

Evaluation of Pilot Ladder Safety Systems Using a Checklist Approach: Case Study on MV Westerdam and MV Hao Qiang 57 at Tanjung Perak Port

Narko Narko, Slamet Imam Wahyudi, Juny Andry Sulisty

Master of Civil Engineering Program, Sultan Agung Islamic University, Semarang, INDONESIA

E-mail: narko4062@gmail.com, wahyudi@unissula.ac.id, juny.andry@unissula.ac.id

| Submitted: August 22, 2025 | Revised: October 18, 2025 | Accepted: January 22, 2026 |

| Published: March 04, 2026 |

ABSTRACT

Pilot ladder operations are a critical component of pilotage services and inherently involve high safety risks. Although international standards such as SOLAS and ISO 799-1 provide strict guidelines, accidents continue to occur due to technical limitations, human factors, and managerial deficiencies. This study assesses the pilot ladder safety systems on Cruise Ship MV Westerdam and Cargo Ship MV Hao Qiang 57 at Tanjung Perak Port. A descriptive qualitative approach was employed using a safety checklist, short interviews, and limited observations, focusing on six aspects: ladder condition, safety fittings, lighting, cleanliness, usage, and maintenance. The results show that MV Westerdam achieved full compliance (100%) with all safety standards, supported by complete maintenance records and regular crew training. In contrast, the MV Hao Qiang 57 demonstrated only 70% compliance, with key deficiencies in the availability of safety harnesses, updated crew training, and maintenance documentation. These findings indicate that pilot ladder safety cannot be ensured solely through the physical conditions of the ladder but requires an integrated approach encompassing technical, human, and managerial dimensions. MV Westerdam illustrates best practices in implementing safety systems, while MV Hao Qiang 57 highlights critical areas for improvement. Overall, this study provides both theoretical contributions to maritime safety literature and practical recommendations for enhancing safety systems in Indonesian ports.

Keywords: pilot ladder, maritime safety, occupational safety, Tanjung Perak.

INTRODUCTION

Operational safety in ports is a crucial aspect, especially in pilotage activities that involve the transfer of pilots from one ship to another or from ship to shore. One of the main equipment used in this transfer process is the pilot ladder. Although this tool seems simple, its use carries a high risk, especially when carried out in bad weather conditions, high waves, or on ships with large freeboards. Global data shows that accidents involving pilot ladders still occur frequently, mostly due to lack of compliance with safety procedures, inadequate equipment conditions, or human factors such as fatigue, poor communication, or lack of appropriate training [1], [2], [3].

Accidents have confirmed that pilot ladders are a critical component of port operations. For example, in 2016, a fatal accident occurred on the River Thames in England, killing a pilot after he became trapped between a cargo ship and a transfer vessel. An official investigation revealed that the accident was related to a failure to implement safety systems during the transfer process using a pilot ladder [4]. Similar cases have been reported in various countries, making the issue of pilot ladder safety a global one [5].

In the Indonesian context, PT Pelabuhan Indonesia (Persero) Regional III Tanjung Perak Unit is one of the largest ports with a high intensity of ship pilotage services. As a major hub for domestic and international trade, Tanjung Perak experiences heavy ship traffic, so the risk of accidents in pilotage operations needs to be properly managed. Failure to ensure the safety of pilot ladder use can have serious consequences, such as injury or loss of life, delays in vessel operations, financial losses, and damage to the port's reputation. Therefore, evaluating the pilot ladder safety system at Tanjung Perak is a strategic step to ensure the continuity of safe and efficient operations.



Figure 1. (a) Pilot boarding the ship using a pilot ladder; (b) Pilot ladder with handrails firmly attached to the main deck and hull of the ship

International regulations actually provide strict guidelines regarding the standard use of pilot ladders. The SOLAS (Safety of Life at Sea) Convention through Chapter V Regulation 23, as well as IMO Resolution A.1045(27) and ISO 799-1, specifically regulate the technical specifications, installation methods, and procedures for the safe use of pilot ladders [6]. In addition, the International Safety Management (ISM) Code also emphasizes the importance of implementing a safety management system on board ships, including in the use of critical equipment such as pilot ladders. In Indonesia, related regulations are also stipulated in Law No. 17 of 2008 concerning Shipping, Government Regulation No. 31 of 2021 concerning the Implementation of the Shipping Sector, and Minister of Transportation Regulation No. 57 of 2015 concerning Ship Pilotage and Towing. However, the implementation of these regulations in the field still faces various challenges, both from a technical and human perspective [7].

