Analysis of Factors Influencing Workplace Accidents against Workers at PT. Dok and Perkapalan Gandasari Indonesia In 2025

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Abstract: The shipyard industry is recognized as a high-risk sector for occupational accidents due to the complex interaction between human factors, workplace conditions, and safety management systems; therefore, the increasing operational activities at PT. Dok and Perkapalan Gandasari Indonesia necessitate effective occupational safety management to minimize accident risks. This study aims to analyze the factors influencing occupational accidents among workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025. The study using an analytic observational design with a cross-sectional approach, involving 191 workers selected through simple random sampling; data were collected using structured questionnaires and observation sheets, then analyzed using the Chi-square test for bivariate analysis and multiple logistic regression for multivariate analysis. The results showed that unsafe acts, unsafe conditions, work fatigue, and training experience were significantly associated with occupational accidents ($p < 0.05$); moreover, multivariate analysis indicated that work fatigue was the most dominant risk factor (OR = 15.311), followed by unsafe acts as a significant predictor in the final model, while unsafe conditions and training experience were not statistically significant despite showing a tendency to increase risk. In conclusion, work fatigue is the most dominant factor contributing to occupational accidents, followed by unsafe acts. Therefore, prevention efforts should prioritize controlling work fatigue through adequate regulation of working hours and rest periods, alongside strengthening control of unsafe behaviors, improving workplace conditions, and enhancing continuous safety training programs.

Keywords: Occupational accidents, Unsafe action, Unsafe condition, Work fatigue, Training experience.

INTRODUCTION

Occupational safety and health is an essential component of public health because workplace hazards can affect workers' physical, mental, and social well-being. Occupational accidents are therefore not merely operational or managerial events but worker health outcomes that may result in injury, disability, psychological distress, reduced quality of life, work absence, and increased healthcare and compensation burdens. Effective occupational safety and health implementation is particularly important in high-risk industries, where workers are routinely exposed to physical, mechanical, chemical, ergonomic, and organizational hazards [1].

In Indonesia, occupational accidents remain a major worker health concern. BPJS Employment data indicate that occupational accident cases have remained high and increased in recent years, demonstrating that existing preventive measures have not fully controlled workplace injury risks. Beyond their effects on productivity, these incidents place substantial burdens on workers, families, employers, healthcare services, and social protection systems. Occupational safety and health should therefore be regarded as a long-term investment in worker health rather than solely as a regulatory obligation or operational cost [2].

Maritime and shipyard workers face distinctive occupational health risks because their work combines hazardous equipment, confined spaces, heavy materials, welding activities, irregular schedules, environmental exposure, and demanding physical tasks. Seafarers and maritime workers may also experience sleep disruption, psychological strain, and somatic symptoms associated with workload and onboard working conditions [3]. Globally, the International Labour Organization estimates that approximately 2.78 million workers die annually from occupational accidents and work-related diseases, while hundreds of millions experience non-fatal occupational injuries [4]. These figures demonstrate that occupational accidents constitute a substantial medical and public health burden rather than an isolated workplace safety problem.

The maritime sector remains particularly vulnerable. International data reported by 51 countries documented 403 seafarer deaths in 2023, with diseases, persons falling overboard, and occupational accidents among the principal reported causes [5]. Shipyard and maritime operations involve complex interactions between workers, equipment, workplace environments, and organizational systems. Fatigue is especially important because physically demanding work, inadequate rest, environmental stressors, and disrupted sleep may reduce alertness, concentration, reaction time, decision-making ability, and motor coordination. Studies among ship crews have shown that physical workplace conditions are closely related

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to occupational fatigue, indicating its importance as both a physiological health concern and an injury risk factor [6].

Unsafe actions are another important component of occupational accident risk. In shipyard settings, these actions may include failing to use personal protective equipment, ignoring standard operating procedures, welding without appropriate eye protection, working beneath suspended loads, or entering restricted and confined areas without authorization. Unsafe behavior may be associated with inadequate knowledge, unfavorable attitudes, weak supervision, production pressure, and insufficient safety reinforcement [7]. However, occupational accidents should not be attributed solely to individual workers because unsafe actions often occur within organizational environments characterized by workload pressures, inadequate hazard control, limited communication, and weaknesses in safety management.

