

2. Literature Review

2.1 Formal safety assessment and HAZID

Formal Safety Assessment (FSA) provides a structured sequence of problem definition, hazard identification, risk analysis, identification of risk-control options, cost–benefit assessment and decision recommendations. The International Maritime Organization (IMO, 2018) emphasises the quality and traceability of information, expert judgment, the human element and explicit treatment of uncertainty. Earlier discussion of ship safety cases similarly established risk-based decision-making as an alternative to purely reactive accident response (Wang, 2002).

HAZID is useful at the beginning of this process because it provides a systematic catalogue of potential initiating events and consequences. For towing, such events include excessive towline forces, girting or capsize, towline parting, machinery failure, low visibility, restricted water depth, collision or contact, and ambiguous communications. The identification of a hazard is distinct from estimating its probability; a credible hazard may warrant safeguards even when local accident frequencies cannot be reliably established (IMO, 2018; Singh & Raju, 2016).

2.2 Risk matrices and interpretation

The matrix applied in this study uses two 1–5 ordinal judgments: likelihood, L, and consequence severity, S. A descriptive product score $\boldsymbol{R = L \times S}$ produces possible values from 1 to 25. This scoring convention is easy to communicate but should not be treated as a physical measurement or as the mathematical expectation of loss. Differences in assessor experience, operational exposure and category definitions can change assigned values. Cox (2008) showed that conventional matrices may compress unlike risks into similar categories or distort priorities when input scales are poorly calibrated. Consequently, scores below are used to order the reported hazard categories; no port-approved tolerability threshold is inferred from them.

The ALARP principle—reducing risks as low as reasonably practicable—requires evaluation of feasible controls and their implications; a number alone cannot establish that a specific operation is safe or authorised. ISO 31000 frames this as a cycle of risk identification, analysis, evaluation, treatment, review and consultation (ISO, 2018b). The revised IMO FSA guidelines likewise distinguish the assessment of risk-control options from the evaluation of achieved outcomes (IMO, 2018).

2.3 Towage-specific hazards and accident lessons

Environmental conditions can increase hydrodynamic loading, reduce visibility and complicate navigation in confined waters. The IMO guidelines for towed ships recommend consideration of wind, tides, currents, tow geometry, planned route, bollard pull and contingencies when planning a tow; those recommendations must be adapted to the operational situation (IMO, 1993). Equipment condition—particularly towline, winch, propulsion and release-system reliability—affects the ability to apply and recover forces safely. Recent research on rapid tug-operation assessment underscores the need to consider environmental and human elements alongside technical safeguards (Kalinichenko et al., 2024).

The capsize of tug Biter in 2023, investigated by the Marine Accident Investigation Branch (MAIB, 2024), demonstrated how vessel speed, towline loading, communication gaps, inadequate tug-specific planning and failure of protective arrangements can combine into a catastrophic outcome. A subsequent industry safety bulletin reinforced the need for a shared towage plan, speed control, correct rigging and secured doors and hatches (MAIB, 2026). This event is used as external contextual evidence, not as an accident at Penang Port.

Human factors and communication are not secondary simply because their average survey scores are lower than environmental or navigation categories. A literature review of shipping accidents identifies teamwork, fatigue, decision-making, communication and safety culture as recurrent safety issues (Hetherington et al., 2006). Good port-marine practice similarly calls for clear responsibility, pilot–tug interaction, training, incident reporting and emergency procedures (MCA, 2025).

2.4 Governance and operational responsibility

Malaysia's Occupational Safety and Health Act 1994, with the 2022 amendment in force from 1 June 2024, provides an important general occupational safety context (DOSH Malaysia, 2024). ISO 45001 complements this by emphasising leadership, worker participation, competent operations, incident learning and continual improvement (ISO, 2018a). UK port guidance and safety codes offer comparative operational examples but are not presented as Malaysian statutory requirements (Department for Transport, 2025; MCA, 2025).

For practical hazard management, operational controls should be assigned to accountable functions rather than treated as generic recommendations. Table 1 identifies the principal failure pathways for the five survey categories and distinguishes them from potential controls. These pathways are operational interpretations consistent with towage-safety guidance, not incident causes measured in the Penang survey.

