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# Identification and Control of Occupational Safety and Health Risks (K3): A Case Study of The Basarnas K.N. Pacitan 102 Ship in Kendari City

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**A B S T R A C T**

Identification and control of occupational safety and health (OSH) risks on the BASARNAS ship K.N. Pacitan 102, Kendari City, are very important to identify factors that can potentially cause occupational accidents. This study used qualitative methods to characterize the forms of potential hazards and risk control, using observation methods in the K.N. Pacitan 102 ship's room environment, and to assess the risk level of the infrastructure and hazards (safety signs) on the ship. Based on the observation, there is a high risk in the galley room of being struck by glass cutlery or burned by cooking utensils. Moderate risks are partially identified in the wheelhouse area, radio equipment, corridor, gallery room, passenger room, kitchen, mosque, and engine room with risk descriptions in the form of high temperatures (heat), hearing loss, injuries due to collisions, the presence of fragments of iron & glass materials, saturation from a narrow work environment and lack of air circulation. At the same time, low risks are also found in some wheelhouse rooms, radio equipment, corridors, meeting rooms, hospitals, offices, and engine rooms, with risk descriptions such as bumping, slipping, saturation in work positions, and a lack of space for movement. Risk control is grouped into four sub-risk controls, such as substitution, engineering/isolation, elimination, and administration/training/ preparation of personal protective equipment (PPE). This study has had an impact on the readiness of BASARNAS to continue to improve the readiness and completeness of work safety to minimize all opportunities for work accidents that can occur at any time on the BASARNAS Ship K.N. Pacitan 102.

Identifikasi dan pengendalian risiko keselamatan dan kesehatan kerja (K3) di kapal Basarnas K.N. Pacitan 102 Kota Kendari sangat penting dilakukan untuk mengidentifikasi factor yang dapat berpotensi menjadi kecelakaan kerja di kapal BASARNAS K.N. Pacitan 102. Penelitian kualitatif ini diterapkan untuk mencirikan bentuk dari potensi bahaya dan pengendalian risiko dengan metode observasi di lingkungan ruangan kapal, menilai tingkat risiko sarana-prasarana, dan hazard (rambu-rambu K3) yang berada pada kapal. Berdasarkan hasil pengamatan terlihat bahwa risiko tinggi dapat terjadi di ruangan dapur dengan potensi terkena serpihan alat makan terbuat dari kaca maupun luka bakar dari peralatan memasak. Risiko sedang Sebagian teridentifikasi pada area wheel house, radio equipment, koridor, galery room, pessenger room, kitchen, mussolah dan engine room dengan uraian resiko berupa suhu tinggi (panas), gangguan pendengaran, terluka akibat benturan, adanya serpihan material besi & kaca, kejenuhan dari lingkungan kerja yang sempit dan kurang sirkulasi udara. Sedangkan risiko rendah juga terdapat disebagian ruangan wheel house, radio equipment, koridor, meeting room, hospital, office dan engine room dengan uraian risiko seperti terbentur, tergelincir, jenuh pada posisi kerja, kurangnya ruang gerak. Pengendalian risiko dikelompokan dalam empat sub-pengendalian resiko seperti subtitusi, keteknikan/ isolasi, eliminasi, administrasi/ pelatihan/ penyiapan alat pelindung diri (APD). Penelitian ini memberikan dampak dalam kesiapsediaan BASARNAS untuk terus meningkatkan kesiapan dan kelengkapan keselamatan kerja agar dapat meminimalisir semua peluang kecelakaan kerja yang dapat terjadi sewaktu-waktu di Kapal BASARNAS K.N. Pacitan 102.

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## 1. Introduction

The National Search and Rescue Agency (BNPP/BASARNAS) is a non-ministerial government institution of the Republic of Indonesia responsible for conducting search and rescue (SAR) operations for individuals affected by disasters (Adha & Salioso, 2024; Gustaman et al., 2020). These operations typically require swift and coordinated responses to natural disasters, maritime or aviation accidents, and the search for missing persons, such as mountaineers (Mu'ding et al., 2023). All SAR activities must adhere to the standards set by the International Maritime Organization (IMO) and the International Civil Aviation Organization (ICAO) within the search and rescue region of the Unitary State of the Republic of Indonesia (NKRI) (Fadjri & Anggriani, 2024; Hendrawan, 2020). As the leading agency for rescue operations in Indonesia, BASARNAS must maintain optimal performance and be fully equipped, both in terms of human resources and technical equipment (Muchsin, 2017; Setiawan et al., 2024).