Unsafe conditions, including defective equipment, inadequate lighting or ventilation, disorganized material storage, exposed cables, slippery surfaces, insufficient machine guarding, and ineffective emergency communication, may further increase workers' exposure to injury-producing hazards. In combination with fatigue, unsafe behavior, and inadequate training, these conditions can contribute to incidents that affect workers' health and functional capacity. Heinrich's Domino Theory describes occupational accidents as the result of a sequence of contributing factors, including unsafe acts and unsafe conditions [14]. Similarly, Reason's systems approach emphasizes that accidents arise from interacting individual and organizational failures rather than from a single isolated error [16].

Although workplace accident research commonly focuses on safety management, its relevance to medical and public health research lies in the prevention of occupational injuries, disability, psychological consequences, and other adverse worker health outcomes. Statistical analysis is essential for estimating associations between multiple occupational exposures and a binary accident outcome while accounting for other variables included in the model. Therefore, this study aimed to analyze factors associated with occupational accidents among workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025 using bivariate analysis and multiple logistic regression. The findings are expected to support evidence-based occupational injury prevention and strengthen the application of statistical methods in occupational health research.

RESEARCH METHODS

This quantitative analytical observational study used a cross-sectional design to examine factors associated with occupational accidents among workers at PT. Dok and Perkapalan Gandasari Indonesia. The study was conducted from October to November 2025. The study population consisted of all workers at the company, from whom 191 respondents were selected using simple random sampling. The sample size was calculated using the Lemeshow formula. Data were collected using standardized questionnaires and observation instruments that had been tested for validity and reliability, including the Occupational Accident Questionnaire, the Industrial Fatigue Research Committee questionnaire, and an unsafe condition assessment instrument based on Decree of the Director General No. 84 of 1998. Data collection was conducted directly by the research team. PT. Dok and Perkapalan Gandasari Indonesia only provided permission and access to the research site and had no involvement in respondent selection, questionnaire administration, data analysis, interpretation of the findings, or manuscript preparation.

The collected data were processed through editing, coding, data entry, and cleaning. Univariate analysis was performed to describe the distribution of respondent characteristics and study variables using frequencies and percentages. Bivariate associations between the independent variables and occupational accidents were examined using the Chi-square test. Variables showing statistically significant associations in the bivariate analysis were entered into the multiple logistic regression model. A backward sequential selection procedure was applied by removing the variable with the highest non-significant p-value at each stage while retaining variables with statistical or theoretical relevance to occupational accident risk. Associations were reported as odds ratios with 95% confidence intervals. Multicollinearity among the independent variables was assessed using tolerance and variance inflation factor values. The adequacy of the final logistic regression model was evaluated using the Hosmer–Lemeshow goodness-of-fit test and overall classification accuracy. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Validity testing is a test used to determine the validity of a questionnaire. This study conducted a validity test to evaluate the validity of each question in the questionnaire and compared the results with the r table for the significance level. The instrument validity test was conducted using the Pearson product moment correlation between the score of each item and the

Table 1: Summary of Validity Test Results for the Unsafe Condition Questionnaire

Construct	Validation Sample (n)	Number of Items	Critical r-Value	Corrected Item–Total Correlation Range	Lowest Correlation	Highest Correlation	Valid Items
Unsafe condition	32	20	0.361	0.488–0.694	Items 11 and 17 (r = 0.488)	Item 1 (r = 0.694)	20 (100%)

Note: An item was considered valid when its corrected item–total correlation coefficient was greater than the critical r-value of 0.361 at α = 0.05 and df = 30.

total construct score. The item-total correlation value was obtained from the Corrected Item-Total Correlation column in the SPSS reliability analysis output. A statement or question is considered valid if the calculated r is greater than the r table or the significance value is less than 0.05.

The validity test showed that the corrected item–total correlation coefficients of the 20 unsafe condition questionnaire items ranged from 0.488 to 0.694. The lowest coefficients were observed for Items 11 and 17, whereas Item 1 had the highest coefficient. Because all coefficients exceeded the critical r-value of 0.361, all questionnaire items were considered valid and suitable for inclusion in the study. The complete item-level validity results are provided in the supplementary material. Table value obtained based on degrees freedom (df = N − 2), with amount respondents as many as 32 people, so that obtained df = 30. At the level significance α = 0.05, the r- value of the table used as comparator is 0.361. Statement item declared valid if r - value more big from r- table value (r > 0.361). The purpose of the reliability test is to determine the level of internal consistency of the research instrument, namely the extent to which the items in the questionnaire provide stable and uniform results in measuring a construct. The reliability test in this study was conducted using the Cronbach's Alpha coefficient. According to the general criteria for reliability testing, an instrument is declared reliable if the Cronbach's Alpha value is ≥ 0.60, reliability is considered good if the value is ≥ 0.70, and reliability is considered very good if the value is ≥ 0.80.