Table 1. HAZID-oriented hazard categories, plausible consequences and control measures

Hazard	Representative failure pathway	Potential control
Navigational hazards	Restricted channel, obstacle, chart/route mismatch, close-quarters interaction	Verified passage plan, depth and traffic checks, pilot–tug exchange
Weather conditions	Wind/current and reduced visibility affect tow forces and control	Weather limits, updated forecasts, stop/abort criteria
Equipment failure	Propulsion, winch or towline failure during load	Planned maintenance, pre-use inspections, release-system checks
Crew error	Inadequate situation awareness, fatigue or procedural mistakes	Competency checks, task briefing, drills and fatigue controls
Communication failure	Unclear instructions or loss of reliable pilot–tug contact	Single agreed plan, closed-loop radio protocols, fallback channels

3. Methodology

3.1 Design and study setting

A descriptive, mixed-source risk assessment was used to examine towing-operation hazards at Penang Port. The empirical component was a structured stakeholder rating exercise; associated descriptive accounts identified the intended use of interviews, site observation and secondary incident material. The survey contains a complete 10-participant, five-hazard rating matrix. Individual interview transcripts, field observation logs, vessel or tow particulars, survey administration dates and a complete incident inventory were not available for independent analysis. Accordingly, only the recorded ratings are treated as reproducible empirical results, while qualitative operational explanations are used to frame proposed controls rather than as independently coded interview findings.

Figure 1 illustrates the five-stage research logic linking literature review and HAZID, risk assessment and formulation of mitigation strategies. The sequence is used here to describe analytical steps rather than to imply completion of a full IMO cost–benefit assessment.

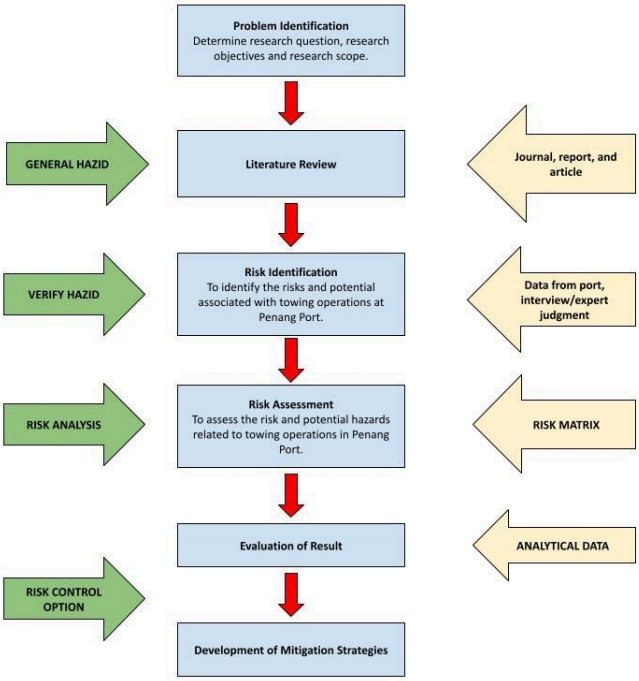


Figure 1. Study framework linking hazard identification, assessment and mitigation development.

3.2 Participants and rating instrument

Ten respondents with experience relevant to port and towing operations contributed ratings. The stated sampling distribution includes four towing crew members, two port operations managers, two maintenance personnel and two port-authority representatives; the occupation-group chart contained duplicate response labels and is therefore not used for inferential interpretation. Professional experience bands were described graphically, but respondent-level job histories and role-linked risk scores were not available for subgroup testing.

Table 2 shows the stated occupational composition of the respondent group. The small purposive sample supports exploratory risk prioritisation, not representation of the entire Penang towage workforce or attribution of accident causation.

Table 2. Respondent roles described in the study (n = 10)

Occupational grouping	Number	Percent
Towing crew	4	40%
Port operations managers	2	20%
Maintenance personnel	2	20%
Port-authority representatives	2	20%
Total	10	100%

Each respondent assigned 1–5 likelihood and 1–5 severity values for weather conditions, equipment failure, crew error, communication failure and navigational hazards. A score of 1 represents the lower end of the reported ordinal scale and 5 the higher end. These ratings reflect judgments of the five hazards rather than incident frequencies over a known time period. There was no separately calibrated threshold for "low," "moderate," "high" or "extreme" validated for the 1–25 product range.