In addition to technical factors, environmental aspects also influence the level of risk. Extreme weather conditions such as strong winds, heavy rain, and strong currents can increase the potential danger during transfers using a pilot ladder. Pilot fatigue due to long working hours, time pressure to speed up the docking or sailing process, and ineffective communication between the crew and the pilot also contribute to worsening the situation [1], [2]. Recent studies have revealed that more than 60% of accidents involving pilot ladders are caused by a combination of technical, environmental, and human factors, so a holistic approach is needed in managing safety [2].

This study focuses on evaluating the safety system for pilot ladder use through the development and implementation of a safety checklist. The checklist covers six key aspects: the physical condition of the ladder, safety system, lighting, cleanliness, usage procedures, and maintenance. This instrument is designed as a simple yet systematic tool to assess compliance with international and national safety standards. Through case studies of the cruise ship MV Westerdam and the cargo ship MV Hao Qiang 57, this study aims to provide a realistic picture of the actual conditions in the field while identifying gaps that need to be addressed.

Based on this background, several key issues can be identified. First, what is the actual situation with pilot ladder use on ships at Tanjung Perak Port? Second, what safety system is implemented in pilot ladder use, and to what extent does it comply with international standards? These questions are crucial for addressing the fundamental issue of the effectiveness of safety regulations and procedures in the field.

This research is motivated by the importance of occupational safety aspects in the use of pilot ladders in ship pilotage activities at ports, which is one of the critical points in the personnel transfer process. The formulation of the problem raised includes two main things, namely how the safety system for using pilot ladders on MV Westerdam and MV Hao Qiang 57 at Tanjung Perak Port is implemented, and whether the existing Occupational Safety and Health (K3) system is adequate to reduce the risk of accidents or whether there are still aspects that need to be improved. This is in line with the view [8] which emphasizes that K3 is a crucial component in maintaining personnel safety in high-risk work environments such as ports. Other studies also add that preventing accidents during embarkation and disembarkation requires more specific technical steps, for example through ladder design and work area layout [9].

The purpose of this study is to identify the adequacy of safety procedures and standards applied to the use of pilot ladders, evaluate the effectiveness of the implementation of the K3 system in minimizing the risk of accidents, and develop recommendations for improvements based on field findings that can improve the work safety system at the port. Theoretically, this study is expected to enrich the academic literature on maritime work safety, especially regarding the use of pilot ladders as a vital tool in the ship pilotage process. From a practical perspective, the results of the study can be utilized by the management of PT Pelindo III Tanjung Perak as a basis for strengthening the safety system and K3 procedures, as well as being a pilot model for other ports in Indonesia in improving operational safety [10].

The limitations of this research include the scope focused on two study objects, namely MV Westerdam and MV Hao Qiang 57 at Tanjung Perak Port, the study period is limited to the last year's data to ensure relevance, and the use of qualitative descriptive methods through safety checklist instruments, short interviews, and limited field observations. With these limitations, the results of the study are exploratory and interpretative, but still provide an in-depth overview of the safety issues of pilot ladder use as well as practical contributions to improving safety standards at ports.

RESEARCH METHODS

Types of research

This research uses a qualitative descriptive approach with a case study method. This approach was chosen because the research aims to conduct an in-depth evaluation of the safety system for using pilot ladders with a focus on MV Westerdam and MV Hao Qiang 57 at Tanjung Perak Port. The qualitative descriptive method allows researchers to describe the phenomena that occur factually, in detail, and contextually based on the results of observations, interviews, and document analysis [11], [12]. The validity of the research is strengthened through triangulation of sources and methods, as well as the application of the principle of trustworthiness in qualitative research [13], [14].

Research Location and Subjects

The research was conducted at PT. Pelabuhan Indonesia (Persero) Regional III Unit Tanjung Perak, Surabaya, one of Indonesia's major ports with high ship traffic volume. The research subjects focused on the MV Westerdam and MV Hao Qiang 57, which served as case studies for the use of pilot ladders in pilotage operations. Vessel selection was conducted purposively, based on data availability and suitability to the research objectives.