Based on results analysis shown in Table **2**, the Unsafe condition variable measured with 20 statement items get Cronbach's Alpha value is 0.941. This value Far exceeds the minimum reliability limit (0.60), so that instrument study This own level very high reliability. With thus, it can concluded that all statement items in questionnaire study This consistent, stable, and can trusted as tool measure, so that worthy used in the research data collection process.

Table 2: Reliability Test Results

Variables	n	Croncbach's Alpha	Information
Unsafe condition	20	0.941	Reliable

Based on Table **3**. Shows distribution respondents based on group work accident of the 191 respondents, 116 workers (60.7%) had experienced an occupational accident, whereas 75 workers (39.3%) had never experienced an occupational accident.

Table 3: Distribution Respondents Based on Work accident on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Work accident	N	%
Accident	116	60.7
Not Accident	75	39.3
Total	191	100

Based on Table **4** shows distribution Frequency Age Respondents, can explained that of a total of 191 respondents, the group age young totaling 102 respondents (53.4%), while group age old totaling 89 respondents (46.6%).

Table 4: Distribution Respondents Based on Age of Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Age	n	%
Young Age	102	53.4
Old Age	89	46.6
Total	191	100

Based on Table **5** shows Distribution Frequency of Respondent Gender, can explained that respondents with type sex Woman totaling 16 people (8.4%), while respondents man totaling 175 people (91.6%).

Table 5: Distribution Respondents Based on Gender of Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Gender	n	%
Man	175	91.6
Woman	16	8.4
Total	191	100

Based on Table **6** shows distribution respondents based on unsafe act of a total of 191 respondents, respondents with level of unsafe action that has behavior No safe 133 people (69.6%), and behavior 58 people (30.4%) safe.

Table 6: Distribution Respondents Based on *Unsafe Act* on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Unsafe Act	n	%
Unsafe Behavior	133	69.6
Safe Behavior	58	30.4
Total	191	100

Based on Table **7** shows distribution respondents based on unsafe condition of a total of 191 respondents, respondents with unsafe condition level with condition No safe there were 103 people (53.9%) and conditions 88 people (46.1%) safe.

Table 7: Distribution Respondents Based on *Unsafe Conditions* for Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Unsafe Condition	n	%
Unsafe Condition	103	53.9
Safe Condition	88	46.1
Total	191	100

Based on Table **8** shows distribution respondents based on fatigue Work from a total of 191 respondents there were 114 people (57.6%) experiencing it tired and not experience fatigue there were 77 (42.4%).

Table 8: Distribution Respondents Based on Fatigue Work on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Fatigue Work	n	%
Experiencing fatigue	114	59.7
Not experiencing fatigue	77	40.3
Total	191	100

Based on Table **9** shows distribution respondents based on training experience of a total of 191 respondents, respondents who did not have training experience as many as 153 people (80.1%) while those who have 38 people (19.9%) participated in the training experience. Analysis results bivariate is analysis used For see existence influence between two variables. The variables in question is variables dependent (event work accident) and variables independent (age, gender) sex, unsafe act, unsafe condition, fatigue work and training experience). The results analysis bivariate between variables dependent with independent variables as following.

Table 9: Distribution Respondents Based on Training Experience for Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Training Experience	n	%
Not any	153	80.1
There is	38	19.9
Total	191	100

Based on Table **10**, of the 191 respondents based on age, there were 116 respondents experience work accident, where 62 people aged young (46.6%) while at the age of old there were 54 people (46.6%). Analysis Connection between group age with incident work accident namely 0.988 > 0.05 which means No to connection between age with incident work accident.

