

Effectiveness of Implementing Standard Operating Procedures and Job Safety Analysis in Risk Management for Pier Pile Driving Activities: Case Study on Pier Development Pile Driving at KSP BMN Tanjung Wangi Banyuwangi

Sudarta¹, Candra², Lalu Hendra Maniza³

^{1,2}Administrasi Bisnis, Universitas Muhammadiyah Mataram

Article Info

Article history:

Accepted: 2 February 2026

Publish: 4 February 2026

Keywords:

Standard Operating Procedures; Job Safety Analysis; Occupational Safety and Health; Pile Driving; BMN Tanjung Wangi Pier.

Abstract

Occupational safety and health (OSH) is a fundamental right of workers that must be guaranteed by every employer by ensuring effective and professional risk management. In the context of the BMN Tanjung Wangi pier pile driving project in Banyuwangi, the implementation of Standard Operating Procedures (SOP) and Job Safety Analysis (JSA) plays a crucial role in controlling potential occupational hazards. This study aims to evaluate the effectiveness of SOP and JSA implementation in risk management during the project. A qualitative approach was used in this study, with data collection through in-depth interviews and field observations of parties directly involved in the project, such as planners, supervisors, technicians, and workers. The results of the study show that PT Lombok Karya Perkasa (LKP) has successfully developed and implemented SOPs and JSAs as effective work guidelines for identifying, assessing, and controlling risks. The use of SOPs and JSAs significantly helps in managing hazards, such as the risk of falling, being hit by materials, and equipment damage, which have the potential to cause work accidents. With consistent implementation, it is hoped that the pile driving project can run more safely and efficiently.

This is an open access article under the [Lisensi Creative Commons Atribusi-BerbagiSerupa 4.0 Internasional](https://creativecommons.org/licenses/by-sa/4.0/)



Corresponding Author:

Sudarta

Administrasi Bisnis, Universitas Muhammadiyah Mataram, Indonesia

Emai: sudarta@ummat.ac.id

1. INTRODUCTION

Occupational safety and health are basic needs of workers that are protected by law, which is a direct mandate from the state to employers in order to ensure the certainty of occupational risk management in order to fulfill the rights of workers to safety and health (Teoh & Leka, 2025). This is in line with the provisions that require employers to ensure occupational safety and health for workers (Mathisen, 2025).

Job Safety Analysis (JSA) is a systematic method for identifying potential hazards and assessing work risks based on the sequence of work steps (Ali Asnawi, 2025), with the main objective of preventing work accidents and controlling potential hazards before work begins (Saputra et al., 2024). This approach emphasizes the relationship between employers, supervisors, workers, tasks, tools, and the work environment (Wijaya, 2025), so that every potential hazard can be anticipated appropriately before it causes an incident (Novita, 2023). According to OSHA, Job Safety Analysis (JSA) helps organizations understand job hazards and develop effective controls to reduce risks to workers (Zaid Vagas et al., 2023). The Job Safety Analysis (JSA) process includes identifying work plans, work methods, identifying hazards at each step (Ardhiya Ulkhaq Nasrulloh et al., 2023), and recommending risk

management or control measures (Muffi & Abdullah, 2024). In the context of construction, especially high-risk jobs such as pile driving (Perth - Construction of New Premises, Forrest Place - Pile Driving - July 16, 1930, 2022), the application of Job Safety Analysis (JSA) is crucial to improve safety performance (P. A. K. Wijaya & Armyn Machfudiyanto, 2025). Construction risks are often dynamic, so Job Safety Analysis (JSA) provides risk documentation that can be used for safe work planning (Desman et al., 2023). Without the implementation of Job Safety Analysis (JSA), organizations tend to experience higher rates of workplace accidents because hazards are not systematically identified (Ilmansyah et al., 2020a).

Health, Safety, Security, and Environment (HSSE) are key assets for companies (employers) to ensure that project work runs effectively and efficiently (Cahyono & Yudoko, 2022). especially since the implementation of job safety analysis increases the awareness of companies/employers regarding the sustainability or smooth running of work as well as the management of internal and external environments (Akerstrom et al., 2026). The company/employer is committed to providing responsible and safe occupational health and safety management by protecting employees, contractors, local communities, and the environment from hazards arising from the pile driving activities at the State-Owned Property (BMN) pier at Tanjung Wangi Port – Banyuwangi (East Java).

Without a formal Job Safety Analysis and Standard Operating Procedures prepared in accordance with risk management requirements (Oktopiani & Nurwathi, 2023), hazard identification becomes unsystematic and unmeasurable in its management, so that potential work hazards are not visible and mitigation measures are not clearly formulated before work begins (Swandito et al., 2025). As a result, workers tend to face risks such as physical injury, falling, or being hit by equipment because work actions are not planned with proper risk controls (Byers & Boley, 2023). Research shows that a low understanding of SOPs correlates with an increased risk of accidents because safety procedures are not applied consistently and workers do not have safe work guidelines.

The absence of JSA also reduces the organization's ability to conduct step-by-step hazard assessments, which are a common cause of workplace accidents in construction projects. As a result, the rate of workplace accidents and the negative impact on workers and project productivity will increase significantly due to the failure to prepare job safety analysis designs and standard operating procedures related to pier pile driving work.