3.3 Scoring, aggregation and verification

For respondent i and hazard j, the score was calculated as $R_{ij} = L_{ij} \times S_{ij}$. For each hazard, the arithmetic mean of the 10 product scores was computed as $\bar{R}_j = \frac{\sum_i R_{ij}}{10}$. Mean likelihood and mean severity were calculated separately, and descriptive standard deviations of respondent product scores were retained to illustrate

dispersion. Importantly, the product of mean likelihood and mean severity is not generally identical to the mean of individual products. All 50 pairs were recalculated, and the complete observations are presented in Appendix A and the editable calculation workbook.

The analysis did not use hypothesis tests, confidence intervals, incident-rate models or risk tolerability acceptance bands. The proposed interventions in the following sections have not been evaluated in before-and-after towing trials. The approach is consistent with a cautious reading of ordinal risk matrices and the importance of disclosing data limitations (Aven, 2016; Cox, 2008; Goerlandt & Montewka, 2015).

4. Results

4.1 Ranked risk perceptions

Table 3 presents the independently calculated means and variability. Navigational hazards received the highest mean score (16.6), marginally above weather conditions (15.7). Equipment failure was third (13.6), followed by crew error (11.6) and communication failure (11.3). The 0.9-point difference between the top two categories is descriptive and should not be treated as statistical evidence of distinct underlying operational risks.

Table 3. Descriptive scores for five towage hazard categories (10 judgments per hazard)

Hazard	Mean L	Mean S	Sum of R	Mean R	SD of R
Navigational hazards	3.8	4.3	166	16.6	5.66
Weather conditions	3.7	4.1	157	15.7	6.31
Equipment failure	3.3	4.0	136	13.6	5.50
Crew error	3.3	3.3	116	11.6	6.48
Communication failure	3.1	3.6	113	11.3	4.60

Figure 2 displays the same ranked means on a common 1–25 scale. The values are mean products of ordinal responses; they do not represent the probability of a collision, weather incident or equipment failure.

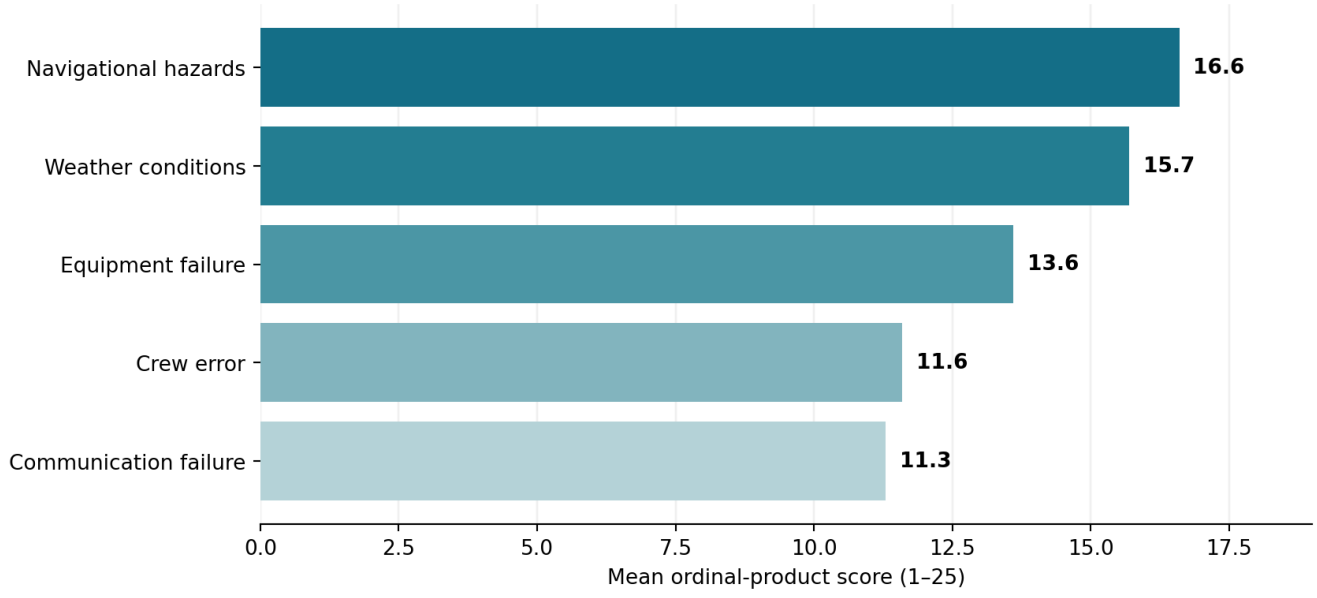


Figure 2. Respondent-rated towage hazard priorities (mean likelihood × severity scores).

