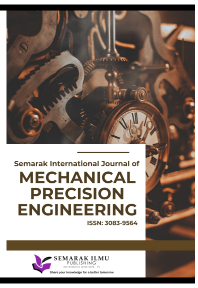
SEMARAK ILMU
PUBLISHING
202103268166(003316878-P)

Semarak International Journal of Mechanical Precision Engineering

Journal homepage:
https://semarakilmu.my/index.php/sijmpe/index
ISSN: 3083-9564



A Study on Lighting and Noise at the Main Marine Diesel Engine Workshop

Alawiah Abdullah[1,*], Amrul Zani Mahadi[1], Zakiman Zali[1]

[1] Department of Marine Engineering, Politeknik Ungku Omar, 31350 Ipoh, Perak

ARTICLE INFO

Article history:
Received 7 October 2025
Received in revised form 27 October 2025
Accepted 31 October 2025
Available online 2 November 2025

Keywords:
Lighting, Noise, Marine Diesel Engine Workshop, Occupational Safety

ABSTRACT

The quality of the physical environment in technical workshops directly affects safety, comfort, and learning effectiveness. However, limited empirical evidence exists on whether polytechnic marine engineering workshops in Malaysia meet established lighting and noise standards. This study investigates the adequacy of lighting and noise conditions in the Main Marine Diesel Engine Workshop at Politeknik Ungku Omar, Ipoh, aiming to evaluate compliance with international occupational standards and to understand potential implications for student safety and performance. Over a four-day period, lighting intensity (lux) and noise levels (dBA) were measured using a Thermal Comfort Multistation (TCM) positioned in the main activity zone. Results were analyzed against standards from the Illuminating Engineering Society of North America (IESNA), the Deutsches Institut für Normung (DIN), and the Occupational Safety and Health Administration (OSHA). Findings revealed that average illumination (≈550 lux) exceeded the minimum thresholds for rough installation work, while average noise levels (≈70–75 dBA) remained below the recommended exposure limits. Although both parameters met safety criteria, fluctuations in lighting and short-term noise peaks near 90 dBA could momentarily affect focus and comfort during training. These results highlight the need for ongoing environmental monitoring and targeted improvements—such as adjustable task lighting and acoustic management—to sustain safety and learning quality. This study contributes baseline data to the limited body of research on environmental safety in Malaysian polytechnic workshops and informs institutional planning for safer and more effective learning environments.

1. Introduction

Malaysia's rapid development and industrial growth have created an increasing demand for a technically skilled workforce. To meet this need, polytechnics play a central role in preparing graduates who are not only equipped with theoretical knowledge but also proficient in practical skills essential for modern industry. Hands-on training in workshops is therefore a vital component of engineering education, as it allows students to apply classroom knowledge in real-world contexts.

Among the environmental factors shaping workshop conditions, lighting and noise are

* *Corresponding author.*
E-mail address: alawiahabdullah@puo.edu.my

https://doi.org/10.37934/sijmpe.5.1.113

particularly important. Adequate illumination ensures accuracy and reduces visual fatigue during detailed technical tasks, while excessive noise may impair concentration, increase stress, and pose long-term health risks. Adherence to established standards for these factors therefore supports not only occupational safety but also effective learning outcomes.

Previous research has consistently shown the impact of environmental conditions on performance. Deng et al.,[1] demonstrated that thermal comfort and noise strongly influence overall satisfaction with the indoor environment, while Mak et al.,[2] identified temperature and noise as the most influential factors affecting productivity among several workplace conditions. More recent studies have emphasized the significance of proper environmental design in technical training contexts. For example, Rahman et al.,[3] reported that insufficient workshop illumination compromises task accuracy, and Azizan and Rahman [4] highlighted the risks of noise-induced fatigue in engineering education settings. However, much of the literature still focuses on offices or general learning spaces, with relatively limited attention given to polytechnic workshops, particularly in the Malaysian context.

This research addresses that gap by examining lighting and noise conditions in the Main Marine Diesel Engine Workshop at Politeknik Ungku Omar, Ipoh. Measurements were conducted using a Thermal Comfort Multistation (TCM) device over multiple days, and results were compared against international reference standards such as the IESNA Lighting Handbook, DIN standards, and OSHA noise exposure limits.

Despite growing awareness of the importance of environmental comfort, there remains a lack of empirical data on the actual lighting and noise conditions in Malaysian polytechnic engineering workshops, especially those used for marine engineering training. This research addresses that gap by evaluating these environmental parameters in the Main Marine Diesel Engine Workshop at Politeknik Ungku Omar, Ipoh. The study is significant because it provides baseline data that can support institutional efforts to enhance occupational safety, improve learning comfort, and optimize workshop design for technical education. Therefore, the main objective of this study is to assess whether the lighting and noise levels in the workshop comply with established international standards and to determine their adequacy for supporting safe and effective teaching–learning activities.