2. METHOD

This study used a qualitative approach. The location of the study was at the state-owned goods dock (BMN) of Tanjung Wangi port, which is a port working area under the coordination of the Tanjung Wangi – Banyuwangi (East Java) Class III Port Authority and Harbor Master's Office. The contractor for the pile driving of the BMN Tanjung Wangi pier is PT Lombok Karya Perkasa, a contractor company that has the necessary competencies and business licenses in accordance with OSS (online single submission) licensing standards.

The research was conducted from October 2025 to January 2026. The research subjects consisted of four (4) informants who had direct knowledge and responsibility for welding activities, namely a planner, supervisor, technician, and one (1) welder. Data collection was carried out through in-depth interviews, field observations, and documentation. To increase data validity, source triangulation was carried out by comparing information obtained from various informants through the interview method.

To improve data validation, triangulation of sources was carried out using information obtained from various sources through the same interview method. The

219 | Effectiveness of Implementing Standard Operating Procedures and Job Safety Analysis in Risk Management for Pier Pile Driving Activities (Case Study on Pier Development Pile Driving at KSP BMN Tanjung Wangi Banyuwangi) (Sudarta)

collected data was then analyzed using interactive analysis methods, which involved the processes of collection, reduction, presentation, and conclusion drawing. Data was systematically organized into specific categories, described in units of analysis, and then interpreted in a coherent and systematic manner, resulting in a comprehensive understanding of the potential occupational hazards involved in the pile driving activities at the BMN Tanjung Wangi pier.

3. RESULTS AND DISCUSSION

Results of the identification and management of risks and hazards to workers driving piles for the Tanjung Wangi State Property (BMN) pier by PT Lombok Karya Perkasa, based on direct observation and in-depth interviews conducted by researchers, the work process observed was found to have various potential hazards. The potential risks and hazards include: being hit by piles due to collapse or breakage, being hit by hammers due to broken wire selling, pontoons or barges tilting or leaning due to stability being disrupted by materials on top of the pontoon or barge being overloaded or unbalanced, and possibly also due to the strong underwater currents in the Banyuwangi area, people or workers falling into the water, pile pipe fractures due to the hardness of the seabed where the pile is located after being struck by a hammer, work accidents due to being hit by piles when erected next to pontoons or barges, lightning strikes due to implementation during the rainy season, and other related risks.

In the context of the risk management mentioned above, the implementing party, in this case PT Lombok Karya Perkasa, has created a Job Safety Analysis (JSA) and Standard Operating Procedures (SOP) as a reference for work related to the implementation of pile driving activities at the BMN Tanjung Wangi - Banyuwangi (East Java) pier.

Below is a summary of the Job Safety Analysis (JSA) and Standard Operating Procedures (SOP) for risk management of pile driving activities at the BMN Tanjung Wangi – Banyuwangi (East Java) pier, as follows:

A. Job Safety Analysis (Jsa) Pile Driving Work For The Bmn Tanjung Wangi Pier

1. General Job Information

- Job Name : Pile Driving for Pier
- Location : BMN pier waterfront area Tanjung Wangi – Banyuwangi (East Java)
- Method : Hammer piling / Hydraulic piling / Vibratory hammer
- Main Equipment : Crane, piling rig, pile driver, barge, sling, shackle
- Workforce : Crane operator, rigger, welder, surveyor, foreman, HSE officer
- Mandatory PPE : Safety helmet, reflective vest, safety shoes, gloves, safety goggles, life jacket

2. Work Stages, Hazards, Risks, and Control Measures;

No	Work Stage	Potential Risks & Hazards	Occupational Health and Safety Management
1	Stage 1. Site and equipment preparation;	Main Activities; a. Mobilization of pile driving equipment and materials; b. Inspection of pontoons/barge cranes and hammers; c. Marking of pile driving locations Danger;	a. Equipment inspection (daily checklist); b. Use of complete PPE and life jackets; c. Weather monitoring (BMKG info) and sea tide tables;

		<p>a. Slipping due to wet pontoon or barge deck floors caused by water or oil splashes/spills and other slippery substances;</p> <p>b. Being hit by pile driving equipment (fallen piles, falling hammers due to loss of restraint or broken wire hammers);</p> <p>c. Bad weather causing waves and sea swells that disrupt the stability of the pontoon/barge.</p> <p>Risk;</p> <p>a. Minor to fatal injuries;</p> <p>b. Damage to equipment;</p> <p>c. Workers falling into the sea.</p>	<p>d. Safety Briefing (toolbox meeting);</p> <p>e. Ensuring that no oil, fuel, or other related chemicals are placed on the pontoon/barge work area;</p> <p>f. Do not carry out piling work or activities during bad weather.</p>
2	Stage 2. Lifting and Placement of Piles;	<p>Main Activities;</p> <p>a. Securing the pole with a sling</p> <p>b. Lifting using a crane</p> <p>c. Initial placement of the pole at the pre-floated pile point</p> <p>Hazards;</p> <p>a. Sling breakage</p> <p>b. Swinging load c. Fingers, head, and other body parts getting pinched during securing</p> <p>d. Crane boom collapsing, breaking</p> <p>e. Unstable pontoon position</p> <p>Risk;</p> <p>a. Serious/fatal injury</p> <p>b. Pile falling into the sea</p> <p>c. Temporary structural damage</p> <p>d. Pontoon capsizing</p>	<p>Occupational Health and Safety Management;</p> <p>a. Certified slings and shackles, ensured to be fit for purpose and meet work requirements</p> <p>b. Certified riggers, ensured to be fit for purpose and meet work requirements</p> <p>c. Sterile work area (exclusion zone)</p> <p>d. Standard hand signals</p> <p>e. Use of complete PPE</p> <p>f. Focus and perform checks and rechecks before commencing activities;</p> <p>g. Ensure that the crane position does not exceed the pontoon stability settings and that there is no accumulation of materials on the pontoon other than those specified in relation to pontoon stability.</p>
3	Stage 3: Alignment and Welding of Joints (If Any)	<p>Activities;</p> <p>a. Vertical alignment of poles;</p> <p>b. Welding of pole joints;</p> <p>c. Setting the position of the hammer;</p>	<p>Occupational Health and Safety Management;</p>