Supporting facilities owned by BASARNAS include ships, helicopters, ports, SAR posts, and motor vehicles, all of which are essential for the efficient execution of rescue operations (Dewi Dyah, 2016; R. Munaf & Sulistyaningtyas, 2015; Suarjana & Kamil, 2024). Given these operational demands, it is critical to prioritize Occupational Safety and Health (OSH) on BASARNAS vessels to ensure their readiness in safeguarding both crew members and those being rescued (Gayatri et al., 2014; Ratnawati et al., 2023). For instance, sea vessels involved in SAR operations often remain at sea for extended periods—sometimes for several months—while searching for missing persons (Sinaga et al., 2023). OSH management on board BASARNAS vessels is implemented consistently across all operational units, as evidenced by routine inspections of safety equipment at BASARNAS offices and vessels.

K.N. Pacitan 102, operated by the Kendari City SAR office in Southeast Sulawesi, plays a vital role in safeguarding SAR posts in Indonesia's eastern region (Mutmainah & Hasanudin, 2021). The vessel can reach speeds up to 29 knots (53.7 km/h), is highly stable, and can withstand adverse weather conditions (A. B. C. Putra & Hasanudin, 2019). It is well-equipped for maritime rescue operations, featuring an onboard hospital, a BO-105 helicopter landing pad, and search-and-rescue navigation systems, such as the PLEAR camera for victim detection (Mutmainah & Hasanudin, 2021).

Despite its advanced features, the vessel must also uphold high standards of occupational safety and health for both crew and rescued individuals. Onboard safety protocols must comply with the International Safety Management Code (ISMC), which governs the safe management and operation of ships (Akpinar & Özer-Çaylan, 2023; Hendrawan, 2020). Reducing occupational accidents is essential, as studies show that approximately 80% of such incidents are caused by human error, often resulting from inadequate onboard management (Andoyo et al., 2015; Hendrawan, 2020; Wahyuni et al., 2021). Therefore, workplace safety aboard rescue vessels must be assessed from both an infrastructural and OSH programmatic perspective. This includes the implementation of safety briefings (toolbox meetings), safety talks, supervision and inspection programs, and other initiatives that support safe working conditions (Hendrawan, 2020; Wibowo & Susianti, 2022). Accordingly, this study aims to identify and control potential risks in the working environment of BASARNAS K.N. Pacitan 102, assess its preparedness, and identify possible sources of workplace accidents. The findings are expected to provide a foundation for improvement and development efforts to minimize the impact of occupational hazards on crew members aboard the vessel.

## 2. Methods

This study employs a qualitative descriptive research approach. Data was collected through direct observation to assess the level of hazards and risks that may arise aboard the K.N. SAR Pacitan 102 vessel operated by BASARNAS in Kendari City. The population in this study comprises the entire K.N. SAR Pacitan 102 vessel, while the sample comprises the various rooms and facilities on board. The data collection technique involved observing the physical conditions and facilities in each area of the vessel and examining daily OSH-related activities to identify potential hazards encountered by crew members. Tools and materials used during the observation included

writing instruments and a camera for documenting the actual conditions onboard.

The assessment of workplace accident risk levels was conducted based on the potential severity of hazards, categorized from minor to severe, as defined by the Consequence Criteria (see Table 1). The assessment framework is guided by the Hazard Identification, Risk Assessment, and Risk Control (HIRARC) method, which aims to prevent and mitigate workplace accidents by identifying types of work activities, determining sources of hazards, and evaluating associated risks (Nur et al., 2023). Based on the risk assessment results, appropriate risk control measures are implemented to minimize exposure to hazards for each specific work activity (Bintoro et al., 2018; G. Putra & Saputra, 2022).

