

Identification of Dominant Factors Causing Barge and Tug Shipping Accidents by Analyzing Secondary Data on Accidents on the Mahakam River and Palembang

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ABSTRACT

Barge and tugboat shipping accidents in the Mahakam River and Palembang continue to occur from year to year, causing material losses, fatalities, and disruptions to transportation and economic activities. This problem indicates the existence of dominant factors that need to be thoroughly identified, whether from the aspects of ship technical conditions, human negligence, environmental conditions, or weaknesses in regulation and supervision. This study aims to identify the dominant factors causing accidents through secondary data analysis, which can serve as the basis for recommendations to improve maritime safety. This research employs a descriptive qualitative method with documentation techniques to collect secondary data related to barge and tugboat accidents. Data analysis was carried out using the Miles and Huberman model through three stages: data reduction, data presentation, and conclusion drawing with verification. The results of the study indicate that accidents are influenced by three main groups of factors, namely human factors (operator negligence, lack of training, and low safety awareness), technical factors (unseaworthy vessels, engine damage, infrastructure limitations), and natural factors (extreme weather, strong currents, inadequate water depth). The implications of this research underscore the need for integrated measures, including enhancing crew competence, improving shipping infrastructure, implementing early warning systems, and strengthening regulations and oversight. The implementation of these recommendations is expected to reduce accident rates and support the sustainability of river transportation in both regions.

KEYWORDS *Dominant Factors, Shipping Accidents, Mahakam River, Barge, Tugboat*



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INTRODUCTION

Shipping is an activity with a very high level of mobility, as ships serve both as a means of transportation and as a workplace, connecting various regions, both between islands within the country and across countries. Seafarers, as maritime workers, come from diverse regions and have duties that require them to travel internationally and domestically. This high level of mobility makes seafarers vulnerable to occupational safety and health (OHS) risks, especially if regulatory

protection does not fully support their needs (Erwin, 2022). Since its inception, the International Maritime Organization (IMO) has been committed to reducing the number of ship accidents by establishing minimum safety standards for ships and their crews. Although technical malfunctions or mechanical failures are now rarely the primary cause of incidents, accidents still frequently occur due to human factors, which continue to be a major challenge in maintaining global maritime safety (Wahyuni et al., 2021).

Ship accidents at sea not only result in loss of life but also have serious consequences for the marine environment, coastal communities, and maritime ecosystems. One of the main causes of passenger ship accidents is a lack of awareness among crew members regarding the understanding and application of maritime safety principles. Poor adherence to safety procedures, negligence in carrying out duties, and inadequate training are factors that increase the risk of accidents. Therefore, improving crew competence and awareness is crucial to reducing the number of accidents at sea (Malik et al., 2025).

The Directorate General of Sea Transportation (*Dirjen Hubla*) reports that the number of shipping accidents shows an increasing trend year by year, with 87 accidents recorded in 2020, rising to 100 accidents in 2021, and again increasing to 108 accidents in 2022. These data reflect the need for increased supervision, safety standards, and awareness among all related parties in implementing stricter shipping regulations to reduce the number of accidents at sea (Kementerian Perhubungan Republik Indonesia, 2023).

Each shipping lane has established rules and regulations with the primary goal of minimizing the potential for ship accidents. This is crucial because shipping lanes are densely trafficked, carry a high risk of collisions, and are often located near shallow waters prone to grounding (Andries et al., 2024). Grounding is divided into two types: *beaching* and *stranding*. *Beaching* is when a ship is intentionally grounded on the seabed as a rescue effort to prevent sinking, while *stranding* is when a ship runs aground due to an accident, either caused by external factors such as currents and waves or internal factors such as negligence of the ship's crew on duty and limited navigation equipment (Cook et al., 2021).

In Indonesia, provisions regarding occupational safety and health are clearly regulated through Law No. 1 of 1970 concerning Occupational Safety and reinforced by Ministerial Regulation No. PER-05/MEN/1996 concerning the Occupational Safety and Health Management System (Pambayun et al., 2024). These regulations are designed as preventative measures to prevent and anticipate potential workplace accidents that could harm workers, companies, and the work environment. They are expected to create a safer, healthier work culture that meets labor protection standards.