		<p>Potential Hazards;</p> <ul style="list-style-type: none"> a. Exposure to welding fumes b. Sparks c. Falling from heights <p>Risks;</p> <ul style="list-style-type: none"> a. Burns b. Respiratory problems c. Fall injuries 	<ul style="list-style-type: none"> a. Complete welding PPE (welding helmet, heat-resistant gloves) b. Adequate ventilation c. Full body harness when working at heights d. Hot work permit
4	Stage 4: Piling Process	<p>Activities;</p> <ul style="list-style-type: none"> a. Hammer lowering b. Pile driving to planned depth <p>Potential Hazards;</p> <ul style="list-style-type: none"> a. Hammer detaching from its mount b. Vibrations causing disruption to surrounding properties and high noise levels c. Pile breaking or tilting d. Hammer detaching from its mount e. Hearing impairment <p>Risks;</p> <ul style="list-style-type: none"> a. Pile breakage b. Pile tilting due to hammer blows that do not comply with established techniques c. Pontoon or barge tilting due to unbalanced/inappropriate pontoon load or overcapacity. 	<p>Occupational Health and Safety Management;</p> <ul style="list-style-type: none"> a. Create SOPs for lowering the hammer head. b. Lowering is assisted by a safety support system. c. Do not immediately carry out piling in positions close to other properties. d. Ensure that properties at the piling location are monitored for strength and accurate information related to valid data and information related to properties in the piling area (buildings, existing docks, and other related properties).
5	Stage 5: Cutting the Pole Head and Finishing	<p>Activities;</p> <ul style="list-style-type: none"> a. Cutting piles b. Cleaning the work area c. Potential Hazards d. Sparks e. Cut wounds f. Falling materials g. Structural failure <p>Potential Hazards;</p> <ul style="list-style-type: none"> a. Sparks b. Cuts c. Falling materials d. Cutting tools detaching from handles <p>Risks;</p> <ul style="list-style-type: none"> a. Minor to severe injuries 	<p>Occupational Health and Safety Management;</p> <ul style="list-style-type: none"> a. Complete PPE b. Fire extinguisher standby c. Housekeeping work area <p>General K3 Control</p> <ul style="list-style-type: none"> a. Implementation of SMK3 and Permit to Work b. Continuous HSE supervision c. Emergency Response Plan (ERP) d. Special K3 training for marine work

		b. Small fires c. Workers' positions during cutting are unsafe and prone to falling into the sea	e. Daily briefing and evaluation
--	--	---	----------------------------------

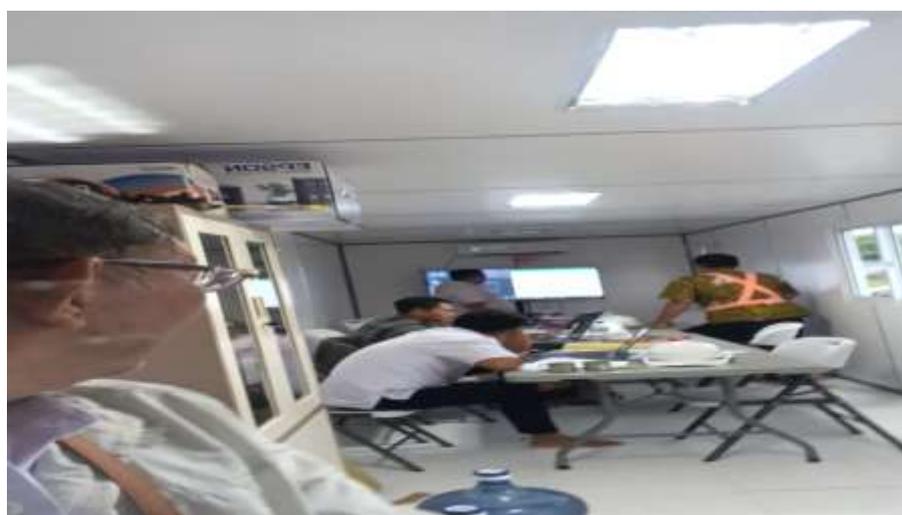
Based on the table above, the researcher concluded that the types of hazards with the highest potential for occurrence were: broken or collapsed crane piles, workers falling into the water, being hit by a crane hammer due to a broken wire, because the work is carried out above water where the floor contour is unstable due to being above the water surface and is highly dependent on the weather, where the work is carried out during the rainy season (September, October, November, and December). In addition to the major risks mentioned above, there are medium risks that have the potential to cause hearing impairment, noise from the sound of the hammer hitting the steel piles, and the fumes and strong smell from welding, especially during the welding of steel piles.