**Table 1.** Levels of potential danger range from mild to very severe

| Level | Description | Example |
|---|---|---|
| 1 | Very mild | Minor injury that does not require first aid |
| 2 | Mild | Injury requiring first aid |
| 3 | Moderate | Injury requiring professional medical treatment |
| 4 | Severe | Injury requiring hospitalization |
| 5 | Very severe | Incident resulting in death or permanent disability |

## 3. Results

The results of hazard identification aboard the BASARNAS K.N. Pacitan 102 vessel revealed various risks present in specific operational areas, including the Wheelhouse, Radio Equipment Room, Corridor, Galley, Passenger Room, Meeting Room, Hospital, Office, Kitchen, Musholla (prayer room), and Engine Room. These findings are summarized in Table 2. Based on the observations presented in Table 2, several compartments aboard the K.N. Pacitan 102 exhibit conditions that pose occupational hazards to crew members. Additionally, these hazards range in severity, with some presenting a moderate to high risk of occupational accidents. To evaluate the likelihood of such incidents, hazards were classified based on frequency of occurrence—from rare to very frequent—using the Likelihood Criteria, which estimate the probability of an event occurring based on causal relationships.

The likelihood value (Table 2) and the consequence value (Table 1) are key metrics used to evaluate the overall risk associated with each hazard. Following this, a Risk Assessment was conducted to determine the probability and severity of occupational accidents. The objective of this assessment is to ensure that all work processes, operations, and individual activities are carried out under acceptable and controlled risk conditions (Ramadhan, 2017; Ressa & Sari, 2023). This approach allows personnel to anticipate and adapt to environmental conditions encountered in different areas of the vessel.

Based on the standard risk analysis presented in the Risk Assessment Matrix (Table 3), along with the Likelihood Criteria (Table 2) and Consequence Levels (Table 1), several potential occupational hazards were identified and categorized based on their scores and frequency of occurrence. Table 5 shows that the highest levels of occupational risk are found in the kitchen area, due to several contributing factors, including the risk of collision with or injury from glass kitchenware. Additionally, not all cooking utensils are heat-resistant, increasing the risk of burns. During vessel movement, items may shift or fall, further increasing the likelihood of accidents in this space (Maharani et al., 2025).

**Table 2.** Identification of Hazards Occurring on the Basarnas K.N. Pacitan 102 Ship

| Process | Hazard | Risk |
|---|---|---|
| Wheelhouse | Metal material | Discomfort during prolonged interaction |
| | Steel plate floor | Risk of slipping under certain conditions |
| | Permanent position | Can cause fatigue |
| | Stairs to the main deck | Risk of falling due to the steep angle |
| Radio | Small space | Risk of bumping during heavy shaking |
| Equipment | Fixed position | Reduced mobility space |
| Corridor | Stairs to the main deck and helipad | Risk of falling due to poor positioning |
| | No railing on the rescue boat | Risk of falling into the sea if not cautious |
| | Outdoor unit of the air conditioner | Hearing disturbance |
| | Spare propeller | Risk of injury from impact |
| Galley Room | Glass material | Risk of shattering |
| Passenger | Narrow spacing between seats | Discomfort among passengers |
| Room | Tight spacing between front and back seats | Difficulty entering and exiting seats |
| Meeting Room | Large table | Reduces movement space |
| | Too many chairs | Reduces movement space |
| Hospital | Small space | Uncomfortable when occupied by more than three people |
| Office | Small space | Uncomfortable for prolonged use |
| Kitchen | Proximity of the wet and dry kitchens | Discomfort while washing dishes and cooking simultaneously |
| | Small space | Severely restricted movement, especially while cooking |
| | Glass tableware | Easily breaks upon impact. |
| | Non-heat-resistant cookware | Risk of burns when touched while hot |
| Prayer Room | Table with sharp edges | Risk of tripping during prayer |
| Engine Room | High engine temperature | Risk of skin burns |
| | Loud engine noise | Hearing disturbance |
| | Poor air circulation | Breathing difficulty |
| | Narrow access | Difficulty entering and exiting |

**Table 3**. Risk Assessment (Risk Matrix) of occupational safety risk identification

| Frequency | Potential Hazard Level | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| A | Moderate | High | Very high | Very high | Very high |
| B | Moderate | Moderate | High | High | Very high |
| C | Moderate | Moderate | High | High | Very high |
| D | Low | Low | Moderate | Moderate | High |
| E | Low | Low | Moderate | Moderate | Moderate |