Based on Table **11**, of the total 191 respondents, 175 respondents (91.6%) were of the same type. sex male and 16 respondents (8.4%) were female sex women. In the group men, there were 109 people (62.3%) who experienced it work accident and 66 people (37.7%) who do not experience work accident. Meanwhile in the group women, there were 7 people (43.8%) who experienced it work accident and 9 people (56.2%) who don't experience work accident. Results of the relationship test show p- value is 0.146 > 0.05 which means that No there is significant relationship between type sex with incident work accident

Based on Table **12**, of the 191 respondents, there were 116 respondents experience work accident, unsafe action category with category behavior No safe as many as 99 people (85.3%) while behavior safe as many as 17 people (14.7%). The results of the relationship test show p- Value 0.001, which means that there is very significant relationship between unsafe action and incident work accident. This is show that the more tall the level of unsafe action, the more big risk occurrence work accident.

Based on Table **13**, of the 191 respondents, among workers who had experienced occupational accidents, 84 (72.4%) were exposed to unsafe working conditions, whereas 32 (27.6%) worked under safe conditions. Unsafe conditions were significantly associated with occupational accidents ($p < 0.001$). This is show that the more bad condition work (unsafe conditions), increasingly big risk occurrence work accident.

Based on Table **14**, Of the 116 workers who had experienced occupational accidents, 99 (85.3%) reported work fatigue, whereas 17 (14.7%) did not. Work fatigue was significantly associated with occupational accidents ($p < 0.001$).

Based on Table **15**, of the 191 respondents, there were 116 respondents experience work accident with condition No Once participated in the training experience, namely 101 people (87.1%), while Once There were 15 people (12.9%) participating in the training experience. Relationship test results namely p Value 0.003 < 0.05 means to connection significant

Table 10: Relationship Age with Incident Work Accident on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Age	Incident Work accident				Total		*p-value*
	Once		Never				
	n	%	n	%	n	%	
Young Age	62	53.4	40	53.3	102	53.4	0.988
Old Age	54	46.6	35	46.7	89	46.6	
Total	116	100	75	100	191	100	

Table 11: Relationship between Gender and Incident Work Accident on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Gender	Incident Work accident				Total		*p-value*
	Once		Never				
	n	%	n	%	n	%	
Man	109	94.0	66	88.0	175	91.6	0.146
Woman	7	6.0	9	12.0	16	8.4	
Total	116	100	75	100	191	100	

Table 12: Connection Unsafe Action with Incident Work Accident on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Unsafe action	Incident Work accident				Total		p-value
	There is		There isn't any				
	n	%	n	%	n	%	
Behavior No safe	99	85.3	34	45.3	133	69.6	0.001
Behavior safe	17	14.7	41	54.7	58	30.4	
Total	116	100	75	100	191	100	

Table 13: Connection Unsafe Condition with Incident Work Accident on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Unsafe condition	Incident Work accident				Total		p-value
	Once		Never				
	n	%	n	%	n	%	
Condition No safe	84	72.4	19	25.3	103	53.9	0.001
Safe	32	27.6	56	74.7	88	46.1	
Total	116	100	75	100	191	100	

Table 14: Connection Work Fatigue with Incident Work Accident on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Fatigue Work	Incident Work accident				Total		*p-value*
	Once		Never				
	n	%	n	%	n	%	
Experiencing fatigue	99	85.3	15	20.0	114	59.7	0.001
Not experiencing fatigue	17	14.7	60	80.0	77	40.3	
Total	116	100	75	100	191	100	

Table 15: Connection Training Experience with Incident Work Accident on Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Training experience	Incident Work accident				Total		p-value
	Once		Never				
	n	%	n	%	n	%	
n't any	153	87.1	52	69.3	153	80.1	0.003
There is	15	12.9	23	30.7	38	19.9	
Total	116	100	75	100	191	100	

Table 16: Diagnostic Assessment and Performance of the Final Logistic Regression Model

Diagnostic Component	Indicator/Variable	Result	Interpretation
Multicollinearity	Unsafe action: Tolerance	0.712	No problematic multicollinearity
	Unsafe action: VIF	1.404	
	Unsafe condition: Tolerance	0.685	
	Unsafe condition: VIF	1.460	
	Work fatigue: Tolerance	0.748	
	Work fatigue: VIF	1.337	
Model fit	Hosmer–Lemeshow χ^2	6.214	—
	Hosmer–Lemeshow p-value	0.623	Adequate model fit
Model deviance	−2 Log Likelihood	147.386	Indicates the deviance of the final model
Explanatory power	Nagelkerke R^2	0.612	The model explained approximately 61.2% of the variability in occupational accidents
Classification performance	Overall classification accuracy	82.7%	The model correctly classified 82.7% of respondents