B. Pre-Piling Implementation

At this stage, all members of the Tanjung Wangi state-owned property (BMN) pier construction project team must review the following brief explanation in the form of images and descriptions before carrying out the main construction activities:



The workers performed a thanksgiving ceremony before carrying out the piling work. This is a familiar ritual performed before the implementation of a project. The



purpose of the thanksgiving ceremony is to ask Allah SWT for ease and smoothness in carrying out the piling work.

Pre-activity meeting as part of Check Only Do Action, where prior to the implementation of the piling activity, a final meeting is held to ensure that nothing is overlooked in relation to the implementation of the piling, starting from administrative verification, manpower readiness, pontoon/crane barge, pile pipes, hammers, wire quality, and other related preparations.



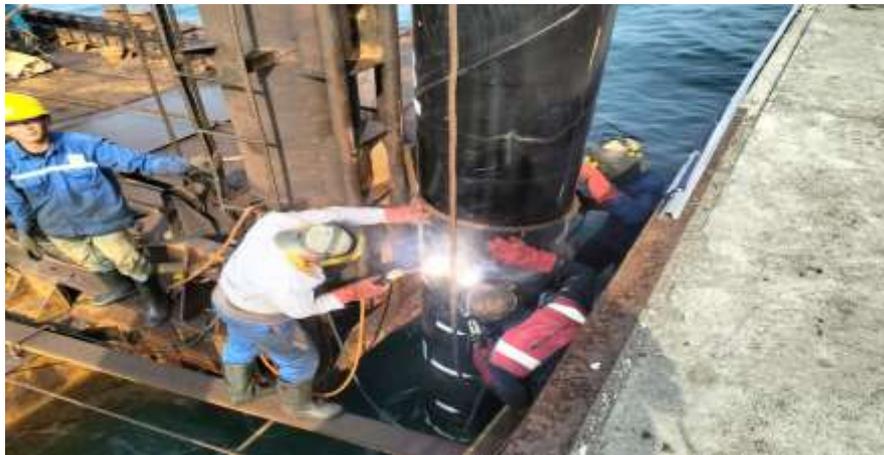
The final survey is related to ensuring that the equipment, tools, manpower, and other supporting factors are ready and in accordance with the list of equipment and tools as well as manpower requirements prior to the implementation of the piling.



Modification or addition of material to the lower piles is related to the function of the piles that go into the seabed.



Ensuring that the pile position is straight before striking it with a hammer is related to the pile driving process.



The pipe pile connection process is related to the depth of the pipe pile embedded in the seabed, which is adjusted to the pile strength at a certain depth.

C. Standard Operating Procedures

In addition to the job safety analysis above, a standard operating procedure was also developed to serve as a barrier to activities in risk management, as follows:

STANDARD OPERATING PROCEDURES (S.O.P) **PILING ACTIVITIES FOR THE KSP – BMN TANJUNG WANGI** **DEVELOPMENT PIER**

1. Objective;

This SOP has been prepared as a guideline for the implementation of pile driving activities in the construction of the KSP BMN Tanjung Wangi pier so that it runs safely, systematically, efficiently, and in accordance with Occupational Safety and Health (OSH) standards and technical provisions for port construction.

2. Scope;

This SOP applies to all stages of pier pile driving work, including; Work preparation, Mobilization of equipment and materials, Piling implementation, 225 | Effectiveness of Implementing Standard Operating Procedures and Job Safety Analysis in Risk Management for Pier Pile Driving Activities (Case Study on Pier Development Pile Driving at KSP BMN Tanjung Wangi Banyuwangi) (Sudarta)

Quality control and work safety, Emergency response, Work closure, Job safety analysis.

3. Legal Basis and Reference Standards;

Law No. 1 of 1970 concerning Occupational Safety

- Law No. 2 of 2017 concerning Construction Services
- Regulation of the Minister of Manpower of the Republic of Indonesia No. 5 of 2018 concerning Occupational Safety and Health in the Workplace
- Regulation of the Minister of Public Works and Public Housing No. 10 of 2021 concerning the Construction Safety Management System (SMKK)
- Indonesian National Standards (SNI) related to pile driving and pier structures
- International Labour Organization (ILO) – Occupational Safety and Health in Construction

4. Definition;

- Piles: Vertical structural elements driven into the seabed to transfer the load of the pier structure.
- Piling: The process of driving piles into the ground using piling equipment.
- Work Area: A restricted zone where piling activities take place.
- PPE: Personal Protective Equipment that must be used by all workers

5. Responsibility;

- Project Manager: Responsible for the overall implementation of the work.
- Site Engineer: Oversees the technical aspects of piling.
- K3 Officer: Oversees the implementation of K3 and compliance with PPE use.
- Piling Equipment Operator: Operates equipment in accordance with procedures and safety standards.
- Field Worker: Carries out work in accordance with instructions and SOPs.