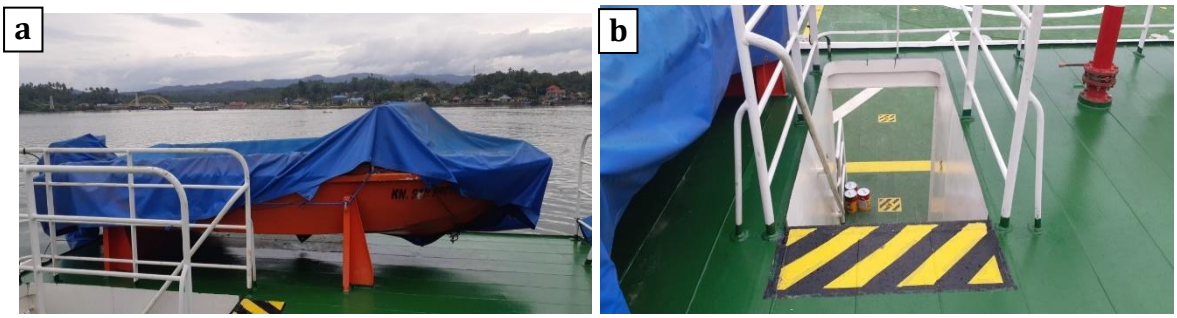


**Figure 1.** Examples of Hazard Identification on the K.N. Pacitan 102 Vessel: (a) Absence of guardrails on the rescue boat, and (b) Use of black-yellow hazard markings to indicate ladder positions.

The next level of risk is categorized as moderate, particularly in the Radio Equipment Room, due to confined space and limited mobility. In addition, certain corridors lack guardrails, especially near the rescue boat area, posing a fall risk. Outdoor air conditioning units may impair hearing, and glass materials pose a risk of shattering. In the Passenger Room, the narrow spacing between seats may cause discomfort and hinder movement. The Engine Room also presents significant hazards—such as high temperatures that can cause burns, loud noises that may lead to hearing damage, and poor ventilation that could result in respiratory issues (see Table 5).

Table 5 also shows that the highest hazard severity level identified aboard the K.N. Pacitan 102 was Level 4 (Severe), indicating incidents that may require hospitalization. These conditions are critical, especially during navigation in rough seas, where glass kitchenware may break and pose injury risks. Corridors in categories 4 and 5 are also identified as high-risk zones due to potential slipping, heavy sea conditions, or crew unawareness. Noise generated by outdoor AC units can significantly affect hearing, making the use of earplugs part of mandatory Personal Protective Equipment (PPE) protocols.

To manage these risks, risk controls and design recommendations were formulated. These include the installation of hazard warning signs, room modifications, and procedural adjustments to mitigate occupational risks aboard the K.N. Pacitan 102 vessel. Proposed interventions are detailed in Table 4.

**Table 4.** Guidelines for Reducing Occupational Accident Risks

| Control Type | Effectiveness | Description |
|---|---|---|
| Elimination | 100% hazard eliminated | Renovation or redesign to remove hazards completely |
| Substitution | 75% hazard eliminated | Replacing the hazard with a less risky alternative |
| Engineering/Isolation | 50% hazard reduced | Engineering controls or isolation methods to separate hazards |
| Administration/Training | 25% hazard reduced | Procedural interventions such as training, signage, and safety briefings |
| Personal Protective Equipment (PPE) | 5% injury reduction | Usage of PPE to limit injury severity and exposure to residual hazards |

Based on Table 4, several Occupational Safety and Health (OSH) control measures for the K.N. Pacitan 102 vessel are recommended to reduce the impact of workplace accidents across different compartments. These measures fall into four key categories: substitution, improving or replacing hazardous materials with safer alternatives. Engineering/Isolation improving spatial layouts to isolate hazards or prevent worker access. Elimination, removing the source of hazard entirely or relocating it to a safer area. Administrative/Training Measures, developing clear guidelines, installing hazard signs, and providing PPE and safety instructions to ensure worker protection during operations

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**Table 5.** Hazard Scores and Associated Risk Levels