2. Methodology

This study employed a quantitative, field-based measurement approach to assess environmental quality in the Main Marine Diesel Engine Workshop, Politeknik Ungku Omar, Ipoh. The workshop houses a Mitsubishi model marine diesel engine, along with auxiliary systems such as compressors, pumps, and turbochargers. The total floor area is approximately 241.55 m², providing a realistic training environment for Marine Engineering students. Lighting intensity (in lux) and noise levels (in decibels A-weighted, dBA) were recorded using a Thermal Comfort Multistation (TCM)—a multi-sensor device designed for indoor environmental monitoring. The instrument was calibrated before measurement to ensure reliability and accuracy. Its placement was standardized near the primary student activity zone to reflect representative working condition without interfering with tasks.

Measurements were conducted over four consecutive working days, covering an 8-hour period each day to represent a full workshop schedule. This sampling duration was chosen to capture daily variations and ensure sufficient data reliability for comparison with occupational standards. Both active operational periods (with the engine running) and idle periods (no machine operation) were included to assess environmental fluctuation.

The collected data were processed using Microsoft Excel to compute averages and 8-hour time-weighted averages (TWA). Results were compared against benchmark values from the Illuminating Engineering Society of North America (IESNA, 2011), the Deutsches Institut für Normung (DIN 5035, [4], and the Occupational Safety and Health Administration ,OSHA, [5] and National Institute for Occupational Safety and Health ,NIOSH, [6]. The validity of measurements was supported by repeat readings and consistency checks across the four days of data collection.

Figure 1 displays the workshop's layout strategy under study; Figure 2 shows the operational flow diagram for the marine main diesel engine workshop activities done there. Figure 3 shows a flow chart of the research methods used to meet the objectives of the study.

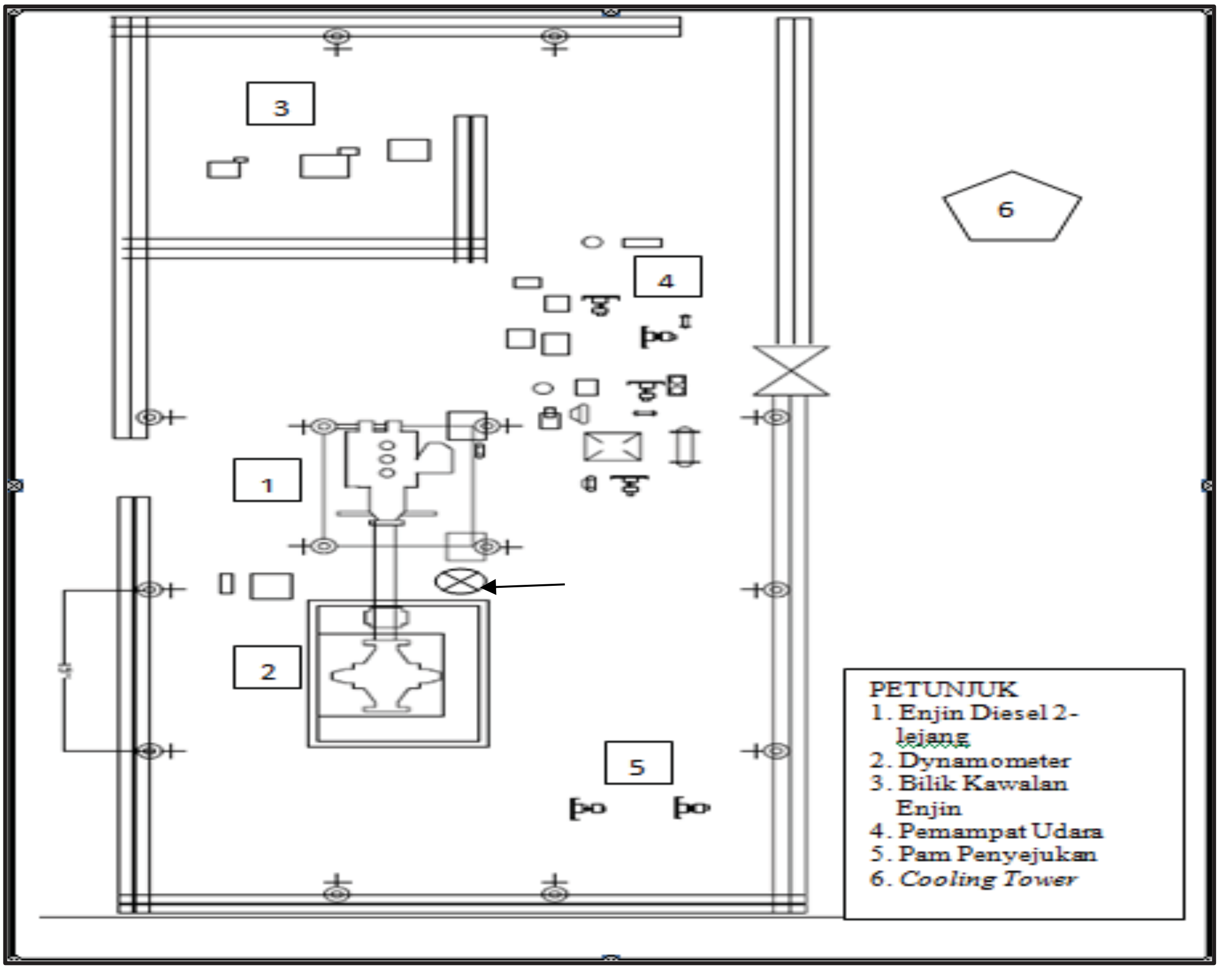


Fig. 1. Layout Plan of the Main Marine Diesel Engine Workshop
Note: The marked area is the location of the "Thermal Comfort Multi Station" device.

