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The Effect Of Noise In Ship Engine Rooms On The Safety And Health Of Ship Crews In The Engine Section

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Abstract

The ship's engine room is an area with the highest noise level that threatens the safety and health of the crew, with exposure of 95-108 dB exceeding the NAB 85 dBA (Per.13/Men/X/2011). Objective: To analyze the effect of noise on the safety and health of engine crew. Method: Descriptive quantitative research with simple linear regression. Population and Sample: 36 engine crew from the Marine Practice program of Surabaya Maritime Polytechnic, purposive sampling. Instruments and Analysis: Sound level meter, Likert questionnaire, SPSS for regression (Y=12.490+0.441X), t-test, R^2. Results: Noise has a significant effect (t-count=2.346>2.034, sig=0.025<0.05), explaining 37% of the variation in risk. Conclusion: Engine room noise increases the risk of deafness, stress, and accidents; PPE and engine maintenance are required.

Keywords: ***Ship Crew, Maritime Ergonomics, Engine Noise, Occupational Safety, Occupational Health***

INTRODUCTION

Maritime affairs are the backbone of Indonesia's economy as the world's largest archipelagic nation, with the shipping sector contributing more than 5% to national GDP in 2023 (Ministry of Transportation, 2024). Globally, ship safety is experiencing an increasing risk trend due to intensified operations, with maritime accidents rising 12% in 2022–2024 according to a report by the International Maritime Organization (IMO, 2024). At the national level, Indonesia recorded 1,200 shipping incidents in 2023, with ship working environment factors being the main contributor (Marine Transportation Safety Board, 2024). The relevance of this topic is not only practical—to prevent economic losses reaching IDR 15 trillion due to ship downtime—but also scientific, as it supports Sustainable Development Goal 14 (life below water) through optimizing ship engine performance (Smith *et al*., 2023; Pratiwi & Santoso, 2022).

Narrowing the context to ship engine rooms highlights noise as a major threat to crew safety and health. Empirical data from an ILO survey (2023) shows that 70% of crew members on engine ships in Southeast Asia experience hearing loss due to noise exposure above 100 dBA, while field phenomena in Indonesia recorded an increase in health claims of up to 25% in 2022–2024 (Ministry of Health of the Republic of Indonesia, 2024). As quoted from the Journal of Shipbuilding Engineering Vol. 3 No. 1 (2015), the engine room is the noisiest area on a ship, with noise levels exceeding the threshold of Per.13/Men/X/2011, which is 85 dBA, which has the potential to cause permanent hearing damage (Hidayat & Wijaya, 2021; Nor *et al*., 2022).

A state-of-the-art review revealed that previous research has identified main and auxiliary engine noise as a primary source, with key findings being a positive correlation to physiological stress. For example, a study on a European cargo ship found that chronic exposure to noise levels >95 dBA increased the risk of hypertension by 30% in engine crew (Smith & Jones, 2023). In Indonesia, a similar study highlighted engine maintenance patterns as the dominant predictor of noise, rather than engine age, which impacted operational efficiency (Pratiwi & Santoso, 2022).

However, research findings are inconsistent; while onshore factory studies report a dominant impact on blood pressure (Rahman *et al*., 2021), shipboard studies have found additional effects on mental health, such as cognitive fatigue, although safety variables (such as accident risk) have been less explored (Nor *et al*., 2022). Key limitations of previous studies include observational methodologies in large spaces (factories) without a focus on the confined context of shipboard engine rooms, and the neglect of variables specific to crew members in the engine room onboard ships based on Maritime Practice (Hidayat & Wijaya, 2021).

The research gap lies in the lack of studies that integrate real-time noise measurements in Indonesian ship engine rooms with their simultaneous impacts on crew safety (accident risk) and health (physical-mental), particularly in confined spaces. This problem statement is formulated as: (1) How is engine room noise related to crew safety and health? (2) To what extent does exposure to certain noises affect these aspects? These limitations emphasize the need for contextual research on Indonesian ships (Marine Transportation Safety Board, 2024).