The recurring barge and tugboat accidents on the Mahakam and Palembang Rivers, with significant impacts on safety, the economy, and the environment, highlight the need for a deeper understanding of their root causes. Various factors, such as human error, vessel technical conditions, adverse weather, and heavy shipping traffic, pose complex challenges to maintaining safety on these river routes. These conditions have prompted research aimed at identifying the dominant factors causing accidents, allowing strategic steps to be formulated to prevent them and improve shipping safety standards.

Previous research conducted by Yahya and Amalia (2022) explained that shipwrecks are generally caused by loading factors, the ship's technical condition, and crew errors. Fifty-six percent of cases were triggered by errors in the loading process, 49% due to technical problems on the ship, and 34% due to crew negligence or error. This indicates that operational management and ship maintenance play a crucial role in preventing shipwrecks. Meanwhile, in ship collisions, bad weather was the primary cause, accounting for 86% of cases, confirming that environmental conditions also significantly impact shipping safety.

Previous studies have shown that ship sinking accidents are generally caused by loading errors (56%), technical problems with the ship (49%), and crew negligence (34%), while ship collisions are more often triggered by bad weather (86%) (Yahya & Amalia, 2022). The incident involving the BG. RMN 3316 barge at the Batang Power Plant occurred due to a lack of communication between the crew and the jetty, as well as natural factors such as strong currents, high waves, and strong winds; this was followed up with an investigation, crew training, and improved coordination (Putra et al., 2024). The grounding of MV. *Belik Mas* in the Kapuas River was caused by human error and bad weather, with handling conducted through standard safety procedures until the ship was successfully released (Savero et al., 2025).

The novelty of this research lies in its focus on identifying the dominant factors causing barge and tug accidents by utilizing in-depth secondary data analysis in two strategic locations, namely the Mahakam River and Palembang, which have high vessel traffic intensity but also significant accident rates. This approach provides added value because there are not many previous studies that specifically compare the two areas using qualitative descriptive methods. The purpose of *this* study is to identify the main factors contributing to the occurrence of accidents, both from technical, human, environmental, and regulatory aspects, so that it can provide relevant recommendations for improving shipping safety and strengthening policies in the sea and river transportation sector.

Despite the critical role of barge and tugboat operations in Indonesia's riverine logistics, particularly on vital waterways like the Mahakam and Musi Rivers, accidents continue to recur with significant material, environmental, and human

costs. Previous studies, such as those by Yahya and Amalia (2022), have identified general causes of maritime accidents, including loading errors, technical failures, and crew negligence. However, a distinct research gap exists in the form of a focused, comparative analysis that utilizes in-depth secondary data to pinpoint the dominant, interconnected factors specifically responsible for accidents in these two high-traffic, high-risk strategic locations. This study seeks to address this gap by moving beyond generalized causes to provide a nuanced understanding of the precise accident etiology in these unique riverine environments.

The urgency of this investigation is underscored by alarming accident trends reported by the Directorate General of Sea Transportation, which show a consistent annual increase in shipping incidents nationally. The recurring nature of accidents on these specific rivers highlights a persistent threat to local communities, the environment, and regional economic stability, disrupting crucial supply chains for commodities like coal and timber. This persistent problem signals an urgent need for evidence-based interventions that can only be formulated through a clear identification of the root causes, making this research not merely an academic exercise but a necessary step toward enhancing maritime safety and operational reliability.

The primary objective of this research is to identify the dominant factors causing barge and tugboat accidents on the Mahakam River and in Palembang through a meticulous analysis of secondary data from official reports and company records. By employing a qualitative descriptive method and the Miles and Huberman analysis model, this study aims to dissect the complex interplay of human error, technical deficiencies, and challenging natural conditions. The significant benefit of this work lies in its potential to inform strategic policies and practical recommendations for stakeholders, including government agencies and shipping operators, ultimately contributing to a reduction in accident rates, the protection of the environment, and the sustainability of river transportation systems.

RESEARCH METHOD

This study uses a qualitative descriptive method with the aim of providing an in-depth overview of the dominant factors causing barge and tug accidents. Data were obtained using documentation techniques, namely by collecting secondary data from official government agency reports, shipping company records, and other relevant documents. Through this approach, the study focuses on describing phenomena based on existing data, without manipulation or experimentation, thereby obtaining factual information consistent with conditions in the field.