Table 17: Multiple Logistic Regression Analysis of Factors Associated with Occupational Accidents among Workers at PT. Dok and Perkapalan Gandasari Indonesia in 2025

Model	Independent Variable	B	SE	Wald	p-Value	AOR	95% CI for AOR
Stage 1	Unsafe action	0.846	0.514	2.716	0.099	2.331	0.851–6.382
	Unsafe condition	0.844	0.454	3.458	0.063	2.326	0.955–5.662
	Work fatigue	2.830	0.431	43.072	<0.001*	16.952	7.281–39.439
	Training experience	−0.906	0.562	2.600	0.107	0.404	0.134–1.216
Stage 2 (final model)	Unsafe action	1.136	0.490	5.379	0.020*	3.113	1.192–8.137
	Unsafe condition	0.809	0.457	3.133	0.077	2.245	0.917–5.500
	Work fatigue	2.729	0.416	42.987	<0.001*	15.311	6.778–34.618

Statistically significant at $p < 0.05$. AOR: adjusted odds ratio; CI: confidence interval; SE: standard error.

between Training experience and incident work accident. This is show that workers who do not get training experience have risk accident remote work more tall compared to workers who have take part in training experience.

Multicollinearity diagnostics showed tolerance values ranging from 0.685 to 0.748 and VIF values ranging from 1.337 to 1.460. These results indicated no problematic multicollinearity among unsafe action, unsafe condition, and work fatigue. The Hosmer–Lemeshow goodness-of-fit test was not statistically significant ($\chi^2 = 6.214$; $p = 0.623$), indicating that the final logistic regression model adequately fitted the observed data. The model had a −2 Log Likelihood value of 147.386 and a Nagelkerke R^2 of 0.612, suggesting that approximately 61.2% of the variability in occupational accidents was explained by the variables included in the model. The final model correctly classified 82.7% of respondents.

In the initial model, unsafe action, unsafe condition, work fatigue, and training experience were entered simultaneously. Training experience had the highest

non-significant p-value (p = 0.107) and was subsequently removed from the model. In the final model, work fatigue was the strongest factor associated with occupational accidents. Workers experiencing fatigue had 15.311 times higher odds of occupational accidents than workers who did not experience fatigue (AOR = 15.311; 95% CI: 6.778–34.618; p < 0.001). Unsafe action was also significantly associated with occupational accidents (AOR = 3.113; 95% CI: 1.192–8.137; p = 0.020). Unsafe working conditions were significantly associated with occupational accidents in the bivariate analysis. However, after adjustment for other variables in the final logistic regression model, the association was no longer statistically significant (AOR = 2.245; 95% CI: 0.917–5.500; p = 0.077). Nevertheless, the magnitude and direction of the adjusted odds ratio suggest that workers exposed to unsafe conditions may have more than twice the odds of experiencing occupational accidents compared with those working under safe conditions. The lack of statistical significance may reflect limited statistical power or an insufficient sample size to detect this association, indicating a possible Type II error. Therefore, the finding should not be interpreted as evidence that unsafe conditions have no role in occupational accidents. Larger prospective studies with more comprehensive workplace exposure measurements are needed to clarify this relationship.

DISCUSSION

From an occupational health perspective, workplace accidents are not merely safety incidents but important worker health outcomes because they may result in injury, disability, psychological distress, work absence, reduced quality of life, and increased healthcare and compensation burdens. Individual characteristics such as age and gender are commonly examined because they may be related to physical capacity, work experience, risk perception, and decision-making at work [8]. In this study, age and gender were not significantly associated with workplace accidents. The relatively uniform application of standard operating procedures, personal protective equipment requirements, and workplace supervision may have reduced differences in accident occurrence between demographic groups. Greater experience among older workers may also compensate for reduced physical capacity, whereas younger workers may have better endurance but less occupational experience. This interpretation is consistent with Musnadimarniati, who reported that demographic differences may become less apparent when safety procedures are implemented consistently [9]. However, these findings indicate associations only and should not be interpreted as evidence that age or gender has a protective or causal effect.