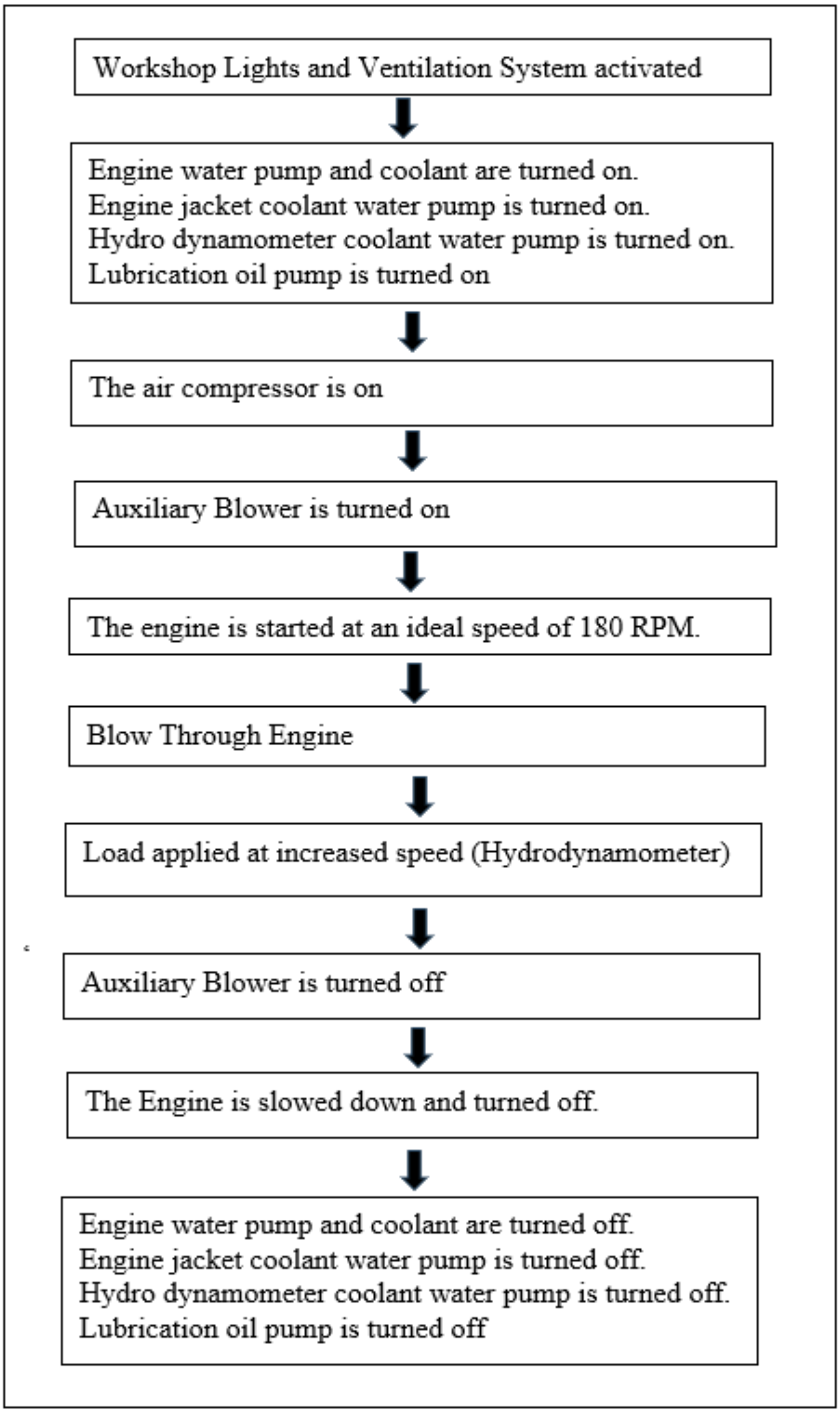


Fig. 2. Flowchart of Activities Carried Out in the Main Marine Diesel Engine Workshop