4.2 Variation across respondents

Figure 3 shows all 50 individual risk-product scores. While navigational and weather hazards ranked highest in the pooled data, individual ratings varied considerably: for instance, weather scores ranged from 6 to 25 and crew-error scores from 4 to 25. This spread is important when interpreting the mean rankings and argues against converting the scores into site-wide operating limits.

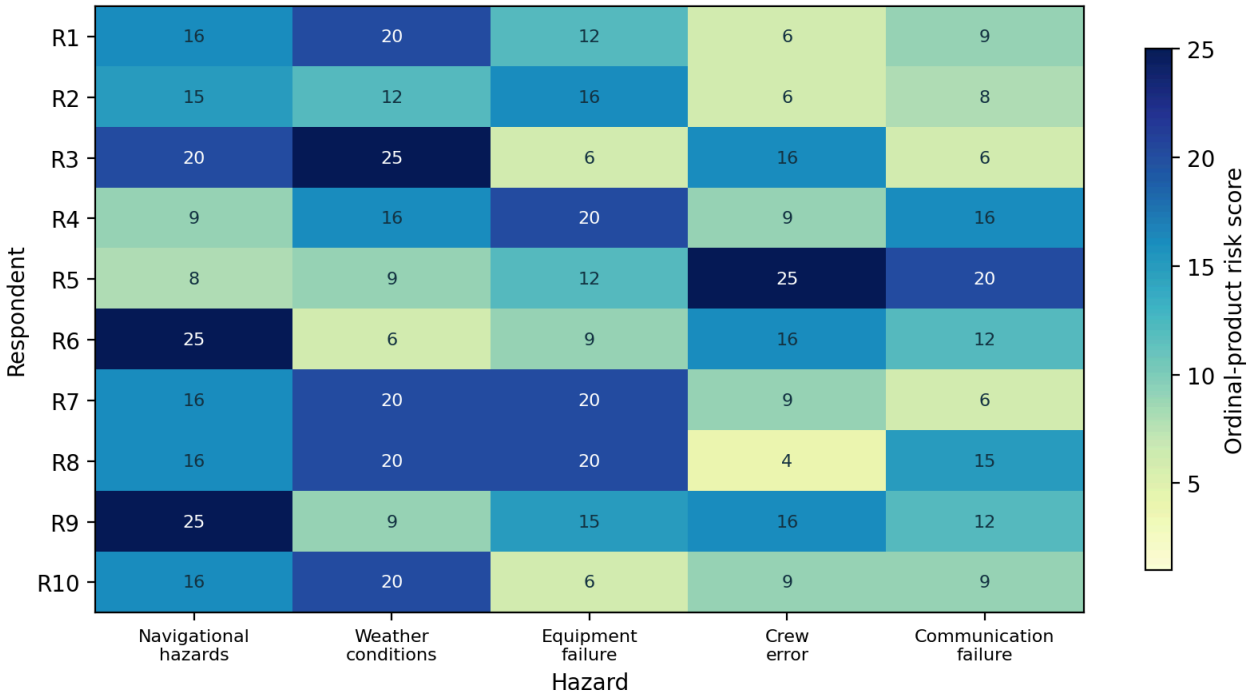


Figure 3. Heatmap of 50 survey risk-product scores by respondent and hazard.

The full 10-by-five matrix of individual likelihood/severity ratings is supplied in Appendix A; its values can be recomputed independently. The individual navigational-hazard scores sum to 166 and yield a mean of 16.6. All five category totals are reproducible from the respondent-level ratings.

4.3 Interpretation of the hazard priorities

The most prominent category, navigational hazards, encompasses shallow or restricted water, underwater obstructions, chart currency and interactions with other traffic. These are credible concern areas for towage because the tug, towline and assisted vessel may require different manoeuvring envelopes. However, the scores alone cannot establish which location within Penang Port is more hazardous. Such judgments would require route-specific charts, traffic data, vessel and tow particulars, tide and current records and incident reports.