Human factors theory emphasizes that occupational injuries are associated not only with individual characteristics but also with work behavior and the organizational environment in which such behavior occurs [10]. Unsafe acts were significantly associated with workplace accidents, indicating that workers who disregarded procedures, failed to use personal protective equipment, or had limited awareness of hazards had higher odds of reporting accidents. Such behavior may increase exposure to mechanical, physical, chemical, and ergonomic hazards that can cause acute injuries and other adverse health effects. This finding is consistent with Li *et al*. [11], who identified unsafe acts as an important factor in occupational accidents, while Ramdan *et al*. [12] demonstrated that shipyard workers are also vulnerable to work-related health problems arising from hazardous workplace exposures. Nevertheless, unsafe acts should not be viewed solely as individual failures because production pressure, supervision, workload, and safety culture may influence workers' decisions. Imron *et al*. [13] similarly emphasized the interaction between human and organizational factors in maritime accidents. This interpretation is also consistent with Heinrich's accident causation framework, which identifies unsafe acts and unsafe conditions as important contributing elements in occupational accidents [14].

Unsafe working conditions remain relevant from an occupational health perspective because inadequate equipment, poor lighting, disorganized work areas, hazardous materials, and insufficient environmental controls may increase exposure to injury-producing hazards. Although unsafe conditions were significantly associated with workplace accidents in the bivariate analysis, the association was not statistically significant after adjustment in the final model (AOR = 2.245; 95% CI: 0.917–5.500; p = 0.077). Nevertheless, the magnitude and direction of the estimate suggest that workers exposed to unsafe conditions may have more than twice the odds of reporting workplace accidents. Therefore, this finding should not be interpreted as evidence that unsafe conditions have no occupational health importance. The non-significant result may reflect limited statistical power or an insufficient sample size to detect the association, indicating a possible Type II error. Consistent with loss-control principles, routine workplace inspections, equipment maintenance, environmental monitoring, and corrective action remain important for reducing occupational injury risks [15].

Work fatigue has particular medical and occupational health relevance because it reflects

reduced physiological and cognitive functioning that may impair alertness, concentration, reaction time, judgment, and motor coordination [1]. Workers experiencing fatigue had substantially higher odds of reporting workplace accidents. This association may be explained by slower responses to unexpected events, reduced hazard recognition, and decreased adherence to safe work procedures. The finding is consistent with Rozal *et al*. [7], who reported that occupational fatigue was associated with accidents and near misses among workers exposed to demanding working conditions. Fatigue should therefore be considered not only a safety management issue but also an indicator of worker health that requires appropriate workload management, rest periods, and occupational health monitoring. However, because exposure and outcome were measured within the same study period, it cannot be concluded that fatigue preceded or directly caused the reported accidents.

Safety training is an important component of occupational health management because it supports workers' knowledge, practical skills, hazard recognition, and risk awareness [4]. Workers who had never attended safety training had higher odds of reporting workplace accidents than those who had attended training. Effective loss-control management requires regular education, supervision, and reinforcement of safe work practices [15]. However, the effectiveness of training may depend on its frequency, duration, content, delivery method, recency, and relevance to specific workplace hazards. Because training experience was classified only as ever or never attended, the observed association may not fully represent the quality or intensity of the training received. In addition, Reason's systems approach emphasizes that accidents should not be attributed solely to workers' errors because weaknesses in organizational procedures, supervision, communication, and hazard control may also contribute to adverse outcomes [16].

From a statistical perspective, this study demonstrates the usefulness of multiple logistic regression for identifying factors independently associated with a binary occupational accident outcome. However, variable selection should combine statistical criteria with theoretical consideration of confounding rather than relying exclusively on p-values. Borderline findings, such as the association between unsafe conditions and workplace accidents, should be interpreted using the odds ratio and confidence interval in addition to statistical significance. Future studies should use larger samples supported by adequate power calculations, include theoretically relevant occupational confounders, and measure training and fatigue more comprehensively. Prospective cohort studies, continuous incident surveillance, objective fatigue assessment, repeated-measures analysis, and time-to-event methods are recommended to clarify temporal relationships and provide stronger evidence for preventing occupational injuries, disability, work absence, and other adverse worker health outcomes. Although this study did not include biomedical measurements or clinical endpoints, its findings remain relevant to medical and public health research through their contribution to occupational injury prevention and worker health protection.