The data analysis process was conducted using the Miles and Huberman analysis model, which consists of three main stages. First, data reduction, which involves selecting and simplifying data relevant to the research focus. Second, data

presentation, which involves organizing the findings in narrative form, tables, or charts for easier understanding. Third, conclusion drawing and verification, which entails analyzing the relationships between data to find patterns and ensure the validity of the results. With these steps, the study was able to identify the dominant factors contributing to barge and tug accidents on the Mahakam River and *Palembang*.

RESULT AND DISCUSSION

Barge and tugboat operations play a crucial role in water transportation on rivers, ports, and open seas. Barges have flat hulls with a block coefficient (C_b) close to 1, making them efficient for transporting large cargo loads; however, they lack propulsion systems, electrical systems, or piping, so they rely on tugboats; their designs vary according to need, such as for transporting coal, mining products, or construction materials (Riyanto et al., 2024; Pawara et al., 2021). Tugboats are designed to assist large ships in maneuvering when docking or anchoring, have large engine power of 500–2,000 kW (up to 20,000 kW in open seas with two main engines), strong construction, and are equipped with special equipment such as towing hooks and stabilizer guiding rings; their maneuverability is influenced by the propulsion system, where conventional types use rear propellers for efficient towing between ports (Wu et al., 2021; Choi et al., 2023).

The operation of barges and tugs carries the risk of accidents caused by technical factors, weather conditions, and human error (Abdussamie et al., 2018; Tseng et al., 2021). Research on the dominant factors causing accidents on the Mahakam and Musi rivers is important to identify the root causes and their impact on the surrounding communities. The Mahakam River in East Kalimantan, which stretches from West Kutai to Kutai Kartanegara via Samarinda, and the Musi River in Palembang, South Sumatra, with a length of approximately 450 km, are both vital transportation routes with heavy ship traffic, making them relevant for studies on the causes of barge and tugboat accidents.

Secondary data analysis shows that shipping accidents on the Mahakam and Musi Rivers occur due to a combination of factors, one of which is human error, which plays an important role. Human error includes negligence, operational errors, lack of crew training, and fatigue, which affects decision-making abilities during navigation. As evidence, an incident in Palembang, South Sumatra, involved a coal-laden barge colliding with two residential houses. According to the police report, the accident occurred due to the negligence of the tugboat captain escorting the barge. At the time of the incident, the water level of the Musi River was high, and the current was flowing from west to east. The barge, which was already loaded with coal, should have waited until the tide receded before sailing, but the captain decided to continue the journey. Harryo explained that the captain's inability to

control the barge's movements indicated that his competence and mastery of ship maneuvering skills were inadequate, leading to the loss of control and the collision with the residents' houses (Adliyah, 2025).

In addition to negligence and technical errors, a lack of safety awareness is also a major cause of shipping accidents. Several incidents occurred because the captain and crew did not fully understand the applicable safety procedures or the shipping regulations that must be followed (Gumelar et al., 2021). This lack of knowledge and understanding, when combined with the physical and mental fatigue of the crew, significantly increases the risk of accidents (Raising et al., 2025). Therefore, human factors, including technical proficiency, physical and mental readiness, and compliance with safety procedures, are key elements determining the safety of barge and tugboat operations in both regions. Awareness of the importance of continuous training and discipline in applying safety rules is essential to reduce the risk of accidents in the future.

Technical factors are also one of the main causes of shipping accidents on the Mahakam and Musi Rivers, particularly those related to vessel conditions and infrastructure limitations. Inadequate vessel conditions often pose serious risks during operations. Some vessels experience technical failures, such as engine or navigation system malfunctions, which can potentially disrupt control and safety during navigation. In addition, the high number of vessel accidents, particularly involving barges, is often linked to leaks in vessel tank openings. The consequences of such leaks are severe, as vessel cargo, such as coal, can spill into the water and contaminate the environment. For example, in 2019, a barge leak occurred on the Mahakam River in Samarinda, resulting in coal spills and river contamination, causing ecological and operational losses (Sava, 2024).

In addition to the ship itself, limited shipping infrastructure also contributes to accidents. Inadequate port facilities, limited navigation, and infrastructure that rarely receives regular maintenance can increase the risk of accidents, especially in busy shipping lanes. For example, on April 28, 2025, a coal-carrying barge collided with a support pillar of the Mahakam Bridge. This incident serves as an important reminder of the need to maintain the safety of strategic infrastructure amid high logistics traffic. According to maritime observer from the IKAL Strategic Center, Dr. Capt. Marcellus Hakeng Jayawibawa, S.SiT., M.Mar, the incident not only highlighted technical construction issues but also underscored governance challenges, the balance between safety and economic considerations, and the effectiveness of cross-sectoral regulations (Jayawibawa, 2025).