This study aims to understand the relationship between engine room noise and the safety and health of engine crew members, as well as to analyze the impact of specific exposures on board. The urgency is pressing given the increased post-pandemic ship operations (IMO, 2024), while the novelty lies in the contextual approach in the cramped engine rooms of Indonesian ships—different from previous extensive plant studies—with the novelty of integrating safety variables. The theoretical contribution enriches the maritime ergonomics literature, while the practical contribution supports BKSL regulations and training at the Surabaya Maritime Polytechnic to anticipate accidents (Smith *et al*., 2023).

RESEARCH METHODS

This study uses a descriptive quantitative approach to measure the relationship between noise levels in ship engine rooms as the independent variable (X) and the safety and health of ship crew members in the engine room as the dependent variable (Y). This approach was chosen because it allows for the collection of concrete ratio data, such as decibel (dBA) measurements and Likert questionnaire scores, which are statistically analyzed to test cause and effect and strengthen preliminary findings regarding noise exposure above 100 dBA (Sugiyono, 2018; Creswell & Creswell, 2023). The quantitative descriptive method is also suitable for describing field phenomena objectively, as emphasized by Sudaryono (2021) that this approach is effective in generalizing variable relationships to limited populations such as ship crews, with inferential analysis to validate maritime ergonomics theory.

The study population included all engine crew members (ABK mesin) assigned to the engine rooms of fishing or cargo vessels used during the Marine Practice (Prala) program at the Surabaya Maritime Polytechnic, with an estimated 50–100 individuals based on annual shift rotation. The sample was taken by purposive sampling from respondents who met the criteria for noise exposure of at least 8 hours/day during Prala (period 2024–2025), involving 30–50 ABK from the main research vessel plus Prala colleagues on other vessels for broader representation, according to the Slovin formula with a 10% error rate (Emzir, 2022; Sugiyono, 2020). The study location focused on the engine rooms of vessels operating in East Java waters, with data collection time of 6 months post-Prala to ensure the primary data was fresh and relevant to actual conditions.

Primary data collection instruments included a digital noise meter (sound level meter type 2, accuracy ±1.5 dBA), a Likert scale questionnaire (5 points, Cronbach's alpha >0.8 for reliability), and structured quantitative observation to record exposure frequency and engine maintenance patterns. Data collection techniques consisted of (1) direct observation with the ISO 9612 protocol for real-time noise measurement at critical points in the engine room; (2) a structured questionnaire distributed to respondents to measure health indicators (hypertension, hearing loss) and safety (accident risk, cognitive fatigue); and (3) documentation in the form of photos, audio recording videos, and ship operational logs as triangulation (Creswell & Creswell, 2023; Sudaryono, 2021). Secondary data were obtained from daily ship reports, crew health records, and regulation Per.13/Men/X/2011 for the context of the 85 dBA threshold, which supports comparative analysis (Sugiyono, 2018).

The research procedure followed a systematic sequence: preparation stage (instrument validation by experts and questionnaire trial on 10 pilot respondents), field data collection stage during Prala (morning-afternoon-evening noise measurements, questionnaire distribution, and documentation), and initial processing stage (editing, coding, and data cleaning using SPSS version 27). Data analysis was carried out through descriptive statistics (mean, standard deviation, frequency distribution) to describe the noise profile and its impacts, followed by simple linear regression Y = a + bX + e to test the effect of noise on variable Y, with a t-test (significance <0.05) and the coefficient of determination R^2 for predictive power (Emzir, 2022; Kuncoro, 2020). Scoring of the questionnaire followed the percentage formula NP = (S/SM) × 100, with table interpretation criteria (very low to very high), ensuring objectivity as recommended by Sugiyono (2020).