Weather conditions were the second-highest priority. Wind, sea state, rain and visibility can increase loads and reduce control authority, while currents affect set, drift and alignment. Therefore, real-time forecasts, pilot–tug planning and clear operational stop criteria are relevant considerations. The IMO's tow planning guidelines address weather and current anticipation and contingencies, although they were drafted for a broader range of towed vessels and must be applied with care to individual harbour manoeuvres (IMO, 1993).

Equipment failure occupied the middle of the ranking, but a score of 13.6 does not make a high-consequence towline or propulsion failure "acceptable." Reliability of towing gear, operating instructions and emergency-release arrangements can be safety-critical. The MAIB's investigation of Biter highlights how rapidly an adverse towline loading configuration can become unrecoverable (MAIB, 2024). Crew error and communication failure scored lower on average yet remain interacting precursors; fatigue, poor teamwork and unclear bridge-to-tug instructions can amplify environmental and mechanical vulnerabilities (Hetherington et al., 2006).

5. Discussion

5.1 Meaning of the ranking

The five-category HAZID summary provides a practical starting point for conversations among tug operators, pilots, marine operations personnel and port authorities. Its greatest value is transparency: each score can be traced to a defined respondent input. The study does not establish an event database or empirical rates that would support statements about actual collision probability, frequency of girting or the statistical effectiveness of risk controls. The Belfast Harbour risk assessment provides an example of a more extensive hazard-specific evaluation that combines accident scenarios, consequence categories and operational controls (Belfast Harbour Commissioners, 2018).

The five-point likelihood and severity scales produce a possible risk-product range of 1–25, whereas the proposed ALARP interpretation stops at scores of 13. This is inconsistent with the attainable product range of 1–25. A validated classification needs explicit cut-offs, operational consequences, stakeholder agreement and evidence that the assigned likelihood and consequence descriptions match local towage conditions. These results therefore report scores and priorities without assigning a blanket “safe” or “unsafe” label. ISO 31000 encourages contextualised risk criteria that are reviewed as knowledge changes (ISO, 2018b).

5.2 Proposed controls for operational safety

Table 4 connects the ranked survey categories to proposed controls, responsibility areas and implementation checks. These proposals build on the practical recommendations regarding weather monitoring, updated navigational information, preventive maintenance, simulation training and standardised communications. They do not imply that technology alone will prevent casualties; measures should be integrated into approved marine operating procedures and reviewed against actual towing arrangements (MCA, 2025; MAIB, 2026).

Table 4. Proposed control measures, responsible functions and indicators for subsequent evaluation

Priority	Control measures	Responsible function	Evidence to obtain
Navigational	Chart/under-keel check; tow geometry and transit plan; agreed traffic coordination	Port marine operations; pilot; tug master	Route plan, exchange checklist, traffic/near-miss log
Weather	Measured wind/current; forecast review; operational pause/abort criteria	Operations manager; tug master	Metocean log and job-specific decisions
Equipment	Pre-use towline and winch inspections; emergency release demonstration	Tug operator; maintenance supervisor	Inspection and maintenance records
Crew competence	Briefing, simulator/drill exercises, fatigue safeguards	Training lead; tug operator	Competency, drill and rest records
Communication	Closed-loop tug/pilot calls, shared manoeuvre plan, standby channel	Pilot; tug master; VTS/port control	Bridge–tug exchange checklist; communication audits

Figure 4 outlines a suggested sequence from pre-tow planning to verification, active monitoring and possible abort or recovery. The sequence is conceptual; no incident reduction, risk-score reduction or improved manoeuvring performance was measured after its introduction.

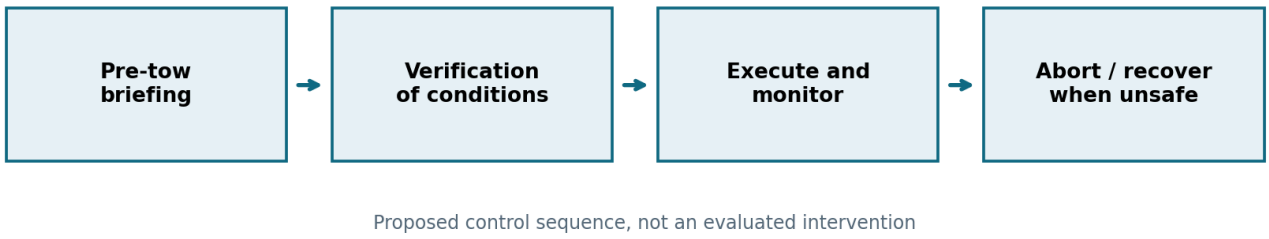


Figure 4. Proposed towage decision and control sequence for operational implementation.