6. Equipment and PPE;

Main Equipment, Hydraulic pile hammer / diesel hammer, Crane / pontoon crane, Pile driver, Elevation and verticality measuring tools, Ear protection (hear off), Personal Protective Equipment (PPE), Safety helmet, Reflective vest, Safety shoes, Work gloves, Safety glasses, Life jacket for work on water.

7. Implementation Procedures;

7.1 Prepare Stage;

- a) Conduct a toolbox meeting before work begins, b) Ensure that a work permit has been issued, b) Inspect the pile driving equipment and crane, c) Establish and install K3 signs and work area barriers, d) Ensure that weather and tidal conditions are safe for work.

7.2 Mobilization of Equipment and Materials;

- a) Transporting piles to the work site using safe methods, c) Arranging piles in a stable manner that does not interfere with the work path, c) Conducting visual inspections of the condition of the piles.

7.3 Piling Process;

- a) Adjusting the position of the piling equipment according to the design points, b) Lift the piles using a crane with appropriate slings, c) Place the piles on the leader in an upright position, d) Start pile driving gradually and in a controlled manner, e) Monitor the penetration, depth, and verticality of the piles, f) Stop work if there are irregularities or potential hazards.

7.4 Quality and Safety Control;

- a) Record piling data (number of blows, depth, time), b) Ensure no workers are under suspended loads, c) Conduct continuous K3 supervision, d) Control noise and vibration according to quality standards.

7.5 Emergency Response;

- a) Stop work immediately in the event of an accident, b) Provide first aid, c) Report the incident to the K3 officer and project manager, d) Secure the incident area.

7.6 Completion of Work;

- a) Clean the work area of materials and equipment, b) Conduct a final inspection of the piling results, c) Prepare a work implementation report, d) Conduct a post-work K3 evaluation.

8. Prohibition;

Working without wearing complete PPE, Operating equipment without certification, Working outside the designated area, Continuing work in extreme weather conditions, Joking around that causes distraction, Working while sick, Using a cell phone while performing piling activities, Ensuring that there are no spills of oil, lubricants, or other chemicals.

9. Closing

This SOP must be complied with by all parties involved in the pile driving activities at the BMN Tanjung Wangi pier. Compliance with this SOP is expected to minimize the risk of workplace accidents and ensure the quality and sustainability of pier construction.

Based on the standard operating procedure design obtained, it is confirmed that the implementation of the BMN Tanjung Wangi pier pile driving work already has sufficient guidelines for pile driving and is capable of managing the risks of pier pile driving work, as well as providing guidelines for workers related to occupational safety and health during the implementation of the BMN Tanjung Wangi pier construction project.

The implementation of Job Safety Analysis (JSA) and Standard Operating Procedures (SOP) in the pile driving activities at the BMN Pier in Tanjung Wangi Port, Banyuwangi, plays a significant role in controlling the risk of workplace accidents. Based on field observations and document analysis, the pile driving work involves several stages carried out by the project leader before the main pile driving activities, including:

Identification of Potential Hazards Using the Job Safety Analysis Method by the Project Leader of PT Lombok Karya Perkasa

Hazard identification in this study was conducted based on primary data obtained through interviews and direct observation of workers, consisting of project managers, planners, supervisors, technicians, and welders. Based on these results, five work stages were identified as having potential hazards, as follows:

Ensuring the legal standing of the BMN Tanjung Wangi pier pile driving construction activity

Legal certainty is the most fundamental aspect of the BMN Tanjung Wangi pier pile driving activity, where this legal aspect must first be secured before carrying out the pile driving activity. The legal standing from relevant agencies, such as building permits, technical recommendations from authorities, RKKPL management, and other related permits, will ensure that the pile driving is legally clear.

Performing line clearance

Line clearance is a field stage that must not be overlooked, ensuring that the location is ready both physically and in terms of layout planning for the placement of equipment, tools, and materials that support the smooth mobilization of materials, equipment, and container offices as multipurpose buildings related to further activity planning and other related supporting factors.

Ensuring Human Resources Understand Piling and Water Structure Aspects

Based on interviews and field observations, the piling process carried out by PT Lombok Karya Perkasa begins with ensuring that all workers involved understand the technical and procedural aspects in accordance with the provisions stated in the Job Safety Analysis and Standard Operating Procedure (SOP). A pre-activity meeting was held, followed by a socialization or presentation of the Job Safety Analysis and Standard Operating Procedures, which was accompanied by a question and answer session in order to obtain clearer and more straightforward explanations so that ignorance or lack of understanding of the SOP could lead to various risks, such as work accidents, minor or serious injuries, and damage to equipment. These findings show that the level of workers' competence and understanding of occupational safety still needs to be improved. Factors contributing to this condition include a lack of guidance before work is carried out, the absence of routine evaluations, and so on.

Conducting a joint field survey related to the placement of property, equipment, tools, and pile driving materials.

The placement of container offices, material stacking, and work equipment, including surveying the position of pontoons/crane barges for pile driving, to ensure more efficient and effective access to pile driving materials, is an equally important step in supporting the smooth implementation of the BMN Tanjung Wangi pier pile driving.

This stage involves inspecting the condition of the work area and the objects to be worked on before welding activities begin. Based on the results of identifying potential hazards using the Job Safety Analysis (JSA) method, it was found that this stage has various risks that can affect worker safety. Working conditions that are cramped, slippery, located at heights, or have inadequate lighting can cause incidents such as slipping, falling, being hit, or being crushed by work objects. In addition, the risk of injury can also arise if workers trip or are pierced by sharp objects hidden around the work area if the environment is not thoroughly inspected.