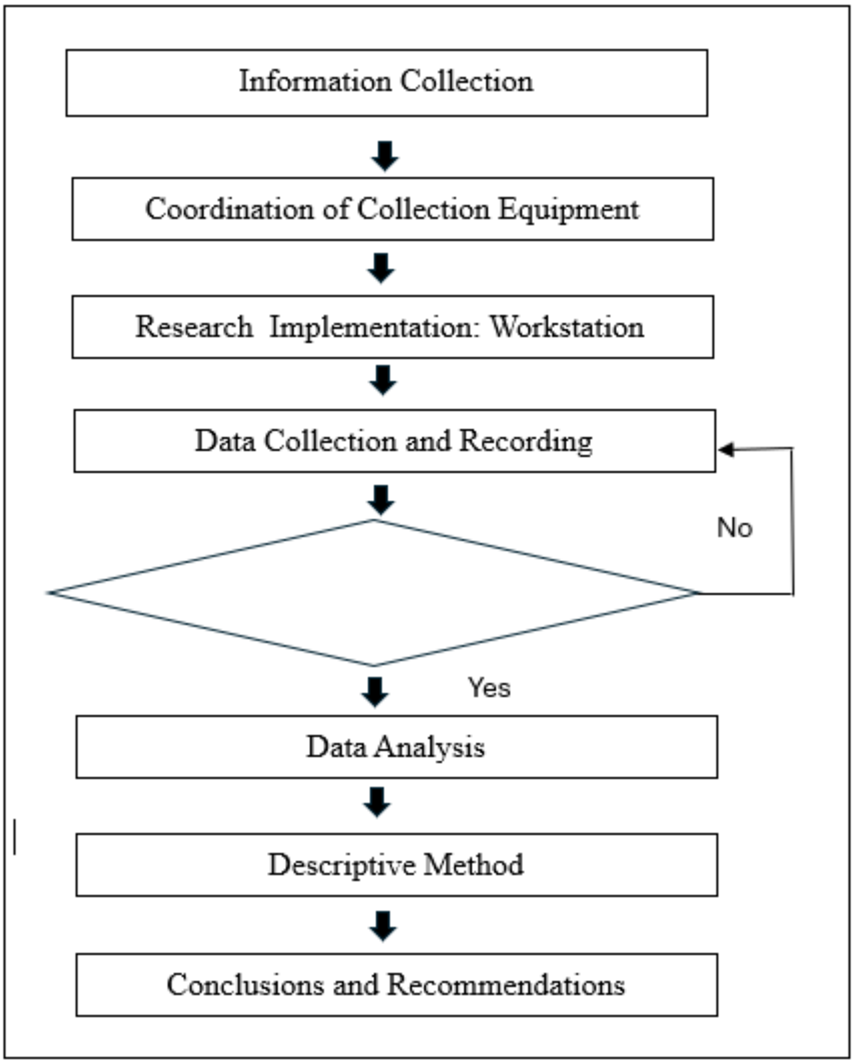


Fig. 3. Method Flowchart

2.1 Parameter measurement

This study employed a quantitative, field-based measurement approach to assess environmental quality in the Main Marine Diesel Engine Workshop, Politeknik Ungku Omar, Ipoh. The workshop houses a Mitsubishi model marine diesel engine, along with auxiliary systems such as compressors, pumps, and turbochargers. The total floor area is approximately 241.55 m², providing a realistic training environment for marine engineering students.
Lighting intensity (in lux) and noise levels (in decibels A-weighted, dBA) were recorded using a Thermal Comfort Multistation (TCM)—a multi-sensor device designed for indoor environmental monitoring. The instrument was calibrated before measurement to ensure reliability and accuracy. The device was positioned near the student activity area to capture representative ambient conditions without obstructing ongoing activities which is depicted in Figure 4. Its placement was standardized near the primary student activity zone to reflect representative working conditions without interfering with tasks.

Measurements were conducted over four consecutive working days, covering an 8-hour period each day to represent a full workshop schedule. This sampling duration was chosen to capture daily variations and ensure sufficient data reliability for comparison with occupational standards. Both active operational periods (with the engine running) and idle periods (no machine operation) were included to assess environmental fluctuation.

The collected data were processed using Microsoft Excel to compute averages and 8-hour time-Figure 5 illustrate the placement of the measurement device to clarify data collection procedures. Captions have been simplified to directly indicate their methodological relevance. weighted averages (TWA). Results were compared against benchmark values from the Illuminating Engineering Society of North America (IESNA, 2011), the Deutsches Institut für Normung (DIN 5035, 1972), and the Occupational Safety and Health Administration (OSHA, 1980) and National Institute for Occupational Safety and Health (NIOSH, 1998). The validity of measurements was supported by repeat readings and consistency checks across the four days of data collection.