| Process | Hazard Description | Risk Description | Hazard Source | Potential Hazard Level | Frequency | Risk Matrix Score |
|---|---|---|---|---|---|---|
| Wheelhouse | Iron/metal materials | Discomfort from prolonged interaction | Work environment | 3 | E | Moderate |
| | Floor plate | Risk of slipping in certain conditions | | 2 | E | Low |
| | Fixed operator position | May cause fatigue over time | | 2 | D | Low |
| | Steep stairs to the main deck | Risk of falling due to nearly vertical inclination | | 1 | E | Low |
| Radio Equipment | Confined space | Risk of collision during heavy vibrations | Work environment | 4 | E | Moderate |
| | Fixed equipment position | Restricts movement space | | 1 | E | Low |
| Corridor | Access stairs to the main deck/helipad | Risk of falling if misstepping | Work environment | 1 | E | Low |
| | Absence of railing near the rescue boat | Risk of falling into the sea | | 4 | E | Moderate |
| | Outdoor air conditioning unit | Can impair hearing | | 5 | E | Moderate |
| | Spare propeller | Potential injury from accidental impact | | 4 | E | Moderate |
| Galley Room | Glass materials | Risk of cuts from shattering | Work environment | 4 | D | Moderate |
| Passenger Room | Narrow seat spacing (side-by-side) | May cause discomfort among passengers | Work environment | 1 | B | Moderate |
| | Tight front-rear seat distance | Discomfort from limited legroom | | 1 | B | Moderate |
| Meeting Room | Oversized table | Limits mobility | Work environment | 1 | D | Low |
| | An excess number of chairs | Limited movement space | | 1 | D | Low |
| Hospital | Limited space | Discomfort when occupied by more than three people | Work environment | 1 | D | Low |
| Office | Limited space | Discomfort during extended use | Work environment | 1 | D | Low |
| Kitchen | Proximity of wet and dry areas | Discomfort while multitasking | Work environment | 2 | B | Moderate |
| | Limited working space | Movement is restricted while cooking. | | 2 | B | Moderate |
| | Fragile glassware | Risk of injury from breakage | | 4 | C | High |
| | Non-heat-resistant cookware | Risk of burns when touched | | 4 | B | High |
| Mosque | Table with sharp corners | Risk of tripping during prayer | Work environment | 3 | D | Moderate |
| Engine Room | High machine temperature | Risk of burns from contact | Work environment | 4 | D | Moderate |
| | High noise levels | Risk of hearing damage | | 4 | D | Moderate |
| | Poor air circulation | Breathing discomfort or issues | | 4 | D | Moderate |
| | Narrow access pathways | Difficulty during emergency evacuation | | 2 | D | Low |

**Table 6.** Occupational Health and Safety (OHS) Risk Control

| Process | Hazard | Risk | Risk Control | Technical Risk Control |
|---|---|---|---|---|
| Wheelhouse | Metal material | Discomfort during prolonged interaction | Substitution | Coating with wood material |
| | Steel plate floor | Slipping under certain conditions | Substitution | Coating with wood or adding texture to the floor surface |
| | Permanent position | Can cause fatigue | Substitution | Replacing with adjustable position materials |
| | Stairs to the main deck | Risk of falling due to the steep angle | Engineering/Isolation | Adding a barrier, such as a gate |
| Radio | Small space | Risk of bumping during heavy shaking | Engineering/Isolation | Expand the space on the rear side |
| Equipment | Fixed position | Reduces mobility space | Substitution | Use newer, smaller equipment |
| Corridor | Stairs to the main deck and helipad | Risk of falling due to poor positioning | Engineering/Isolation | Adding a portal barrier |
| | No railing on the rescue boat | Risk of falling into the sea if not careful | Engineering/Isolation | Adding removable railings |
| | Outdoor unit of the air conditioner | Causes hearing discomfort | Engineering/Isolation | Relocating the equipment |
| | Spare propeller | Risk of injury from impact | Elimination | Moving propeller to storage area |
| Galley Room | Glass material | Risk of shattering | Substitution | Replacing glass with rigid transparent plastic |
| Passenger | Narrow seat spacing | Discomfort among passengers | Substitution | Replace with seats that have more spacing |
| Room | Tight front-back seat spacing | Difficulty entering and exiting the seat | Substitution | Re-adjust seat spacing front and back |
| Meeting Room | Large table | Reduces movement space | Substitution | Replace with a smaller, longer table |
| | An excess number of chairs | Reduces movement space | Substitution | Reduce the number of chairs |
| Hospital | Small space | Uncomfortable with more than three people | Substitution | Relocate the function to a larger space |
| Office | Small space | Uncomfortable for long durations | Engineering/Isolation | Reduce the number of furnishings in the room |
| Kitchen | Proximity of the wet and dry kitchens | Discomfort while washing and cooking | Administrative/Training | Provide instructions not to cook and wash simultaneously |
| | Small space | Limited movement, especially while cooking | Administrative/Training | Provide guidance to limit kitchen activities to cooking only |
| | Glass tableware | Easily breaks upon impact | Substitution | Replace with shatterproof tableware |
| | Not all cooking tools are heat-resistant. | Risk of burns when touched while hot | Substitution | Use heat-resistant cookware such as Teflon |
| Prayer Room (Mussolah) | Table with sharp edges | Risk of tripping during prayer | Substitution | Replace with a round-edged table |
| Engine Room | High engine temperature | Risk of burns on the skin | Administrative/Training | Wear heat-resistant protective clothing while the engine is running |
| | Loud engine noise | Risk of hearing damage | Administrative/Training | Use ear protection |
| | Poor air circulation | Breathing difficulty | Administrative/Training | Ensure ventilation is open when inside |
| | Narrow access | Difficulty in entry and exit | Administrative/Training | Provide training for safe entry and exit from the engine room |