Interviews with workers, supervisors, and welders revealed that field readiness is a factor that can detect potential risks, including lightning strikes, rainwater puddles, material accumulation locations that can obstruct truck maneuvers, and other related risks.

Mobilization of equipment, tools, and materials

This stage describes the readiness of work in progress so that with the delivery of equipment, tools, and materials to support the smooth implementation of the BMN pier pile driving project, it can be realized in accordance with the timeline set by the activity implementer, in this case PT Lombok Karya Perkasa. Some of the equipment in question includes: container offices, project electrical installations, furniture, computers, tables, Wi-Fi installations, lightning rod installations, pile pipes, concrete, sand, cement, and main work equipment such as pontoons/crane barges, crane pile settings, and pile testing readiness to detect factors that could hinder the pile driving activities.

Inspecting equipment, tools, materials, and support systems to ensure the smooth implementation of pile driving.

This stage is part of the “check only, do action” commitment to ensure the readiness of equipment, tools, and other support systems, including the availability and presence of materials that have arrived at the project site. At this stage, modifications are also made to

the pile materials, such as adding plates to the bottom of the tapered pile to facilitate the pile's entry into the seabed at the mapped sea depth. PPE related to offshore and onshore work is ensured to be recorded and optimally fulfilled without any shortage of personal protective equipment (PPE) such as helmets, safety glasses, goggles, etc.

Shifting pontoons/crane barges, setting pile driving equipment, hammers, and ensuring the stability of pontoons/crane barges on the water

The pontoon or crane barge shifting stage is a very crucial initial stage in pile driving activities in the water, as it determines the accuracy of the work position and the safety of the entire team. The shifting is carried out in stages with the help of a land crane in order to move the pontoon/barge and other property from land to the water side (next to the existing pier). The position of the barge or pontoon follows the pile point coordinates that have been determined based on the survey and setting out results. At this stage, the main potential hazards include uncontrolled shifting due to currents and waves, collisions with existing structures, and the risk of workers falling into the sea. Therefore, control is carried out by ensuring effective communication between operators, riggers, and ship crews, as well as installing signs and barriers around the work area to ensure personnel safety.

Once the pontoon or crane barge is in the planned position, the pile and hammer are carefully and controlledly set up. The pile is lifted using lifting gear that has been checked for suitability, then erected vertically in accordance with the permitted tilt tolerance. Next, the hammer is positioned directly above the pile head to ensure that the impact energy is transferred optimally and safely. At this stage, risks such as load swing, lifting equipment failure, and pile misalignment are of primary concern, so the implementation of safe work procedures and strict supervision are essential to prevent work accidents.

The final stage in this series is to ensure the stability of the pontoon or crane barge during the piling process. Stability is achieved by adjusting the ballast, adjusting the spud or anchor system, and regularly monitoring weather and sea current conditions. The pontoon must be in a balanced condition to prevent excessive tilting that could interfere with the piling equipment's operation and endanger workers. Controlling stability is an important part of risk management, as failure to maintain the pontoon's balance can result in serious accidents, equipment damage, and disruption to the dock structure. Therefore, this stage requires good coordination, compliance with Standard Operating Procedures, and consistent implementation of Job Safety Analysis.

Conducting test piling before carrying out the main pile driving work

Test piling is a very important initial stage before the main pile driving work is carried out in full. This test aims to ensure the suitability of the design plan with the actual soil conditions in the field, as well as to verify the performance of the pile driving equipment to be used. This activity forms the technical and safety basis for determining the piling method, type of hammer, impact energy, and estimated expected pile bearing capacity.

The first stage of the piling test begins with determining the test points based on the plan drawings and recommendations from the structural and geotechnical planners. The test point locations are selected in areas that represent the dominant soil conditions at the project site. Once the points are determined, setting out and checking the position of the pontoon or crane barge are carried out to ensure they are at the correct coordinates and in a stable condition on the water. At this stage, the feasibility of the equipment, lifting system, and work safety devices are also checked in accordance with the SOP and Job Safety Analysis (JSA) that have been prepared.

The next stage is the installation and erection of piles in the test position. The piles are lifted vertically using lifting equipment that has been checked for suitability, then positioned and locked in place so that they do not shift during the pile driving process. Next,

229 | Effectiveness of Implementing Standard Operating Procedures and Job Safety Analysis in Risk Management for Pier Pile Driving Activities (Case Study on Pier Development Pile Driving at KSP BMN Tanjung Wangi Banyuwangi) (Sudarta)

the hammer is installed and aligned with the pile head to ensure optimal and safe transfer of impact energy. At this stage, technical and safety supervision is carried out strictly to prevent risks such as load swing, pile tilt, or equipment failure.