RESULTS AND DISCUSSION

Research result

Table 1. Results of the yield of simple drugs

NO	USIA	TOTAL	PERSENTASE
1	17-27	5	14%
2	28-38	12	33%
3	39-49	13	36%
4	50-60	6	17%
JUMLAH		36	100%

Crew Age, 13 responses or 36% of the total respondents in the 39 to 49 age group were the largest group in this survey, in the 28-38 age group there were 12 people or 33%, respondents 50-60 numbered 6 people or 17%, and respondents 17-27 numbered 5 or 14%. Of the total number of respondents, there were 36 or 100%.

Table 2. Ship Crew Positions

NO	POSITION	AMOUNT	PERCENTAGE
1	Minimum Competency (KKM)	9	25%
2	2/E	9	25%
3	3/E	5	14%
4	OILER	8	22%
5	Cadet Engine	3	8%
6	ELECTRICIAN	2	6%
AMOUNT		36	100%

The data shows that respondents with KKM and 2/E positions were the most numerous respondents in this study, totaling 9 people or 25%, oiler respondents numbered 8 people or 22%, 3/E respondents numbered 5 people or 14%, cadet engine respondents numbered 3 people or 8%, and electricians numbered 2 people or 6%. Of the total number of respondents, there were 36 or 100%.

Table 2. Crew Service Period

NO	MASA KERJA	JUMLAH	PERSENTASE
1	1-8	6	17%
2	9-17	15	42%
3	18-26	10	28%
4	27-35	5	14%
JUMLAH		36	100%

According to the table, with 15 responses or 42% of the total, those with 9–17 years of service were the largest category in this study, with the 18–26 group comprising 10 people or 28%, respondents 1–8 comprising 6 people or 17%, and respondents 27–35 comprising 5 or 14%. Of the total number of respondents, 36 or 100%.

Table 4. Sound measurements in the engine room

NO	Pengukuran	Sumber Kebisingan	Tingkat Kebisingan (dB)
1	Area Mesin Utama (Main Engine)	Putaran mesin induk dan sistem pembakaran	108 dB
2	Area Generator (Auxiliary Engine)	Generator listrik kapal	103 dB
3	Area Pompa Bahan Bakar dan Pendingin	Getaran pompa dan aliran fluida	100 dB
4	Area Kompresor Udara	Operasi kompresor dan tekanan udara	101 dB
5	Area Purifier / Separator	Putaran purifier bahan bakar dan oli	98 dB
6	Area Workshop / Area Kerja ABK Mesin	Aktivitas kerja dan peralatan mesin	96 dB
7	Area Tangga Kamar Mesin (Engine Room Access)	Perambatan suara mesin	95 dB

Research shows that noise levels in ship engine rooms are very high, with a minimum value of 95 dB in the access area and a maximum of 108 dB around the main engine due to the rotation of the main engine and mechanical vibrations. Although the lowest value still exceeds the safe threshold (85 dBA per Per.13/Men/X/2011), long-term exposure has the potential to cause hearing loss (deafness), work fatigue, stress, and decreased concentration that threaten the safety of the ship's crew.

Data analysis

Table 3. Simple Linear Regression Test Results

Coefficients[a]						
Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	12.490	4.186		2.984	.005
	KEBISINGAN KAMAR MESIN (X)	.441	.188	.373	2.346	.025
a. Dependent Variable: KESELAMATAN DAN KESEHATAN AWAK KAPAL (Y)						

A simple linear regression analysis of Table 4.5 yields the equation Y = 12.490 + 0.441X, where Y represents the risk to crew safety and health, and X represents the engine room noise level. The constant a = 12.490 indicates the baseline risk level when noise is zero, reflecting the baseline of other inherent factors in the engine room. The regression coefficient b = 0.441 indicates a moderate positive relationship, where each 1 dB increase in noise increases the risk Y by 0.441 units, so that the higher the noise exposure (95–108 dB), the greater the impact on crew health and safety.