## 4. Discussion

Risk identification conducted on the K.N. Pacitan 102 vessel revealed that nearly all workspaces and facilities onboard present varying degrees of hazards. The most identified risks are discomfort due to limited space and fixed working positions, which may lead to fatigue and decreased concentration during task execution. This indicates that, despite being technically and functionally oriented, the onboard work environment still harbors various ergonomic and mechanical hazards that must be systematically anticipated and managed.

The kitchen area represents the highest risk zone, primarily due to the use of non-heat-resistant cooking equipment and the presence of fragile glassware. The main hazards include burns and injuries from broken glass. In addition, the engine room presents moderate to high risk levels due to high machinery temperatures, excessive noise, and poor air circulation, all of which may cause respiratory issues and hearing damage (Fairussihan & Setiono, 2023). These findings highlight the importance of implementing technical control measures and providing adequate personal protective equipment (PPE) in areas with high physical and thermal exposure.

Several parts of the vessel, such as corridors, stairs leading to the main deck, and access to the helipad, pose slip-and-fall risks caused by slippery floors, steep stair designs, or a lack of safety railings (Naga et al., 2024). Furthermore, the presence of outdoor air conditioning units and spare propellers may become injury sources if not properly marked or isolated. These situations emphasize the need for improved safety measures in personnel mobility areas through engineering controls and redesigning access pathways.

Spaces such as the wheelhouse, meeting room, infirmary, and office are categorized as low to moderate risk zones but still warrant attention. Discomfort from cramped spaces, fixed workstations, and excessive furniture (e.g., large tables and too many chairs) can affect crew members' psychological state and concentration. While not always leading to immediate physical harm, these factors contribute to fatigue, stress, and the potential for human error during high-precision rescue operations.

Based on the risk level classification, a comprehensive hazard control approach must be implemented. High-risk areas require elimination and engineering interventions, such as replacing hazardous materials and redesigning workspace layouts. Meanwhile, moderate and low-risk areas should continue to be monitored through training, the provision of hazard signs, and the enforcement of occupational safety standard operating procedures (SOPs). These efforts aim not only to protect personnel from occupational accidents but also to enhance the operational efficiency and readiness of Basarnas during dynamic and high-risk SAR missions.

## 5. Conclusions

Based on the results of the identification and evaluation of occupational accident risks in the environment of the Basarnas K.N. Pacitan 102 vessel, it was found that the highest risk is in the kitchen (*Kitchen*) with the greatest possibility of being hit by broken tableware and the potential for burns from cooking equipment after use. Moderate risks are present in several rooms, including the Wheelhouse, Radio Equipment, Corridor, Gallery Room, Passenger Room, Kitchen, prayer room, and Engine Room, including hot air, accidental falls, hearing impairment, collisions, glass shards, claustrophobia, and poor air circulation. Meanwhile, low risk is also present in several rooms, such as the Wheelhouse, Radio equipment, Corridor, Meeting room, Hospital, Office, and Engine Room, with risks including bumping into hardware, slipping on metal floors, fatigue in work positions, and limited space to move around. Risk control can be implemented using four types of risk control measures: substitution, engineering/isolation, elimination, and administrative measures or worker training, while ensuring the use of appropriate personal protective equipment (PPE).

## References

Adha, M. L., & Salioso, H. (2024). Kinerja Organisasi di Kantor Pencarian dan Pertolongan Basarnas Kelas A Pekanbaru. *Jurnal Kemunting*, *5*(1), 1–16.