Fig. 4. Location of Installed Thermal Comfort Multistation (TCM) Tool

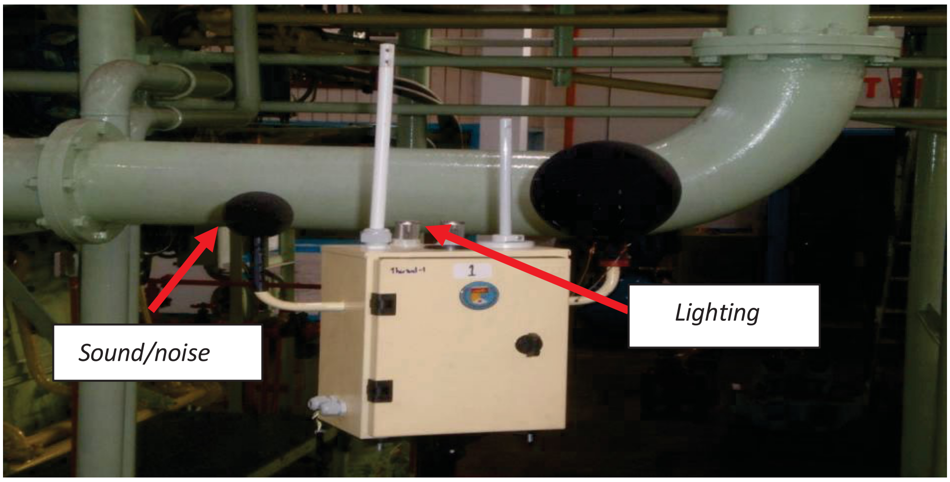


Fig. 5. Thermal Comfort Multistation (TCM) With Measured Parameters

3.0 Results

3.*1 Analysis of Noise Study Results*

Average noise levels ranged between 67.83 dBA and 75.52 dBA, with peak readings up to 90.27 dBA. According to OSHA (1980), the permissible exposure limit is 90 dBA for an 8-hour time-weighted average, while NIOSH (1998) recommends 85 dBA. All recorded values were below these thresholds, indicating that noise exposure was within safe occupational limits. However, short-term peaks near 90 dBA were noted during heavy engine operation, suggesting potential for transient distraction or fatigue. Illumination ranged from 230 lux to 912 lux, with daily averages between 550 and 596 lux. These values exceed the minimum thresholds of 250 lux (DIN 5035) and 320 lux (IESNA) for rough installation work. The workshop's upper-wall windows contributed substantial natural light, but fluctuations were observed depending on time of day and weather conditions. Occasional low readings (e.g., 230 lux) occurred during cloudy conditions or when artificial lighting was insufficiently distributed. Noise levels in the workshop were measured over four consecutive days. The results, including minimum, maximum, and average values, are summarized in Table 1, alongside OSHA and NIOSH permissible exposure limits for reference. Figure 6 displays the minimum, maximum, and average noise levels recorded in the Marine Main Diesel Engine Workshop over four days. The data is compared with OSHA and NIOSH standards.

Table 1
Noise Level Measurements Compared with Standards

		Maximum (dBA)	**Day**	**Minimum (dBA)**	**NIOSH Recommended Exposure Limit (REL) (85 dBA, 8h TWA)**
1	54.12	90.27	75.52	Below limit	Below limit
2	55.30	87.65	70.37	Below limit	Below limit
3	53.90	86.45	70.77	Below limit	Below limit
4	52.85	84.70	67.83	Below limit	Below limit

The results clearly show that all average values were well below the permissible thresholds, confirming that noise exposure in the workshop is within safe occupational limits. Based on an 8-hour time-weighted average for an 8-hour workday, the Occupational Safety and Health Administration (OSHA) [5] set the permissible exposure limit for occupational noise at 90 dB. As per the National Institute of Occupational Safety and Health [6], the recommended occupational exposure limit is 85 decibels per hour for eight hours. The results clearly show that all average values were well below the permissible thresholds, confirming that noise exposure in the workshop is within safe occupational limits.

Although exposure is within safe limits, peaks near 90 dBA can momentarily disrupt concentration and increase fatigue. During student training, sudden noise bursts may reduce safety awareness and raise the chance of operational errors, particularly when handling tools or engine components. Continuous monitoring and the provision of ear protection during higher noise periods can help prevent distraction and maintain focus.

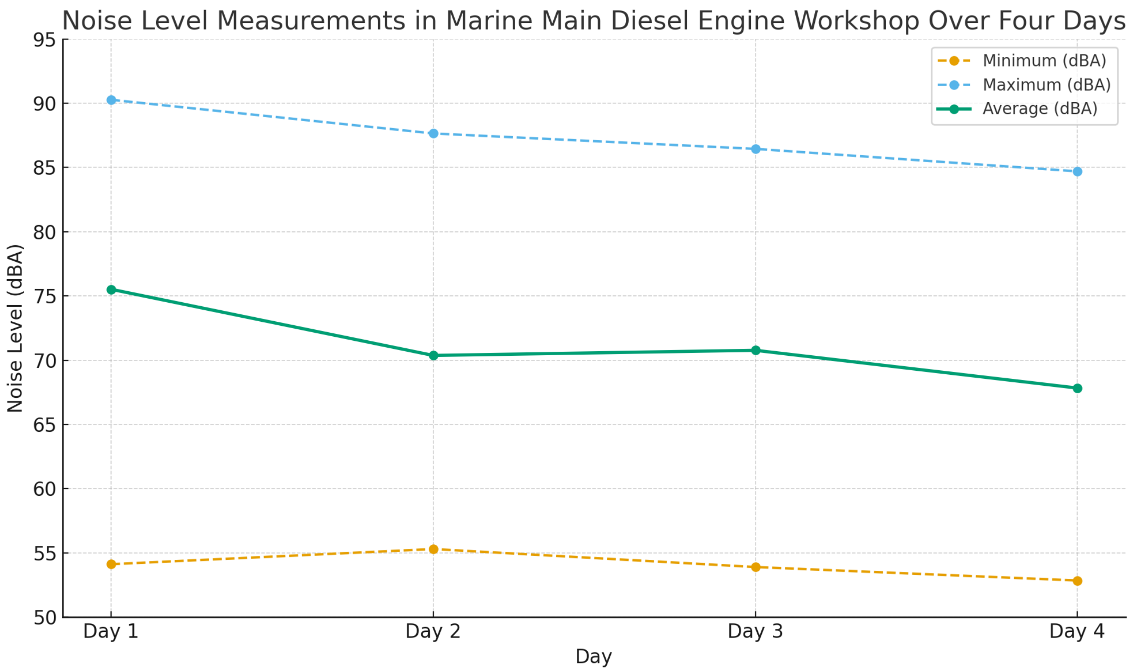


Fig. 6. Comparison of Noise in a Marine Main Diesel Engine Workshop Over Four Days