5.3 Communication, organisational learning and ALARP

A shared towage plan should identify the intended mode (e.g., pushing, alongside assistance or towing on a line), roles, communication terms, operational speed, towline configuration, expected forces and contingency actions. A line-pull strategy acceptable for an azimuth-stern-drive tug cannot automatically be transferred to a conventional tug without attention to stability and girting mechanisms. The MAIB (2024, 2026) emphasises this distinction in lessons from the Biter casualty. Periodic joint exercises for pilots and tug masters, together with a near-miss reporting system, can support review of assumptions used in HAZID (Belfast Harbour Commissioners, 2018).

Residual risks should be assessed once safeguards and their evidence are specified. For risk acceptance, responsible authorities would need documented criteria, evidence about practical control effectiveness and consideration of feasible additional safeguards. The guiding principle is not that every risk-product score below an arbitrary threshold is tolerable, but that operationally meaningful hazards are controlled, responsibilities are clear and changes in exposure trigger reassessment (IMO, 2018; Department for Transport, 2025).

5.4 Limitations and further research

Four limitations are important. First, the purposive sample included only 10 respondents, and their ratings are not linked to vessel type, towage mode, role or operational exposure, preventing subgroup comparisons or sector-wide generalisation. Second, the five dimensions were pre-specified rather than derived from a complete, coded incident dataset, so potentially critical hazards such as towline snapback, capsize, pollution or emergency tow recovery are not separately ranked. Third, dates and detailed logs for the reported observation of five towing operations were not available for verification, limiting replication of the field component. Fourth, the ordinal scales and their implicit multiplication have not been validated against measured accident exposure or site-specific risk criteria (Cox, 2008; Goerlandt & Montewka, 2015).

Future work should collect anonymised respondent-level contextual variables, duty and vessel categories, instrument dates and coding protocols; construct a detailed HAZID register identifying initiating event, escalation factors, barriers and consequences; and obtain event exposure and near-miss data from operational records. Simulation and training exercises could be used to test the feasibility of interventions, while periodic reassessment could determine whether recorded safety indicators change following implementation. These steps would enable a more defensible comparison between perceived risk priorities and observed operational risks.

6. Conclusions

The HAZID-informed survey of 10 respondents identified navigational hazards (mean risk-product score 16.6) and weather conditions (15.7) as the leading perceived towing-operation concerns at Penang Port, followed by equipment failure (13.6), crew error (11.6) and communication failure (11.3). The results support prioritising navigational planning, metocean awareness, towing-gear assurance, crew competence and reliable communications. They do not establish local accident rates, a statistically significant ranking or a validated risk-tolerability boundary. The most defensible contribution is a reproducible hazard-prioritisation dataset accompanied by a practical control framework for subsequent port-specific risk management and evaluation.

Acknowledgements

The authors gratefully acknowledge Universiti Malaysia Terengganu (UMT) for its institutional support and for providing the facilities, resources, and conducive research environment necessary for the successful completion of this study. The availability of institutional resources and academic support contributed to the successful implementation of the research activities.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The study was conducted using available institutional facilities and resources.

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

During the preparation of this manuscript, generative artificial intelligence (AI) and AI-assisted technologies were utilized to support language refinement, grammatical correction, and improvements in the clarity and readability of the manuscript. All AI-assisted content was critically reviewed, verified, and revised by the authors to ensure scientific accuracy, originality, and academic integrity. The authors retain full responsibility for the content, interpretations, conclusions, and overall integrity of the published work.

Conflict of Interest

One of the author is a member of the editorial team of this journal. Appropriate measures were taken to ensure that the manuscript was handled in accordance with the journal's publication ethics and editorial procedures, and the author was not involved in the editorial decision making or peer-review process for this manuscript.

Author Contributions

Rafiq Hanif Mohd Asri contributed to the conceptualization of the research and reviewing and editing the manuscript. Muhamad Nasir Rahmatdin contributed to the supervision and oversight of the research.

Data Availability Statement

No public data available

Ethics Statement

One of the author is a member of the editorial team of this journal. Appropriate measures were taken to ensure that the manuscript was handled in accordance with the journal's publication ethics and editorial procedures, and the author was not involved in the editorial decision making or peer-review process for this manuscript.