Akpinar, H., & Özer-Çaylan, D. (2023). Organizational resilience in maritime business: a systematic literature review. *Management Research Review*,

*46*(2), 245–267. https://doi.org/10.1108/MRR-12-2021-0866

Andoyo, L., Sarwito, S., & Zaman, B. (2015). Analisis human error terhadap kecelakaan kapal pada sistem kelistrikan berbasis data di kapal. *Jurnal Teknik ITS*, *4*(1), G10–G14. https://doi.org/10.12962/j23373539.v4i1.9410

Bintoro, P. A., Maselia, P., Kintoko, A. W., Defanda, A. A., Fitriyanto, A., Ramadhan, F., Kartika, M., & Septiani, U. A. (2018). Pembuatan Tahu Rumahan Khas Ledok Kulon. *Jurnal Pemberdayaan: Publikasi Hasil Pengabdian Kepada Masyarakat*, *1*(2), 245. https://doi.org/10.12928/jp.v1i2.371

Dewi Dyah, W. (2016). Pendapatan Bandar udara Berfungsi Sebagai Pendukung Peningkatan Layanan. *Universitas Surya Darma*, *8*(2), 43–50. https://doi.org/10.35968/jmm.v8i2.513

Fadjri, A. U., & Anggriani, J. (2024). Kedudukan Hukum dan Kewenangan Basarnas dalam Sistem Penanggulangan Bencana di Indonesia. *Innovative: Journal Of Social Science Research*, *4*(6), 3475–3491. https://doi.org/10.31004/innovative.v4i6.16586

Fairussihan, J. D., & Setiono, D. (2023). Analisis Risiko Keselamatan Dan Kesehatan Kerka (K3) Pada Proses Perbaikan Kapal Di Pt. Dock Dan Perkapalan Surabaya Menggunakan Metode Hirarc (Hazard Identification, Risk Assessment, And Risk Control). *Zona Laut Jurnal Inovasi Sains Dan Teknologi Kelautan*, *4*(1), 23–29. https://doi.org/10.62012/zl.v4i1.18977

Gayatri, D. P., Pramono, A., & Setiyono, J. (2014). Implementasi Konvensi Penerbangan Sipil Internasional dalam Pengaturan Aspek Keselamatan dan Keamanan Penerbangan di Indonesia. *Diponegoro Law Journal*, *3*(2), 3–13. https://doi.org/10.14710/dlj.2014.5495

Gustaman, F. A. I., Rahmat, H. K., Banjarnahor, J., & Maarif, S. (2020). Peran Kantor Pencarian dan Pertolongan Lampung dalam Masa Tanggap Darurat Tsunami Selat Sunda Tahun 2018. *Nusantara: Jurnal Ilmu Pengetahuan Sosial*, *7*(2), 462–469. https://doi.org/10.31604/jips.v7i2.2020.462-469

Hendrawan, A. (2020). Program Kesehatan Dan Keselamatan Kerja Di Atas Kapal. *Jurnal Sains Teknologi Transportasi Maritim*, *2*(1), 1–10. https://doi.org/10.51578/j.sitektransmar.v2i1.12

Maharani, A., Hanik, K., & Isyam, A. N. (2025). Pengaruh Lingkungan Kerja Dan Fasilitas Terhadap Kinerja Crew Kapal PT. Asia Marine Temas. *Majalah Ilmiah Bahari Jogja*, *23*(1), 72–87. https://doi.org/10.33489/mibj.v23i1.395

Mu'ding, M., Pangemanan, S. E., & Monintja, D. K. (2023). Strategi Badan Penanggulangan Bencana Daerah (BPBD) Pada Tahap Tanggap Darurat Banjir Di Kota Manado. *Jurnal Governance*, *3*(1), 1–10. https://doi.org/-

Muchsin, S. (2017). *Implementasi Kebijakan Pengurangan Risiko Bencana (Studi pada Pengurangan Risiko Bencana Erupsi Gunung Kelud 2014 di Jawa Timur)*. Universitas Brawijaya.