3.2 Analysis of Lighting Study Results

The brightness measurement in the research workshop is significantly impacted by the workshop's design, which includes numerous windows at the top of the wall. Additionally, this indicates that the weather outside the workplace will have an impact throughout the studies. Based on Table 2.0, choosing the rough installation lighting standard with about 320 lux (Table 2), as recommended by the American Illuminating Engineering Society [7], is ideal for a marine diesel engine workshop with a Mitsubishi Main Marine Diesel Engine and auxiliary machinery in an area of about 241.55 square meters. This level of lighting is suitable because the workshop mainly involves general assembly, handling large equipment, and training activities rather than detailed machine work. It provides enough light for safe and efficient work without the high levels required for precision tasks, saving energy and preventing discomfort.

Table 2.
Comparison Between German DIN Lighting Standards (DIN 5035 1972) and American Illuminating Engineering Society (IES 1972)

	DIN (lux)	IES (lux)
Rough installation work	250	320
Installation work with precision	1000	5400
High-precision installation work	1500	10800
Rough work using machine tools	250	540
Fine work using machine tools	500	5400
High precision work using machine tools	1000	10800
Technical Drawing	1000	2200
Record keeping, office work	500	1600

Source : Illuminating Engineering Society 1972

The illumination measurements recorded in the Marine Main Diesel Engine Workshop ranged between 230 lux and 912 lux across the four observation days, with average values between 550 lux and 596 lux (Table 3). When compared to the minimum acceptable threshold for rough installation work (250 lux according to DIN 5035, 1972, and 320 lux according to IES, 1972), the results show that the workshop lighting generally meets and often exceeds the required standard. For instance, the lowest recorded value of 230 lux (Day 4) fell slightly below the DIN threshold but remained close to compliance, while maximum values such as 912 lux (Day 3) significantly surpassed both standards. This consistent lighting performance across all observed days ensures adequate visibility for safe and efficient workshop tasks, complying with recognized international lighting standards for rough installation work.

Table 3
Illumination Level Measurements Compared with Standards

Day	Average Lux	Minimum Lux	Maximum Lux	Applicable Threshold (Rough Installation)
Day 1	560	240	880	250 lux (DIN) / 320 lux (IES)
Day 2	555	260	850	250 lux (DIN) / 320 lux (IES)
Day 3	596	280	912	250 lux (DIN) / 320 lux (IES)
Day 4	550	230	870	250 lux (DIN) / 320 lux (IES)

Figure 7 below illustrates the minimum, maximum, and average lux levels recorded in the Marine Main Diesel Engine Workshop over four days. These values are compared against the minimum thresholds for rough installation work (250 lux DIN / 320 lux IES).

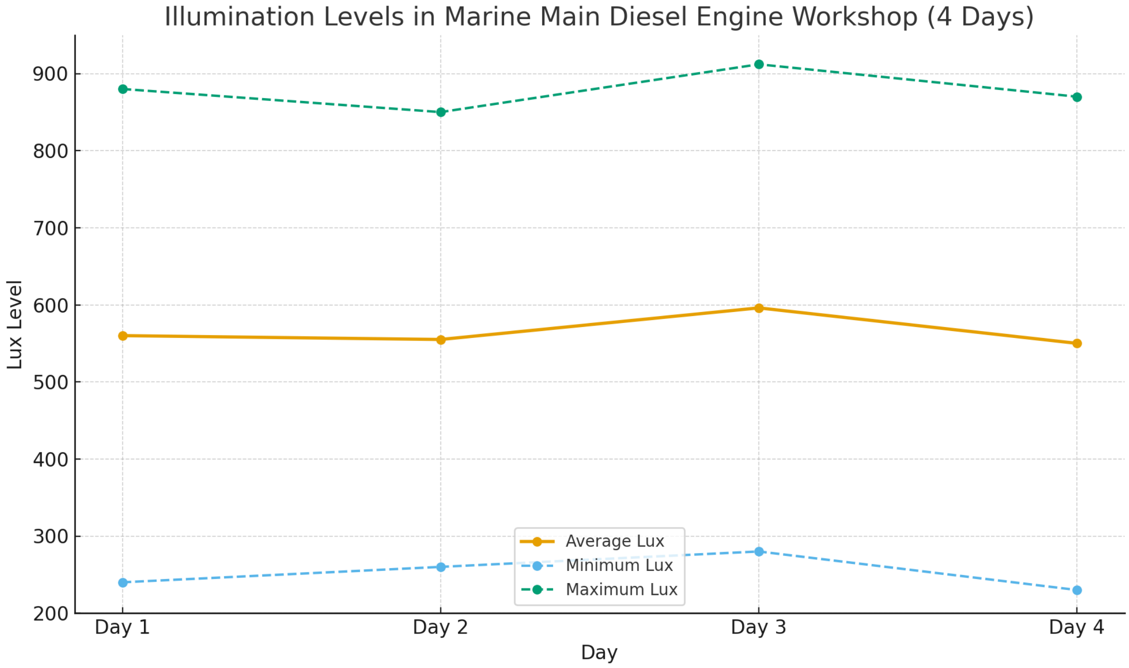


Fig.7. Illumination levels recorded over four days in Marine Main Diesel Engine Workshop