The Mahakam Bridge is not merely a link between land areas in East Kalimantan, but also lies directly on a vital shipping route for the national coal and logistics sectors. Hakeng emphasized that this accident should not be viewed as an isolated incident to be resolved on a case-by-case basis, but rather as a reflection of

the weakness of the national strategic infrastructure management system, which involves more than one authority. Therefore, technical factors, whether stemming from the condition of the vessel or infrastructure limitations, have a significant impact on shipping safety. Inadequate management, insufficient routine maintenance, and weak coordination among relevant parties increase the likelihood of accidents and result in material and environmental losses.

Furthermore, natural factors are also a significant cause of shipping accidents, especially when extreme weather conditions interfere with smooth navigation and ship control. For example, the incident on the Mahakam River occurred when TB.MHKL 205 was pulling the empty barge BG.MARINE POWER 3036 towards Muara Pahu. While waiting for the sorting process at the Mahakam Bridge, the weather suddenly deteriorated with winds of 20–25 knots and heavy rain, forcing operations to be halted. The strong winds pushed the barge onto land, causing the towing rope to break. Although TB.Herlin was immediately dispatched to assist, the strong ebb tide and limited visibility caused the barge to collide with a café building in Samarinda Seberang (Kementerian Perhubungan Republik Indonesia, 2025a).

This incident demonstrates that natural factors, particularly extreme weather, can be a major trigger for accidents that are difficult to fully anticipate, even when the vessel and crew are in good condition. Sudden changes in weather require high alertness from the captain and crew, as well as rapid coordination with the pilotage service and other support vessels. This incident underscores the importance of weather monitoring systems, effective communication, and emergency preparedness to reduce the risk of accidents caused by natural factors on strategic shipping routes such as the Mahakam River.

In addition to extreme weather, currents and water depth are significant natural factors affecting navigation safety on the Mahakam and Musi Rivers. On the Mahakam River, the rapids area is known as a challenging region for river transportation. Strong currents, unpredictable flows, and difficult terrain often serve as the primary causes of accidents. These conditions require intensive monitoring at high-risk points, as any navigational error can have fatal consequences for the vessel and its cargo (Khoiriyah, 2025). Meanwhile, on the Musi River, the water depth varies between 4.5 meters and 25 meters. Some areas, particularly those with a depth of less than 6 meters LWS due to sedimentation, are designated as hazardous navigation areas. This limited depth increases the risk of vessels experiencing maneuvering difficulties or getting stuck on the riverbed, especially for barges carrying heavy cargo.

Several incidents have highlighted the risks posed by strong currents and varying depths. On Sunday, February 16, at 4:00 p.m. WITA, the TB. MTS 28 tugboat towing the BG. Indo Sukses 28 barge collided with the safety vendor pillar

of the Mahakam Bridge. The vessel, operated by PT. Segara Mitra Abadi, was carrying a cargo of sengon wood and was en route from Tanjung Perak to Perawang. After waiting in the bridge clearance queue since 2:00 PM WITA, the vessel finally crossed the bridge at 4:00 PM WITA. However, the barge drifted to the left due to the strong current. TB. Herlin 19 attempted to assist in towing the barge with the help of TB. MTS 28, but the strong current caused the barge to continue moving to the left until it collided with the safety pillar of the bridge (Kementerian Perhubungan Republik Indonesia, 2025b).

Another similar incident occurred on Tuesday, March 12, at around 4:00 p.m. local time in the waters of Keramasan, Musi River, Palembang. The tugboat TB Johan Jaya 171 was pulling the barge Kapuas Jaya 3023 loaded with coal when the accident occurred. As the vessel was maneuvering to change course and move from the Keramasan waters to the waters near Pulau Salah Nama, strong outgoing currents caused the vessel to lose control, resulting in it colliding with a floating house belonging to local residents along the riverbank. This incident highlights how the strength of currents and varying water depths directly impact a vessel's ability to maneuver and maintain its course, thereby increasing the risk of accidents (Kementerian Perhubungan Republik Indonesia, 2025c).