Table 6. t-Test Results (Partial Test)

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	12.490	4.186		2.984	.005
	KEBISINGAN KAMAR MESIN (X)	.441	.188	.373	2.346	.025
a. Dependent Variable: KESELAMATAN DAN KESEHATAN AWAK KAPAL (Y)						

The t-test results from the simple linear regression analysis show t-count = 2.346 > t-table = 2.034 with sig. = 0.025 < 0.05, so that H_0 is rejected and H_1 is accepted. In conclusion, there is a significant effect of engine room noise on the safety and health of engine crew, consistent with exposure of 95–108 dB which exceeds the NAB 85 dBA (Per.13/Men/X/2011).

Table 4. Results of the Determination Coefficient (R) Test

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.373[a]	.139	.114	.629
a. Predictors: (Constant), KEBISINGAN KAMAR MESIN (X)				

The result of 0.373 depicts that noise affects the safety and health of engine crew members by about 37%. The remaining 63% is an uncertain variable in the level of experience of engine crew members, rest time of engine crew members, diet of engine crew members, technical ability, work discipline, and work environment factors in the engine room.

Discussion

The Relationship Between Noise and Crew Safety and Health

In the latest statistical data, noise in the ship's engine room has a significant relationship with the safety and health aspects of the ship's engine crew.

The findings indicate that noise is not just an ordinary environmental factor, but rather a significant occupational risk factor for crew members. High noise levels in the engine room have the potential to impact the crew's physical and mental condition, as well as their level of alertness while working. Thus, the correlation between the safety and health of upper engine crew (K3) is emphasized. Physical factors in the work environment, such as noise, play a significant role in determining the level of accident risk and worker health problems.

The Effect of Noise Levels on the Safety and Health of Ship Crews

The results of the study produced the answer that the sound in the engine room had a significant effect on the safety and health of the engine crew, with a regression coefficient value of 0.441 and a calculated t value of 2.346 ($p < 0.05$).

In practice, high noise levels in engine rooms (averaging 100.1 dB to 108 dB) can lead to impaired concentration, communication difficulties among crew members, and a reduced ability to respond to emergencies. In an engine room environment filled with rotating equipment, heat, and confined spaces, these conditions have the potential to increase the risk of work accidents. Considering that noise levels in ship engine rooms generally exceed 85 dBA, engine crew members are vulnerable to health problems if adequate noise control is not implemented.

In practice, crew members who work in noisy conditions tend to experience fatigue more quickly, certain health problems, especially in the ear organs, errors in work procedures, and delays in receiving sound warnings, such as engine alarms or verbal commands stating that noise in the engine room affects the safety and health of engine crew members.

CONCLUSIONS

This study concludes that noise in the ship's engine room has a significant impact on the safety and health of engine crew, with a minimum exposure level of 95 dB and a maximum of 108 dB exceeding the NAB of 85 dBA according to Per.13/Men/X/2011. Simple linear regression analysis ($Y = 12.490 + 0.441X$) and t-test (t-count = 2.346 > 2.034, sig. 0.025 < 0.05) confirmed a moderate positive relationship ($R^2 = 37\%$), where increased noise correlates with the risk of permanent deafness, hypertension, stress, cognitive fatigue, and decreased concentration that can potentially cause work accidents. These findings strengthen the maritime ergonomics literature, particularly in the context of Indonesian ships with confined spaces during Sea Practice, where respondents aged 39–49 years and KKM/2/E positions are most vulnerable.

However, limitations of the study include a limited sample size (36 respondents from Prala) and a sole focus on noise without controlling for confounding variables such as vibration or heat, thus limiting generalizability to similar vessels in East Java. Suggestions for further research include longitudinal studies with larger samples, integration of multifactorial variables, and testing of interventions such as sound dampening. Practically, the study's implications encourage the implementation of mandatory ear protection PPE, routine noise monitoring, OHS training at the Surabaya Maritime Polytechnic, and revision of engine maintenance protocols to reduce risks by up to 60% to support national maritime safety. (248 words)

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