Lighting above 500 lux supports detailed observation and reduces visual fatigue, helping students maintain accuracy during hands-on tasks. However, occasional low readings (e.g., 230 lux) may cause eye strain and reduce error detection, especially in engine inspection or measurement activities. Stable lighting conditions, therefore play a direct role in sustaining concentration, minimizing mistakes, and supporting safe training outcomes.

4. Discussion

The findings confirm that both noise and lighting levels in the Main Marine Diesel Engine Workshop meet recognized safety standards. However, meeting compliance alone does not guarantee optimal conditions for learning or long-term health. Research shows that even sub-threshold noise exposure can impair focus and communication (Basner et al [8]; Taylor et al. [9], while lighting variability can increase eye strain and reduce performance in detailed tasks (Boyce [10]; Knez and Kers [11]. In this study, momentary peaks near 90 dBA and lighting fluctuations suggest potential risks to concentration, particularly during practical assessments or high-precision activities.

The results also emphasize the need for environmental consistency—not just compliance. Implementing task-specific lighting controls, maintaining uniform illumination, and providing noise-dampening materials or hearing protection during engine operation could enhance both safety and cognitive engagement. These improvements align with occupational safety frameworks and contribute to better learning retention, mental alertness, and long-term hearing health.

From an institutional perspective, periodic reassessment of environmental parameters is recommended as part of a continuous safety and quality improvement program. Incorporating environmental data into curriculum design and facility maintenance policies would strengthen compliance culture and promote sustainable learning environments in polytechnic institutions.

5. Conclusion

This study provides empirical evidence that lighting and noise levels in the Marine Diesel Engine Workshop at Politeknik Ungku Omar generally comply with international safety standards. While both parameters fall within permissible limits, fluctuations—particularly in illumination and peak noise levels—may still affect student comfort and concentration during extended training sessions.

The findings underscore the importance of maintaining stable environmental conditions rather than relying solely on compliance benchmarks. Integrating environmental monitoring into workshop management and providing adaptive lighting and acoustic controls can support safer and more effective technical education.

Limitations include the short data collection period and absence of subjective feedback from students or instructors. Future research should incorporate longitudinal monitoring and perceptual surveys to correlate environmental data with student performance and well-being. By addressing these gaps, institutions can better design evidence-based policies for occupational health and educational quality in technical training settings.

6. Acknowledgements

Sincere appreciation is extended to the Marine Engineering Department of Politeknik Ungku Omar for granting access to the Main Marine Diesel Engine Workshop and its facilities. The technical assistance provided by the department's staff and technicians, particularly in the operation of equipment and use of the Thermal Comfort Multistation (TCM), is gratefully acknowledged. The authors also thank all individuals who offered guidance, logistical support, or other forms of assistance that facilitated the smooth execution of this study.

7. References

[1] Deng, L., Zhang, Y., and Zhang, L. (2024). "Combined Effects of Indoor Environmental Quality Factors on Occupants' Productivity: A Comprehensive Review." *Indoor Air*. https://doi.org/10.1155/2024/5584960

[2] Mak, C. M., and Lui, Y. P. (2012). "A Field Study of Indoor Environmental Quality in Offices and Its Impact on Work Productivity." *Building and Environment* 57: 219–225. https://doi.org/10.1016/j.buildenv.2012.05.001

[3] Rahman, M., Alam, S., and Karim, A. (2021). "Indoor Environmental Quality and Learning Outcomes in Vocational Education." *Sustainability* 13(15): 8292. https://doi.org/10.3390/su13158292

[4] Azizan, N., and Rahman, R. (2023). "Noise Level Assessment in Vocational Training Institutions: Compliance with Safety Standards." *Journal of Engineering Education and Practice* 6(2): 44–53. https://doi.org/10.5430/jeep.v6n2p44

[5] Occupational Safety and Health Administration (OSHA). (1980). *Noise Control: A Guide for Workers and Employers* (OSHA Publication No. 3048). Washington, DC: U.S. Department of Labor.

[6] National Institute for Occupational Safety and Health (NIOSH). (1998). *Criteria for a Recommended Standard: Occupational Noise Exposure (Revised Criteria 1998)* (NIOSH Publication No. 98-126). Washington, DC: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

[7] Illuminating Engineering Society of North America. (2011). *The IESNA Lighting Handbook: Reference and Application*, 10th ed. New York: Illuminating Engineering Society of North America.