References

Aven, T. (2016). Risk assessment and risk management: Review of recent advances on their foundation. European Journal of Operational Research, 253(1), 1–13. https://doi.org/10.1016/j.ejor.2015.12.023

Belfast Harbour Commissioners. (2018). BHC towage risk assessment (Report No. 17UK1389, Issue 2). https://www.belfast-harbour.co.uk/wp-content/uploads/2022/03/BHC-Towage-Risk-Assessment-Ed1-2018.pdf

Cox, L. A., Jr. (2008). What's wrong with risk matrices? Risk Analysis, 28(2), 497–512. https://doi.org/10.1111/j.1539-6924.2008.01030.x

Department for Transport. (2025). Ports and marine facilities safety code. UK Government. https://www.gov.uk/government/publications/port-marine-safety-code

Department of Occupational Safety and Health Malaysia. (2024). Occupational Safety and Health Act 1994 (Act 514), as amended and in force from 1 June 2024. https://www.dosh.gov.my/wp-content/uploads/2025/03/Act-514-Reprint-Version-1.6.2024_English.pdf

Goerlandt, F., & Montewka, J. (2015). Maritime transportation risk analysis: Review and analysis in light of some foundational issues. Reliability Engineering & System Safety, 138, 115–134. https://doi.org/10.1016/j.ress.2015.01.025

Hetherington, C., Flin, R., & Mearns, K. (2006). Safety in shipping: The human element. Journal of Safety Research, 37(4), 401–411. https://doi.org/10.1016/j.jsr.2006.04.007

International Maritime Organization. (1993). Guidelines on the safety of towed ships and other floating objects including installations, structures and platforms at sea (Resolution A.765(18)). https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions

International Maritime Organization. (2018). Revised guidelines for Formal Safety Assessment (FSA) for use in the IMO rule-making process (MSC-MEPC.2/Circ.12/Rev.2). https://www.imo.org/en/ourwork/safety/pages/formalsafetyassessment.aspx

International Organization for Standardization. (2018a). Occupational health and safety management systems—Requirements with guidance for use (ISO Standard No. 45001:2018). https://www.iso.org/standard/45001

International Organization for Standardization. (2018b). Risk management—Guidelines (ISO Standard No. 31000:2018). https://www.iso.org/standard/31000

Kalinichenko, G., Torskyi, V., & Sagaydak, O. (2024). Rapid assessment of risks in tug operations within port areas. Technology Transfer: Fundamental Principles and Innovative Technical Solutions, 18–21. https://doi.org/10.21303/2585-6847.2024.003569

Kamis, A. S., Ahmad Fuad, A. F., Ashaari, A., & Yang, W. W. (2026). Directional sensitivity of wind current alignment in wheel over point geometry: development and validation of ATMM-W through percentage change. Journal of Marine Engineering & Technology, 25(5), 771–780. https://doi.org/10.1080/20464177.2026.2678623

Marine Accident Investigation Branch. (2024). Girting and capsize of tug Biter with the loss of two lives while assisting passenger vessel Hebridean Princess (Investigation Report 17/2024). https://www.gov.uk/maib-reports/girting-and-capsize-of-tug-biter-with-the-loss-of-two-lives-while-assisting-passenger-vessel-hebridean-princess

Marine Accident Investigation Branch. (2026). Safety warning issued following the capsize and sinking of tug Biter (Safety Bulletin 1/2026). https://www.gov.uk/maib-reports/safety-warning-video-issued-following-the-capsize-and-sinking-of-the-tug-biter-while-assisting-the-passenger-vessel-hebridean-princess-with-the-loss-of-two-lives

Maritime and Coastguard Agency. (2025). A guide to good practice on port and marine facilities. UK Government. https://www.gov.uk/government/publications/a-guide-to-good-practice-on-port-marine-operations

Penang Port Commission. (2026). Port notices and marine operation guidelines. https://penangport.gov.my/en/port-users/port-notices

Singh, A., & Raju, T. B. (2016). Hazards analysis of routine ship towage operations in Indian coastal waters. International Journal of e-Navigation and Maritime Economy, 4, 62–74. https://doi.org/10.1016/j.enavi.2016.06.006

Wang, J. (2002). Offshore safety case approach and formal safety assessment of ships. Journal of Safety Research, 33(1), 81–115. https://doi.org/10.1016/S0022-4375(02)00005-1

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