Data and Data Sources

The data used in this study consists of:

1. Primary Data
 - Direct observation of pilot ladder conditions using safety checklist instruments.
 - Short interviews with key personnel, namely pilots, ship's crew (bosun/deck crew), and port safety management representatives.
2. Secondary Data
 - International regulatory documents: SOLAS Chapter V Regulation 23, IMO Resolution A.1045(27), ISO 799-1, and ISM Code.

- National regulatory documents: Law No. 17 of 2008 concerning Shipping, PP No. 31 of 2021, and Permenhub No. 57 of 2015.
- Relevant maritime accident incident reports [4], [5].

Research Instruments

The primary research instrument is the Pilot Ladder Safety Checklist, developed based on international and national regulations. This checklist covers six key aspects:

1. Stair Condition → physical integrity of stairs, strength of handrail.
2. Safety → availability of anti-slip safety and safety rope/harness.
3. Lighting → adequate lighting in the area where the pilot ladder is used.
4. Cleanliness → condition free from oil, dirt, or moss.
5. Use → compliance with standard transfer procedures, including crew training.
6. Maintenance → regular checks and availability of maintenance records.

Each item on the checklist is given space for assessment on a simple scale: √ (fulfills) or X (does not fulfill), as well as a remarks column for providing additional notes.

Data collection technique

1. Observation → is carried out by filling in the checklist directly when the pilot ladder is used.
2. Interview → semi-structured with questions about experience using pilot ladders, technical constraints, and K3 implementation.
3. Documentation → in the form of photos, maintenance reports, and records of ship safety procedures.

Data Analysis Techniques

Data analysis was carried out in three stages:

1. Data Reduction → selecting relevant information from the results of observations, interviews, and documentation.
2. Data Presentation → compile the checklist results in a table to display the level of compliance for each item.
3. Drawing Conclusions → comparing actual conditions with international and national regulatory standards, then identifying weaknesses and providing recommendations for improvement.

Data Validity

To ensure data validity, this study used source and method triangulation techniques. Source triangulation was conducted by comparing observational data with interviews with various respondents. Method triangulation was conducted by combining direct observation, interviews, and document analysis [13].

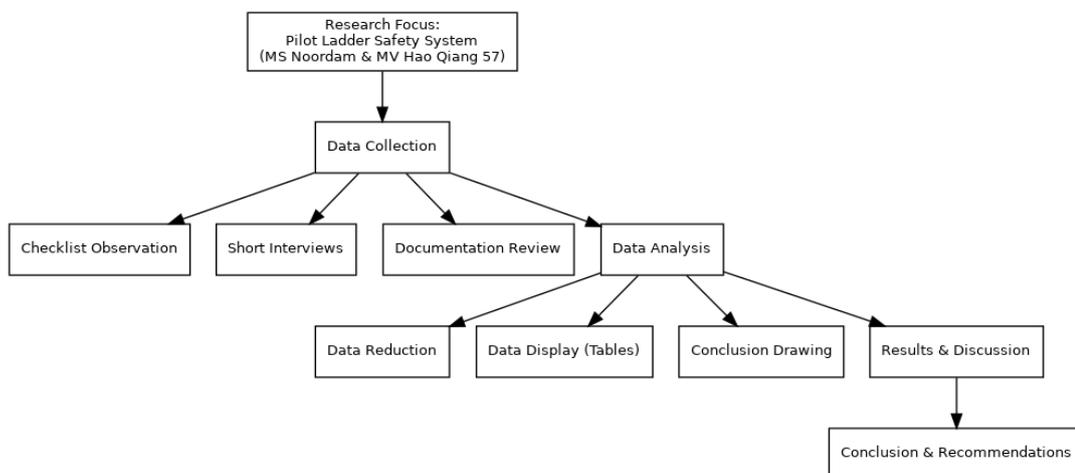


Figure 1. Flow chart

RESULTS AND DISCUSSION

Pilot Ladder Safety Checklist Observation Results

Based on the results of observations of MV Westerdam and MV Hao Qiang 57 at Tanjung Perak Port, the findings were obtained as shown in Table 1 and Table 2 below:

Table 1. MV Westerdam pilot ladder safety checklist results

No	Aspect	Inspection Items	Reference Standard	Result (√/X)	Information
1	Stair Condition	The stairs are in good condition, not damaged.	SOLAS V/23, ISO 799-1	√	Stairs intact, well maintained materials
		The stair handrail is strong and stable	SOLAS V/23	√	No leeway found
2	Security	There is an anti-slip safety	IMO A.1045(27)	√	<i>Spreaders</i> according to available standards
		Safety harness available	ISM Code	√	Harness available on deck
3	Lighting	The area is well lit, especially at night.	SOLAS V/23.6	√	Optimal dock area lighting
4	Cleanliness	Stairs clean from oil/moss	SMS/K3	√	Clean and dry surface
5	Use	Used according to procedure (≤ 9 m)	SOLAS V/23.3	√	Freeboard according to the rules
		Trained crew & pilots	ISM Code/K3	√	Regular training is conducted
6	Maintenance	Stairs are inspected regularly	ISO 799-1	√	Monthly checklist available
		Maintenance notes available	ISM Code	√	Complete documentation

MS Noordam: All 10 items meet the standards (100%).

Meanwhile, the checklist results for MV Hao Qiang 57 can be seen in Table 2 below:

Table 2. MV Hao Qiang 57 ladder pilot safety checklist results

No	Aspect	Inspection Items	Reference Standard	Result (√/X)	Information
1	Stair Condition	The stairs are in good condition, not damaged.	SOLAS V/23, ISO 799-1	√	The stairs are still passable
		The stair handrail is strong and stable	SOLAS V/23	√	No leeway found
2	Security	There is an anti-slip safety	IMO A.1045(27)	√	Spreaders available
		Safety harness available	ISM Code	X	Harness not available
3	Lighting	The area is well lit, especially at night.	SOLAS V/23.6	√	Spotlights are present, distribution is lacking
4	Cleanliness	Stairs clean from oil/moss	SMS/K3	√	No contaminants
5	Use	Used according to procedure (≤ 9 m)	SOLAS V/23.3	√	Freeboard according to the rules
		Trained crew & pilots	ISM Code/K3	X	Last training >2 years ago
6	Maintenance	Stairs are inspected regularly	ISO 799-1	√	There is a monthly checklist

No	Aspect	Inspection Items	Reference Standard	Result (√/X)	Information
		Maintenance notes available	ISM Code	X	Incomplete documentation

MV Hao Qiang 57: 7 items meet the standard (√), 3 items do not meet (X), compliance rate 70%.

From the two tables above, it is clear that MV Westerdam has a much higher level of compliance than MV Hao Qiang 57, especially in the aspects of additional security, crew training, and maintenance documentation.

Visual Observation: Field Documentation

In addition to the checklist results, this research is also supported by visual observations through photo documentation at the Tanjung Perak Port pier, Surabaya.

Figure 3 shows the MS Noordam's guide ladder when docked at the pier during the day. From the photo, it can be seen that the guide ladder access is equipped with a safe path, guardrails, and a red carpet that functions as a protocol path and emphasizes the boundaries of the safe area. This indicates the implementation of good safety standards, especially for passengers or important guests, although the main function is still intended for the guide officers. The orderly layout, flat surface in the dock area, and the presence of supervisory personnel around the ladder are supporting factors in creating a safe and controlled work environment. This observation is in line with the Safe Access to Ships principle in SOLAS V/23 regulation which emphasizes the importance of safe access to and from the ship [15], [9].