The impact of shipping accidents on the Mahakam and Musi Rivers is far-reaching, affecting not only those directly involved, but also the surrounding communities and the environment. Material losses are often the most visible, ranging from damage to ships and barges, loss of cargo, to damage to port infrastructure or buildings around the river. Additionally, these accidents disrupt local economic activities, as the busy shipping routes are a key backbone for the distribution of goods, including coal, timber, and other commodities. Disruptions to these transportation routes can slow down logistics flows, trigger financial losses for companies, and impact the livelihoods of communities dependent on river trade. Equally important, the potential environmental damage caused by cargo spills, water pollution, and damage to the river ecosystem poses long-term impacts that are difficult to repair quickly.

This study recommends strategies to reduce the risk of shipping accidents through improving crew competence, infrastructure improvements, implementation of early warning systems, and safety education and awareness. Enhanced training and certification for all crew members, from captains to deckhands, should cover technical skills, safety procedures, emergency decision-making, and responses to changing environmental conditions to minimize negligence and operational errors (Gumelar et al., 2021). Adequate infrastructure, such as well-maintained port facilities, docks, and navigation systems, plays a crucial role in the smooth operation of ships and logistics (Ubjaan et al., 2024), while early warning systems provide timely and accurate information on extreme weather, strong currents, and

potential hazards for proactive measures (Merrick et al., 2022). Additionally, safety education and awareness for crew members, local communities, and relevant parties, coupled with the implementation of a Safety Management System that includes safety policies, incident reporting, regulatory compliance, clear communication channels, emergency response procedures, and regular internal audits, are integral efforts in maintaining maritime safety (Fransiska et al., 2024).

Through the implementation of these measures, it is hoped that the number of shipping accidents on the Mahakam and Musi Rivers will decrease significantly. Additionally, river transportation safety will improve, thereby supporting the smooth flow of logistics activities, protecting the environment, and safeguarding the well-being of communities that rely on these shipping routes as vital economic and transportation sources.

CONCLUSION

The conclusions of this study indicate that the dominant factors causing accidents involving barges and tugs on the Mahakam and Palembang Rivers are influenced by a combination of human, technical, and natural factors, with the primary causes including crew negligence, lack of training and safety awareness, inadequate vessel conditions, infrastructure limitations, and weather and water conditions. These findings underscore the importance of integrated interventions through crew competency enhancement, improvement of shipping facilities and infrastructure, implementation of early warning systems, and safety education for all stakeholders. The implications of this research point to the need for strategic policies and collaboration between the government, vessel operators, and the community to create a safer, more reliable, and sustainable river transportation system in both regions.

Future research should employ a mixed-methods approach, combining quantitative analysis of a larger dataset of accident reports from multiple Indonesian river systems with in-depth qualitative interviews and ethnographic observation of crew members and operators. This approach would not only statistically validate the dominant factors identified in this study but also explore the underlying socio-technical dynamics, organizational cultures, and economic pressures that drive risky decision-making and hinder the effective implementation of safety management systems in the daily practice of riverine shipping.

REFERENCES

- Abdussamie, N., Zaghwan, A., Daboos, M., Elferjani, I., Mehanna, A., & Su, W. (2018). Operational risk assessment of offshore transport barges. *Ocean Engineering*, 156, 333-346. <https://doi.org/10.1016/j.oceaneng.2018.03.006>