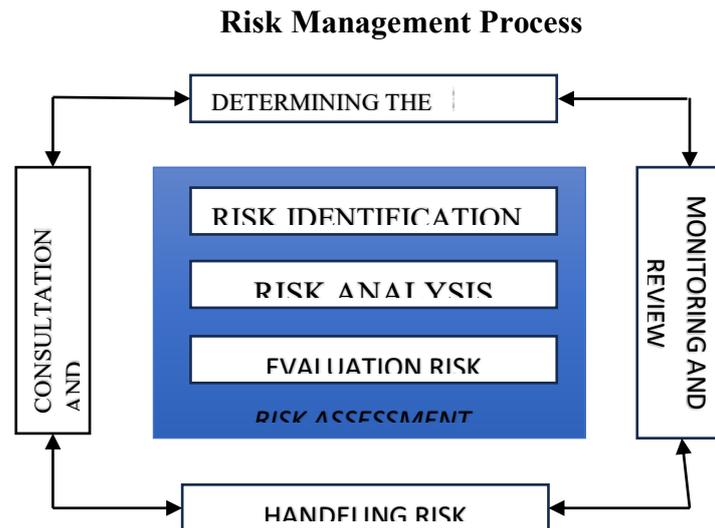
The test pile driving process is then carried out by striking the pile gradually until it reaches the specified depth or criteria, such as the number of blows per penetration (blow count) or the final set value. During pile driving, detailed technical data is recorded, including the number of blows, penetration depth, soil response, and equipment conditions. This data forms the basis for evaluation to determine whether the pile driving method, hammer type, and energy used are in accordance with the initial plan.

The final stage of pile driving testing is the evaluation and analysis of test results. Pile driving records are compared with technical specifications and design calculations to assess the adequacy of pile bearing capacity and structural stability. If the test results show compliance, the pile driving method and parameters are used as a reference for the main pile driving work. Conversely, if discrepancies are found, adjustments are made to the work methods, equipment, or technical design before the main work is carried out. Thus, pile driving tests play an important role in ensuring work safety, construction quality, and the overall success of pile driving.

Risk Control Using the Job Safety Analysis Method and the implementation of Standard Operating Procedures as stipulated by PT Lombok Karya Perkasa as the main contractor for the piling activities.

At this stage, mapping of identified hazards is carried out, requiring control measures to be taken as part of risk management efforts, including prevention and control of risks arising in the work. For all stages of work, the control measures applied to the piling work are as follows:

1. Ensuring the legal standing of the piling activities
2. Ensuring the readiness of manpower
3. Ensuring that Standard Operating Procedures (SOPs) are followed in the implementation of each activity covered by the Standard Operating Procedures and Job Safety Analysis;
4. Monitoring weather conditions related to rain, wind, and lightning, so that if indicators of rain, wind, and lightning risk are monitored, the project implementer, in this case PT Lombok Karya Perkasa, will postpone or temporarily stop the piling work
5. Always conducting safety briefings and safety talks with workers before carrying out piling activities and other supporting activities
6. Always coordinate with relevant personnel before, during, and even after the execution of daily work, in order to report the time sheet for the piling project as part of the daily activity report.



The risk management process is a series of sequential and systematic activities aimed at managing uncertainty so that organizational objectives can be achieved optimally. Risks cannot be eliminated because they are inherent in every organizational activity, but they can be controlled through a structured management approach. With proper management, risks can be reduced to an acceptable level. Therefore, risk management serves as a strategic tool for maintaining organizational sustainability. Below is a diagram of the risk management process concept, which emphasizes that risk management is a sequential and structured risk management concept.

4. CONCLUSION

The existence of job safety analysis and standard operating procedures is a risk management system that has a vital function in the implementation of pile driving projects, awareness and concern as well as compliance of the entire project community, starting from the company, project manager, supervisors, and workers, are supporting components for the successful implementation of job safety analysis and standard operating procedures, and this is accommodated by the implementing party, PT Lombok Karya Perkasa (LKP).

Risk control as inventoried in the job safety analysis will be effective in managing risks and hazards in the implementation of piling activities, as is known, the potential for being hit by a pile, wire hammer breakage, falling into the sea and overturning of pontoons or barges, hearing impairment and even hearing loss due to pile driving noise when the hammer hits the iron pile, and other related risks and hazards can be managed properly by complying with and adhering to standard operating procedures by all pile driving project personnel.

5. ACKNOWLEDGMENTS

Praise be to God and thank you very much for the completion of this research journal, which I have compiled with patience and optimism that it will be completed on time. I realize that this work is not yet optimal and has many shortcomings. Therefore, I kindly request corrections and improvements so that it can become a simple work that is useful in relation to risk management in general and a reference for the creation of job safety analysis and standard operating procedures, particularly in the implementation of water structure

231 | Effectiveness of Implementing Standard Operating Procedures and Job Safety Analysis in Risk Management for Pier Pile Driving Activities (Case Study on Pier Development Pile Driving at KSP BMN Tanjung Wangi Banyuwangi) (Sudarta)

piling activities. Thank you to my small family, colleagues, and those who supported the publication of this journal. That is all, and thank you.