Mutmainah, N., & Hasanudin, H. (2021). Desain Hospital Catamaran untuk Operasional Pulau-pulau di Provinsi Maluku Utara. *Jurnal Teknik ITS*, *10*(2), G87–G94. https://doi.org/10.12962/j23373539.v10i2.80268

Naga, R. A., Arisusanty, D. J., & Pribadi, T. (2024). Optimalisasi Penerapan Keselamatan dan Kesehatan Kerja (K3) pada Kapal Transhipment Batubara Milik PT. Kartika Samudra Adijya Site Tanah Grogot. *Profit: Jurnal Manajemen, Bisnis Dan Akuntansi*, *3*(4), 155–175. https://doi.org/10.58192/profit.v3i4.2552

Nur, M., Valentino, V., Sari, R. K., & Karim, A. A. (2023). Analisa Potensi Bahaya Kecelakaan Kerja Terhadap Pekerja Menggunakan Metode Hazard Identification, Risk Assement And Risk Control (HIRARC) Pada Perusahaan Aspal Beton. *Jurnal Teknologi Dan Manajemen Industri Terapan*, *2*(3), 150–158. https://doi.org/10.55826/tmit.v2i3.179

Putra, A. B. C., & Hasanudin, H. (2019). Desain Self-Righting Rescue Boat Untuk BASARNAS. *Jurnal Teknik ITS*, *8*(2), G99–G105. https://doi.org/10.12962/j23373539.v8i2.43135

Putra, G., & Saputra, O. (2022). Analisis Potensi Bahaya di Area Produksi Kelapa Sawit Menggunakan Metode HIRARC di PT. Beurata Subur Persada. *Jurnal Serambi Engineering*, *7*(2), 2913–2921. https://doi.org/10.32672/jse.v7i2.3896

R. Munaf, D., & Sulistyaningtyas, T. (2015). Sistem Operasi Tersinergi Bakamla Sesuai Dengan Undang-Undang Nomor 32 Tahun 2014 Tentang Kelautan. *Jurnal Sosioteknologi*, *14*(3), 273–288. https://doi.org/10.5614/sostek.itbj.2015.14.3.6

Ramadhan, F. (2017). Analisis Kesehatan dan Keselamatan Kerja (K3) menggunakan metode Hazard Identification Risk Assessment and Risk Control (HIRARC). *Seminar Nasional Riset Terapan*, *November*, 164–169. https://doi.org/-

Ratnawati, F., Alam, H. V., & Monoarfa, V. (2023). Pengaruh Kelelahan Kerja Dan Beban Kerja Terhadap Kesehatan Dan Keselamatan Kerja Pegawai Pada Badan Sar Nasional (Basarnas) Kota Gorontalo. *Seiko: Journal of Management &*

*Business*, *6*(2), 264–269. https://doi.org/10.37531/sejaman.v6i2.5397

Ressa, A., & Sari, M. P. (2023). Analisis Bahaya, Penilaian Risiko dan Pengendalian Risiko K3 Dengan Hirarc di PT. ABC. *Jurnal Inkofar*, *7*(1), 1–9. https://doi.org/10.46846/jurnalinkofar.v7i1.287

Setiawan, A., Ruslanjari, D., & Puspitasari, D. (2024). Penilaian Risiko Kesehatan Mental Rescuer dalam Mendukung Operasi Tanggap Darurat Bencana. *Trends in Applied Sciences, Social Science, and Education*, *2*(1), 1–14. https://doi.org/10.71383/tase.v2i1.25

Sinaga, E., Ambarita, R., & Hasibuan, N. A. (2023). Pengaruh Keselamatan dan Kesehatan Kerja terhadap Produktivitas Pegawai pada Pos Badan SAR Nasional (Basarnas) Sibolga/Tapanuli Tengah. *Jurnal Mahasiswa: Jurnal Ilmiah Penalaran Dan Penelitian Mahasiswa*, *5*(1), 77–88. https://doi.org/10.51903/jurnalmahasiswa.v5i1.519

Suarjana, I. G. E., & Kamil, I. (2024). Peran Badan Nasional Pencarian Dan Pertolongan (Basarnas) Dalam Menjamin Keselamatan Wisatawan Di Tinjau Dari Undang-Undang Republik Indonesia Nomor 29 Tahun 2014 Tentang Pencarian Dan Pertolongan:(Studi Kasus Di Kantor Pencarian Dan Pertolongan Kelas A M. *Unizar Recht Journal (URJ)*, *3*(1), 34–45. https://doi.org/10.36679/urj.v3i1.83

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

Wibowo, D., & Susianti, B. (2022). *Studi K3 dan Lingkungan Kerja*. Eureka Media Aksara. https://doi.org/