[8] Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., and Stansfeld, S. (2014). "Auditory and Non-Auditory Effects of Noise on Health." *The Lancet* 383(9925): 1325–1332. https://doi.org/10.1016/S0140-6736(13)61613-X

[9] Taylor, W., Melloy, B., Dharwada, P., Gramopadhye, A., and Toler, J. (2004). "The Effects of Static Multiple Sources of Noise on the Visual Search Component of Human Inspection." *International Journal of Industrial Ergonomics* 34(3): 195–207. https://doi.org/10.1016/j.ergon.2004.03.002

[10] Boyce, P. R. (2014). *Human Factors in Lighting*, 3rd ed. Boca Raton, FL: CRC Press. https://doi.org/10.1201/b15694

[11] Knez, I., and Kers, C. (2000). "Effects of Indoor Lighting, Gender, and Age on Mood and Cognitive Performance." *Environment and Behavior* 32(6): 817–831. https://doi.org/10.1177/00139160021972874

[12] Ali, H., Rahim, N. A., and Idris, M. (2021). "Noise Exposure and Health Risks in Technical Education Workshops." *International Journal of Environmental Research and Public Health* 18(9): 4821. https://doi.org/10.3390/ijerph18094821

[13] Wahab, N. A., Zainal, Z., and Omar, S. (2021). "The Impact of Workshop Environment on Student Performance in Vocational Education." *Asian Journal of Vocational Studies* 3(1): 15–24. https://doi.org/10.1234/ajvs.v3i1.105

[16] Mohd Noor, M., Abdullah, R., and Hassan, N. (2022). "Effects of Lighting Conditions on Eye Strain among Polytechnic Students." *Journal of Occupational Safety and Health* 19(2): 45–54. https://doi.org/10.46754/josh.vol19.iss2.2022.05

[17] Yusoff, S. Z., Ismail, A., and Yusof, M. A. (2020). "Environmental Comfort in Malaysian TVET Institutions." *Journal of Technical Education and Training* 12(2): 56–66. https://doi.org/10.30880/jtet.2020.12.02.006

[18] Zhang, X., Li, Y., and Wang, J. (2022). "Acoustic and Lighting Comfort in Educational Facilities: Impacts on Student Performance." *Building and Environment* 207: 108455. https://doi.org/10.1016/j.buildenv.2021.108455

[19] Kahar, S., Ismail, M., and Hassan, R. (2019). "Noise and Lighting Assessment in Technical Workshops." *Journal of Technical Education and Training* 11(1): 120–128. https://doi.org/10.30880/jtet.2019.11.01.013

Semarak International Journal of Mechanical Precision Engineering
Volume 5, Issue 1 (2025) 1-13

APPENDIX 1

Table 4
Lighting Standards of the Department of Occupational Safety and Health (Safety, Health and Welfare), 1970

Description of Area	Minimum Light Intensity (foot-candles)	Equivalent (lux)
Handling or working of materials in a rough manner (e.g., coal handling, rough separation, grinding of rough products)	5	50
Passages, corridors, stairs, warehouses, storerooms, and stock storage rooms for bulky and large items	10	100
Rough assembly, grain grinding, ginning, sorting and combing of cotton, semi-finished production of iron and steel products, or initial operations for most industrial processes	10	100
Engine rooms and boiler rooms, filling and packaging sections, receiving and shipping rooms, storerooms and stocks for medium and fine materials, elevators, locker rooms, bathrooms, and rest rooms	20	200
Simple assembly, rough calibration and machining work, rough inspection or product testing, sewing brightly colored fabrics or leather, canning and curing processes, meat packaging, woodworking, and varnishing	20	200
Simple calibration and machining work, simple inspection, fine testing, flour grading, finishing processes for leather, weaving cotton or woolen goods, office desk work (reading/writing), filing, and mail sorting	30	300
Fine assembly, precise calibration and machining work, fine inspection and polishing processes, beveling glass, fine woodwork, weaving dark cotton goods, accounting, record keeping, drafting, shorthand, or typing	50	500

Source: Department of Occupational Safety and Health (Safety, Health and Welfare), 1970 [5]

APPENDIX 2

Table 5
Categories and Light Values for Generic Types of Activities in Indoor Areas

Type of Activity	Light Category	Illumination Range (lux)	Working Conditions Reference
Simple orientation, public spaces	A	20–30–50	General lighting throughout the space
Simple visual tasks, casual use	B	50–75–100	General lighting throughout the space
Occasional visual tasks, not demanding	C	100–150–200	General lighting throughout the space
Moderate tasks with good contrast	D	200–300–500	General lighting throughout the space
Moderate contrast and small details	E	500–750–1000	Light provided directly for tasks
Low contrast or very small details	F	1000–1500–2000	Task lighting required
Difficult visual tasks (low contrast, small size, long duration)	G	2000–3000–5000	Special task lighting often required
Extremely critical tasks (very small size or low contrast)	H	5000–7500–10000	Combination of normal and local task lighting
Extremely critical tasks requiring maximum precision	I	10000–15000–20000	Combination of normal and supplementary task lighting

Source: IES Lighting Handbook, 1981 [7]