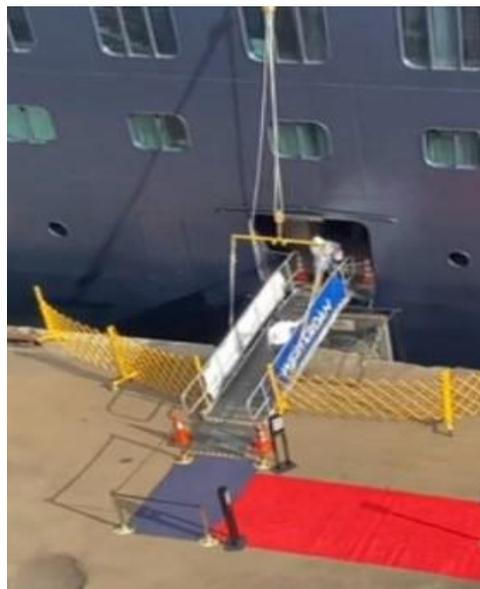


Figure 3. The MV Westerdam guide ladder while at the tanjung perak port pier in Surabaya

Figure 4 shows the MV Hao Qiang 57's gangplank at night, with additional lighting installed to ensure visibility. The photo shows the crew using the gangplank on the side of the ship, with a spotlight directed directly at the access area. Although lighting is available, it appears to be focused on the gangplank area only, while the surrounding area is relatively dark. This situation has the potential to be a safety weakness, as the deck area and the path around the gangplank should also be adequately lit to prevent potential accidents, especially during adverse weather conditions. This fact is in line with the findings in the checklist which states that lighting is one of the crucial aspects that needs to be improved, not only in terms of quantity (number of lights) but also light distribution.



Figure 4. The MV Hao Qiang 57 guide ladder at the Tanjung Perak harbor dock in Surabaya at night with lighting.

From the comparison of the two photos, it can be concluded that there are differences in the level of safety standards between MV Westerdam and MV Hao Qiang 57. MV Westerdam tends to pay more attention to visual aspects, comfort, and protocol procedures, while MV Hao Qiang 57 focuses more on functional aspects. However, in the context of pilotage safety, the implementation of K3 standards must be uniform, both for MV Hao Qiang 57 and passenger ships, because the risks faced remain the same.

Thus, this visual documentation reinforces the checklist findings which emphasize that lighting, supervision and safe path design are important factors in ensuring the safety of using lifeguard ladders in ports.

Results Analysis

The results of the checklist evaluation showed a difference in the level of compliance between MV Westerdam and MV Hao Qiang 57 in implementing the safety system using the pilot ladder.

On the MS Noordam, all technical and administrative aspects are met according to international standards (100% compliance). Stairs are in good condition, access areas are adequately lit, cleanliness is maintained, usage procedures comply with SOLAS requirements, crew training is conducted regularly, and maintenance documentation is complete. This demonstrates a strong safety culture and a high level of attention to both operational and managerial aspects.

In contrast, the MV Hao Qiang 57 showed a compliance rate of only 70%, with three items unmet. It had several significant weaknesses, including:

1. Lack of safety rope/harness → even though it is vital equipment to reduce the risk of falling, especially during bad weather conditions or high waves.
2. Out-of-date crew training → the last training was conducted more than two years ago, so not all personnel are prepared to face emergency conditions.
3. Incomplete maintenance records → although routine inspections are carried out, documentation is not well documented, making the safety audit process based on the ISM Code difficult.

Thus, although both vessels showed compliance in technical aspects such as the physical condition of the stairs, lighting, cleanliness, and usage procedures, striking differences were seen in the aspects of additional security, human resource competency, and safety management systems.

Discussion

The findings of this study are in line with global reports which state that most pilot ladder accidents are not only caused by physical damage to the ladder, but also by weak implementation of safety procedures and human factors [2], [3], [4].

1. Technical factors
 - On MS Noordam, the physical condition of the stairs and supporting facilities fully complies with the provisions of SOLAS V/23 and ISO 799-1.
 - On MV Hao Qiang 57, the physical condition of the stairs is relatively good, but deficiencies appear in supporting aspects such as limited lighting in the area around the stairs, even though spotlights are functioning at key points.
 - This finding differs from some reported incidents [5], where ladder damage was the main cause of the accident.
2. Human factors
 - MV Westerdam has a regular training system, so the readiness of the crew and pilots is more guaranteed.
 - MV Hao Qiang 57 has not had any training updates for >2 years, so the crew's competence has the potential to decline.
 - Research [8] emphasizes that repeated training and refresher training of safety materials is crucial in high-risk jobs such as using pilot ladders.
3. Management factors
 - At MS Noordam, maintenance documentation is complete and systematic, supporting consistent implementation of the ISM Code.
 - In contrast, the MV Hao Qiang 57 had incomplete documentation, indicating weaknesses in the safety management system.
 - Documentation provides formal evidence that maintenance has been performed. If these records are neglected, safety audits will be ineffective, potentially compromising regulatory compliance.