STRENGTH AND LIMITATIONS

This study has several strengths, including the use of primary data from 191 shipyard workers selected through simple random sampling, the application of validated and highly reliable measurement instruments, and multivariable logistic regression analysis to identify the dominant factors associated with occupational accidents. Nevertheless, several limitations should be acknowledged. The cross-sectional design does not allow temporal or causal relationships to be established between the investigated factors and occupational accidents. In addition, potentially important confounding variables, including shift work patterns, overtime duration, length of employment, specific job roles, and job complexity, were not comprehensively measured or included in the adjusted model; therefore, residual confounding may have influenced the estimated associations, particularly those related to work fatigue and unsafe acts. Training experience was also classified only as ever or never having attended training, without considering its frequency, duration, content, quality, or recency. This simplified classification may have caused exposure misclassification and may not fully represent the actual effectiveness of occupational safety training. Future studies should use longitudinal designs, incorporate more comprehensive occupational and organizational confounders, and employ more detailed measures of safety training exposure.

CONCLUSION

Based on the results of research conducted at PT Dok andPerkapalan Gandasari Indonesia in 2025, it was found that there was a relationship between unsafe acts, unsafe conditions, work fatigue, and training experience with the occurrence of work accidents, while the variables of age and gender did not show a significant relationship. Among all the variables studied, work fatigue was the most influential factor in the occurrence of work accidents, because it consistently showed a significant relationship and had the largest risk contribution in the multivariate model. Therefore, efforts to prevent work accidents at PT Dok

andPerkapalan Gandasari Indonesia need to prioritize controlling work fatigue through regulating adequate working hours and rest periods, strengthening supervision of work behavior to suppress unsafe acts, and improving control of unsafe conditions through routine inspections and maintenance of the work environment. These efforts need to be supported by optimizing safety training programs so that all workers receive applicable and ongoing training, while workers are expected to increase awareness of fatigue conditions, utilize rest periods optimally, and comply with safe work procedures to reduce the risk of work accidents. In addition, further research is recommended to use a longitudinal design with more objective measurement methods and a more comprehensive multivariate analysis to strengthen the research findings and explain the causal relationship in more depth.

ETHICAL CONSIDERATIONS

This study obtained ethical approval from the Health Research Ethics Committee of the Faculty of Public Health, Hasanuddin University, with approval number 2736/UN4.14.1/TP.01.02/2025. All respondents were informed about the objectives, procedures, benefits, and potential risks of the study before participation. Written informed consent was obtained from each respondent prior to data collection. Participation was voluntary, and respondents had the right to withdraw from the study at any time without any consequences. The confidentiality and anonymity of respondents were maintained throughout the research process. All collected data were used solely for research purposes and were managed securely to protect respondents' personal information.

LIST OF ABBREVIATIONS

BPJS = Social Security Administrative Body

CI = Confidence Interval

DALYs = Disability-Adjusted Life Years

ILO = International Labour Organization

K3 = Occupational Safety and Health

OHS = Occupational Health and Safety

OR = Odds Ratio

PPE = Personal Protective Equipment

PT = Limited Liability Company

SE = Standard Error

SOP = Standard Operating Procedure

SPSS = Statistical Package for the Social Sciences

WHO = World Health Organization

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this article. The authors declare no conflict of interest. PT. Dok and Perkapalan Gandasari Indonesia only provided permission and access for data collection and had no role in the study design, data analysis, interpretation of the findings, manuscript preparation, or decision to submit the manuscript for publication.

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AUTHOR CONTRIBUTIONS

B.A.B.S.S. contributed to the conceptualization of the study, research design, data collection, data curation, statistical analysis, interpretation of the findings, and preparation of the original manuscript draft. Y.T. contributed to the study methodology, supervision, validation of the research process, interpretation of the findings, and critical revision of the manuscript. A.W. contributed to conceptual guidance, occupational health interpretation, supervision, and critical review of the manuscript. M.M. contributed to methodological supervision, validation, interpretation of the results, and manuscript review and editing. A.S. contributed to the public health perspective, interpretation of the findings, and critical revision of the manuscript. All authors read and approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

USE OF ARTIFICIAL INTELLIGENCE (AI)

Artificial intelligence (AI) tools were used solely for language editing, grammar checking, and manuscript formatting assistance. All study design, data collection,

analysis, interpretation of findings, and final manuscript content were completed, reviewed, and approved by the authors, who take full responsibility for the integrity and accuracy of the work.

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