6. BIBLIOGRAPHY

- Akerstrom, M., Wahlström, J., Reineholm, C., & Jonsdottir, I. H. (2026). Employers' utilization of and collaboration with occupational health services in preventive occupational health and safety management. *Scandinavian Journal of Work, Environment & Health*. <https://doi.org/10.5271/sjweh.4269>
- Ali Asnawi. (2025). Analisis Keselamatan dan Kesehatan Kerja (K3) untuk Meminimalisir Potensi Bahaya Menggunakan Metode Job Safety Analysis (JSA) di UMKM Bleduk Jati. *Journal of Engineering and Applied Technology*, 1(2), 108–119. <https://doi.org/10.65310/3tnv1192>
- Ardhiya Ulkhaq Nasrulloh, Aloysius Tommy Hendrawan, & Erny Untari. (2023). 1. Pendahuluan, Hak setiap peker ANALISIS POTENSI BAHAYA KERJA DENGAN METODE JOB SAFETY ANALYSIS (JSA) SEBAGAI UPAYA PENCEGAHAN KECELAKAAN DI PT X. *Metode: Jurnal Teknik Industri*, 9(2), 134–143. <https://doi.org/10.33506/mt.v9i2.2699>
- Byers, M., & Boley, A. (2023). *Airplanes face a growing risk of being hit by uncontrolled re-entries of rockets used to launch satellites*. The Conversation. <https://doi.org/10.64628/aam.hhkx9e4m3>
- Cahyono, B. N., & Yudoko, G. (2022). Toward health, safety, security, & environment (HSSE) integration into business sustainability of marine, shipping, & logistics companies in Indonesia. *Inclusive Society and Sustainability Studies*, 2(2), 17–31. <https://doi.org/10.31098/issues.v2i2.1118>
- Desman, S., Ridha Sari, & Hanifah Hasnur. (2023). Identifikasi risiko keselamatan kerja dengan menggunakan metoda job safety analysis (JSA) pada rencana proyek perkantoran terpadu Kota Payakumbuh. *Jurnal Bangunan, Konstruksi & Desain*, 1(3), 141–148. <https://doi.org/10.25077/jbkd.1.3.141-148.2023>
- Ilmansyah, Y., Mahbubah, N. A., & Widyaningrum, D. (2020b). Penerapan job safety analysis sebagai upaya pencegahan kecelakaan kerja dan perbaikan keselamatan kerja di PT Shell Indonesia. *PROFISIENSI: Jurnal Program Studi Teknik Industri*, 8(1), 15–22. <https://doi.org/10.33373/profis.v8i1.2521>
- Mathisen, G. E. (2025). Occupational health and safety interventions for older workers: Best practice. In *Research Handbook on Older Workers and Occupational Health and Safety* (pp. 196–218). Edward Elgar Publishing. <https://doi.org/10.4337/9781035330447.00016>
- Muffi, K., & Abdullah, R. (2024b). Job Safety Analysis (JSA) of work accidents on wood work machines in the construction workshop. *CIVED*, 11(1), 380–393. <https://doi.org/10.24036/cived.v11i1.607>
- Novita, H. I. S. (2023). Perlindungan hukum terhadap pekerja rumah tangga (PRT) dalam perjanjian kerja secara lisan dengan pemberi kerja. *HUKUM DAN DINAMIKA MASYARAKAT*, 21(2), 75. <https://doi.org/10.56444/hdm.v21i2.4314>
- Oktopiani, Y., & Nurwathi, N. (2023). Rancangan standar operasional prosedur (sop) pekerjaan pengelasan sesuai keselamatan dan kesehatan kerja (k3) menggunakan metode job safety analysis (jsa). *Prosiding Seminar Sosial Politik, Bisnis, Akuntansi Dan Teknik*, 5, 192. <https://doi.org/10.32897/sobat.2023.5.0.3097>
- Perth - Construction of new premises, Forrest Place - Pile driving - 16 July 1930. (2022). Reserve Bank of Australia. https://doi.org/10.47688/rba_archives_pn-000407

- Saputra, R., Wahyu, A., Muhammad Saleh, L., Thamrin, Y., Naiem, M. F., & Syam, A. (2024). Analysis of potential hazards with Job Safety Analysis (JSA) method on cargo loading work on cargo ship MV. Wujiang at PT X. *International Journal of Chemical and Biochemical Sciences*, 25(19). <https://doi.org/10.62877/89-ijcbs-24-25-19-89>
- Swandito, A., Kobandaha, T. M. P., Rusba, K., & Ramdan, M. (2025). Analisis bahaya dan risiko pekerjaan pemasangan support dan cable tray proyek RDMP PT.WIFGASINDO dengan metode Job safety analysis. *IDENTIFIKASI*, 11(2), 244–249. <https://doi.org/10.36277/identifikasi.v11i2.568>
- Teoh, K., & Leka, S. (2025). Occupational safety and health for older workers: A European policy perspective. In *Research Handbook on Older Workers and Occupational Health and Safety* (pp. 14–32). Edward Elgar Publishing. <https://doi.org/10.4337/9781035330447.00007>
- Wijaya, P. A. K., & Armyn Machfudiyanto, R. (2025). Identification of construction safety risks for irrigation network project based on the work breakdown structure (WBS) to improve construction safety performance. *Jurnal Infrastruktur*, 11(1), 35–43. <https://doi.org/10.35814/s7x16v93>
- Zaid Vagas, A., Ruwana, I., & Galuh, H. (2023). Usulan penerapan (K3) pada stasiun boiler untuk mengurangi risiko kecelakaan kerja menggunakan metode Job safety analysis (JSA). *Jurnal Valtech*, 6(2), 153–156. <https://doi.org/10.36040/valtech.v6i2.7269>