- Adliyah, S. (2025). *Polisi sebut tongkang yang tabrak 2 rumah warga di Palembang kelalaian nakhoda*. Detik. <https://www.detik.com/sumbagsel/berita/d-7822212/polisi-sebut-tongkang-yang-tabrak-2-rumah-warga-di-palembang-kelalaian-nakhoda>
- Andries, A. H., Wahyuni, A. A. I. S., Yudianto, P. Y., & Sutralinda, D. (2023). Analisis kandasnya kapal AHTS Etzomer 1601 saat memasuki alur pelayaran Surabaya. *Hengkramajaya*, 5(2), 1–6. <https://doi.org/10.61759/hmj.v5i2.861><https://doi.org/10.61759/hmj.v5i2.861>
- Choi, J. H., Jang, J. Y., & Woo, J. (2023). A review of autonomous tugboat operations for efficient and safe ship berthing. *Journal of Marine Science and Engineering*, 11(6), 1155. <https://doi.org/10.3390/jmse11061155>
- Cook, M., Reneker, J. L., Nero, R. W., Stacy, B. A., Hanisko, D. S., & Wang, Z. (2021). Use of drift studies to understand seasonal variability in sea turtle stranding patterns in Mississippi. *Frontiers in Marine Science*, 8, 659536. <https://doi.org/10.3389/fmars.2021.659536>
- Erwin, R. (2022). Tanggung jawab negara untuk mencegah terjadinya kecelakaan kapal transportasi laut menurut hukum internasional dan hukum nasional. *Supremasi: Jurnal Hukum*, 4(2), 222–238. <https://doi.org/10.36441/supremasi.v4i2.716>
- Fransiska, E., Ritonga, N., Ginting, D., & Andrio, F. (2024). Penerapan Sistem Manajemen Keselamatan (SMK) Guna Kelancaran Operasional Kapal Mt. Mumbai Pada Pt. Pelayaran Multi Jaya Samudera Belawan. *Journal of Maritime and Education (JME)*, 6(2), 668-675. <https://doi.org/10.54196/jme.v6i2.145>
- Gumelar, F., Sutanto, H., Sunusi, M. S., & Adiputra, I. K. H. P. (2021). Optimalisasi Kompetensi Awak Kapal Dalam Penerapan Keselamatan Kerja Di Kapal Latih Frans Kaisiepo. *JPB: Jurnal Patria Bahari*, 1(2), 10-28. <https://doi.org/10.54017/jpb.v1i2.24>
- Jayawibawa, M. H. (2025). 20 kali 'tertabrak', nol solusi permanen: Mengapa Jembatan Mahakam jadi langganan kecelakaan? Bandung Punya Berita. <https://bandungpunyaberita.com/20-kali-tertabrak-nol-solusi-permanen-mengapa-jembatan-mahakam-jadi-langganan-kecelakaan/>
- Kementerian Perhubungan Republik Indonesia. (2023). Kemenhub kukuhkan 39 orang pejabat pemeriksaan kecelakaan kapal. *Direktorat Jenderal Laut*. <https://hubla.dephub.go.id/home/post/read/15111/kemenhub-kukuhkan-39-orang-pejabat-pemeriksaan-kecelakaan-kapal>
- Kementerian Perhubungan Republik Indonesia. (2025a). *Cuaca buruk sebabkan tali towing putus dan tongkang tabrak kafe di Sungai Mahakam / Bad weather causes towing line to break and barge collides with café on Mahakam River*.

- <https://hubla.dephub.go.id/indonesianmaritimesafetyinformation/page/news/read/24706/cuaca-buruk-sebabkan-tali-towing-putus-dan-tongkang-tabrak-kafe-di-sungai-mahakam-bad-weather-causes-towing-line-to-break-and-barge-collides-with-cafe-on-mahakam-river-1>
- Kementerian Perhubungan Republik Indonesia. (2025b). *Tongkang Indo Sukses 28 tabrak tiang safety vendor Jembatan Mahakam, evakuasi berlangsung aman / Barge Indo Sukses 28 collides with safety vendor pillar of Mahakam Bridge, evacuation conducted safely*.<http://hubla.dephub.go.id/indonesianmaritimesafetyinformation/page/news/read/24863/tongkang-indo-sukses-28-tabrak-tiang-safety-vendor-jembatan-mahakam-evakuasi-berlangsung-aman-barge-indo-sukses-28-collides-with-safety-vendor-pillar-of-mahakam-bridge-evacuation-conducted-safely>
- Kementerian Perhubungan Republik Indonesia. (2025c). *Kapal tongkang tabrak rumah rakit di Sungai Musi, tidak ada korban jiwa // Barge collided with floating house on Musi River, no casualties reported*.<https://hubla.dephub.go.id/indonesianmaritimesafetyinformation/page/news/read/25129/kapal-tongkang-tabrak-rumah-rakit-di-sungai-musi-tidak-ada-korban-jiwa-barge-collided-with-floating-house-on-musi-river-no-casualties-reported>
- Khoiriyah, A. B. (2025, 12 Agustus). Keselamatan transportasi Sungai Mahakam. *BeritaKini.co.id*. <https://beritakini.co.id/detail/98702/keselamatan-transportasi-sungai-mahakam>
- Malik, D., Mudiyanto, & Widodo, W. (2025). Analisis pengaruh human faktor terhadap keselamatan pelayaran di kapal penumpang perusahaan Surabaya. *Jurnal Sains dan Teknologi Maritim*, 25(2), 215–228. <https://doi.org/10.33556/jstm.v25i2.457>
- Merrick, J. R., Dorsey, C. A., Wang, B., Grabowski, M., & Harrauld, J. R. (2022). Measuring prediction accuracy in a maritime accident warning system. *Production and Operations Management*, 31(2), 819-827. <https://doi.org/10.1111/poms.13581>
- Pambayun, F. D., Rahmawati, M., & Purwitasari, D. (2024). Analisis penanggulangan resiko kecelakaan kerja proses sandar kapal di Pelabuhan Tanjung Perak Surabaya. *Jurnal Bintang Pendidikan Indonesia*, 2(4), 264–288. <https://doi.org/10.55606/jubpi.v2i4.3299>
- Pawara, M. U., Setiawan, W., Alamsyah, A., Suardi, S., & Ramadhani, R. (2021). Design of Self-Propelled Container Barge for Logistics Transportation of Samarinda-Kotabangun. *Jurnal Penelitian Enjiniring*, 25(2), 92-97. <https://doi.org/10.25042/jpe.112021.02>