From these results, it can be emphasized that pilot ladder safety evaluation should not only focus on the physical condition of the ladder. Human resources (training) and managerial aspects (documentation & maintenance records) play a crucial role in ensuring that safety standards can be implemented comprehensively. The differences between the MV Westerdam and MV Hao Qiang 57 demonstrate that the successful implementation of a safety system is highly dependent on the integration of technical, human, and management factors.

CONCLUSION

The results of research on the evaluation of the safety system for using pilot ladders on MV Westerdam and MV Hao Qiang 57 at Tanjung Perak Port show significant differences in the level of compliance with international standards. 1) MV Westerdam demonstrates 100% compliance with all safety aspects. This is demonstrated by its ladders in good condition, adequate lighting, cleanliness, regular crew training, and complete maintenance documentation. This ship represents best practice in the implementation of pilot ladder safety systems, 2) The MV Hao Qiang 57 achieved only a 70% compliance rate, with weaknesses in three key areas: the lack of safety harnesses, the lack of updated crew training, and incomplete maintenance records. While the physical condition of the ladder and main lighting was satisfactory, weaknesses in additional safety measures, human resource competency, and documentation management could have increased the risk of accidents. In general, this study confirms that pilot ladder safety evaluation is not sufficient by only ensuring the physical condition of the ladder, but must include the integration of technical factors, human factors, and managerial factors. Recommendations that can be submitted include: a) additional safety enhancements by providing safety harnesses on all vessels, b) regular training programs for crew and pilots to ensure current competencies, as well as, c) strengthening the safety management system through more systematic and documented maintenance recording. By implementing these steps, it is hoped that the risk of accidents due to the use of pilot ladders can be minimized, so that work

safety at the port can be maintained while improving the reputation of Tanjung Perak Port at the national and international levels.

ACKNOWLEDGEMENT

The author sincerely thanks the Master of Civil Engineering Program, Sultan Agung Islamic University, for the academic guidance and facilities provided. Gratitude is also addressed to colleagues, experts, and researchers whose valuable inputs enriched this study. Appreciation is extended to all who contributed, directly or indirectly, to the completion of this article.

REFERENCES

- [1] Brown, R. (1993). Human factors in ship operations. *Journal of Navigation*, 46(1), 98–110.
- [2] Shekari, T. (2020). Risk assessment of pilot ladder operations: A holistic approach. *Safety Science*, 129, 104798.
- [3] Darbra, R. M., Crawford, J. F. E., Haley, C. W., & Morrison, R. J. (2007). Safety culture and hazard risk perception of maritime professionals. *Safety Science*, 45(1), 29–46.
- [4] Marine Accident Investigation Branch (MAIB). (2017). Report on the investigation of the fatal accident to a pilot boarding Sunmi on the River Thames. UK Department for Transport.
- [5] Australian Transport Safety Bureau (ATSB). (2023). Marine safety investigations and reports. ATSB.
- [6] Britannia P&I Club. (2023). Pilot ladders: Compliance and safety requirements. Britannia Publications.
- [7] PT Inampa. (2024). *Kajian sistem keselamatan pelabuhan di Indonesia*. Jakarta: Indonesian Maritime Pilots Association.
- [8] Seguí, X., Llinàs, J., & Ponsa, P. (2016). Occupational risk prevention in maritime pilots: A case study. *Safety Science*, 89, 1–10.
- [9] Lee, S., Park, H., & Kim, J. (2017). Design considerations for safe access to ships: Case studies on pilot ladder arrangements. *Ocean Engineering*, 137, 205–214.
- [10] Tangga Pandu Tak Laik. (2021). Laporan investigasi kecelakaan tangga pandu. Surabaya: Kementerian Perhubungan RI.
- [11] Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). Thousand Oaks, CA: Sage.
- [12] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.
- [13] Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.
- [14] Shenton, A. K. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information*, 22(2), 63–75.
- [15] International Maritime Organization (IMO). (2012). *SOLAS Consolidated Edition 2012*. London: IMO Publishing.