- Putra, W. P., Rahmawati, M., & Ratnaningsih, D. (2024). Analisis penyebab terjadinya incident process berthing pada tongkang BG. RMN 3316 milik PT. Kartika Samudra Adijaya di Jetty PLTU Batang. *Trending: Jurnal Ekonomi, Akuntansi dan Manajemen*, 2(4), 318–329. <https://doi.org/10.30640/trending.v2i4.3194>
- Raising, R., Mamusung, E. V., Hidayat, R., Jamaluddin, J., & Raising, R. (2025). Penanganan Kecelakaan Kerja Crew di Kapal MT Pribumi. *INSOLOGI: Jurnal Sains dan Teknologi*, 4(3), 512–520. <https://doi.org/10.55123/insologi.v4i3.5091>
- Riyanto, N. S., Yudo, H., & Trimulyono, A. (2020). Analisa Kekuatan Deck Akibat Perubahan Muatan Pada Tongkang TK. NELLY-34. *Jurnal Teknik Perkapalan*, 8(3), 454–460.
- Sava, A. (2024). *Kebocoran Tongkang Akibat Muatan Longsor Di Pelabuhan Tanjung Intan Cilacap Oleh Pt. Trans Power Marine* (Doctoral Dissertation, Politeknik Ilmu Pelayaran Semarang).
- Savero, M. S. F., Wahyuni, A. A. I. S., Rahmawati, M., & Sutralinda, D. (2025). Identifikasi faktor penyebab grounding MV. Belik Mas pada narrow channel Kapuas River dengan pendekatan root cause analysis. *Jurnal Riset Rumpun Ilmu Teknik*, 4(1), 653–670. <https://doi.org/10.55606/jurritek.v4i1.5330>
- Tseng, W. J., Ding, J. F., Liu, C. M., & Li, L. Y. (2021). Key risk factors influencing harbor tugboat operations for Kaohsiung port. *Journal of Marine Science and Technology*, 29(3), 363–374. <https://doi.org/10.51400/2709-6998.1439>
- Ubjaan, M. M., Pramono, A., & Pramono, B. (2024). Enhancing International Cooperation for Ship and Port Facility Security to Address Security Disruptions. *JILPR Journal Indonesia Law and Policy Review*, 5(3), 694–704. <https://doi.org/10.56371/jirpl.v5i3.256>
- Wahyuni, A. A. I. S., Wahdiana, D., Hasugian, S., & Paramitha, A. A. I. S. B. (2021). Analisis human error terhadap penggunaan peralatan komunikasi dan navigasi kapal sebagai penyebab kecelakaan kerja. *Infokes: Jurnal Ilmiah Rekam Medis dan Informatika Kesehatan*, 11(1), 59–64. <https://doi.org/10.47701/infokes.v11i1.1049>
- Wu, G., Zhao, X., Sun, Y., & Wang, L. (2021). Cooperative maneuvering mathematical modeling for multi-tugs towing a ship in the port environment. *Journal of Marine Science and Engineering*, 9(4), 384. <https://doi.org/10.3390/jmse9040384>
- Yahya, S., & Amalia, P. A. (2022). Analisis faktor dominan penyebab kecelakaan kapal di perairan laut Indonesia. *Jurnal Maritim*, 12(2), 24–28.