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EVALUATION OF PHYSICAL WORK ENVIRONMENT MEASUREMENTS TO PREVENT OCCUPATIONAL DISEASES IN AGRIBUSINESS INDUSTRIES

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ABSTRACT

Occupational Safety and Health (OHS) is a fundamental aspect in maintaining industrial productivity and sustainability, particularly in the agribusiness sector, which is at high risk of exposure to physical hazards. This study aims to evaluate the conformity of physical work environment measurements, including noise, Wet Bulb Globe Temperature (WBT), and lighting, with the Threshold Limit Value (TLV) and the requirements of Minister of Manpower Regulation No. 5 of 2018, and to provide control recommendations for the prevention of Occupational diseases. This research method is descriptive qualitative by analyzing secondary data from measurements in 2024–2025 from the accredited laboratory Envilab. The results show that several production areas such as the Buhler Bagging Off and Workshop have noise levels exceeding the TLV of 85 dBA, with values reaching 90 dBA. The WBT and lighting factors also show non-compliance in several areas, although there is a trend of improvement. These findings emphasize the need to improve company compliance with regulations through the implementation of technical and administrative controls, as well as the use of Personal Protective Equipment (PPE). The research conclusion shows that continuous evaluation and regular monitoring of the physical work environment is a strategic step in strengthening the implementation of K3 and preventing the emergence of occupational diseases in the agribusiness industry.

Keywords: Physical Work Environment, Noise, Wet Bulb Globe Temperature (WBGT), Lighting, Occupational Diseases.

INTRODUCTION

Occupational Safety and Health (OSH) is a fundamental prerequisite for creating a productive and sustainable le work environment. At a macro level, effective OSH implementation plays a crucial role in national economic development, as reflected in the Indonesian government's efforts through the launch of a five-year national OSH program (2024-2029) with an ambitious target of reducing the number of workplace accidents by at least 10 percent from the 298,137 cases recorded in 2022 (International Labour Organization, 2024). However, the reality on the ground shows that the industrial sector, particularly the agribusiness sector, still faces significant challenges. Data from the Ministry of Manpower of the Republic of

Indonesia indicates that the agriculture and agribusiness sector contributes 23.4% of total national workplace accidents, with a fatality rate of 1.8 per 100,000 workers, a figure even higher than the manufacturing industry average (1.2 per 100,000 workers).(Ministry of Manpower of the Republic of Indonesia, 2023)This situation underscores the high urgency to strengthen the implementation of OHS across the agribusiness value chain, particularly in the context of preventing occupational diseases.

Occupational Safety and Health (OSH) is a strategic component in achieving industrial productivity and sustaitainibiility in Indonesia. OSH implementation not only aims to protect workers from accidents and occupational diseases but also serves as an indicator of the maturity of company management in managing operational risks. According to the International Labour Organization (ILO, 2024), each year more than 2.78 million workers worldwide die from occupational diseases and workplace accidents, while another 374 million suffer non-fatal injuries. In Indonesia, data from the Ministry of Manpower of the Republic of Indonesia (2023) shows that there were 298,137 cases of occupational accidents in 2022, of which 23.4% occurred in the agriculture and agribusiness sector, making it one of the sectors with the highest risk of physical hazards in the work environment.

The agribusiness industry, particularly in the animal feed processing sector, has complex work environments characterized by simultaneous mechanical, thermal, and chemical activities. This exposes workers to various physical hazards, such as noise, high temperatures, and inadequate lighting (Rozaki, 2021). These three factors significantly contribute to the increased risk of occupational diseases. Noise exposure exceeding the Threshold Limit Value (TLV) of 85 dBA for 8 hours of work can cause permanent Noise-Induced Hearing Loss (NIHL) (Steven, 2023). Furthermore, exposure to high temperatures can lead to heat stress and heat exhaustion, which can lead to fatigue, dehydration, and even cardiac arrest if left untreated.(Ramdan et al., 2007). Meanwhile, lighting that is less than the standard of 100–300 lux has the potential to reduce concentration, increase the risk of work accidents, and reduce the quality of production results.

In the national context, regulations regarding the physical work environment are regulated through Minister of Manpower Regulation Number 5 of 2018 concerning Occupational Safety and Health. This regulation stipulates that every company is required to measure physical factors such as noise, temperature, and lighting at least twice a year, and ensure that the values obtained do not exceed the established TLV (Reza, Mulyani, & Widodo, 2022). However, various studies show that many agribusiness companies in Indonesia are still inconsistent in monitoring their work environment in accordance with these provisions (Sofia, 2024; Hananingtyas, 2023). This situation indicates a gap between policy and implementation, which has the potential to hinder efforts to prevent occupational diseases in the agribusiness sector.

In addition to compliance aspects, evaluating the physical work environment is also an important basis for improving an OHS management system based on a hierarchy of control. The principles of Corporate Hygiene and Occupational Health (Hiperkes)

emphasize that hazard control must begin with elimination, substitution, engineering control, administration, and the use of Personal Protective Equipment (PPE) (Sumamur, 2009). This hierarchy-based approach has proven effective in reducing the potential for occupational diseases, especially in high-risk sectors such as the animal feed industry (Gucci & Nalendra, 2022).

Thus, this study is relevant to assess the extent to which the physical work environment measurements in agribusiness companies align with the TLV standards stipulated in Ministerial Regulation No. 5 of 2018, and to analyze their implications for preventing Occupational diseases. This evaluation is expected to provide practical recommendations for companies in strengthening physical hazard control systems and improving worker protection.

LITERATURE REVIEW

The core concept of this study is rooted in the principles of Corporate Hygiene and Occupational Health (Hiperkes), which require evaluation of the work environment to identify, measure, and control hazards (Sumamur, 2009). Legally, the operational framework is regulated by Minister of Manpower Regulation No. 5 of 2018, which stipulates Threshold Limit Values (NAV) for physical factors (e.g., 85 dBA Noise). Compliance with this regulation includes a minimum measurement frequency of once every six months (Reza et al., 2022).

The main physical hazard factors in the agribusiness industry, particularly animal feed, include Noise, Wet Bulb Globe Temperature (WBGT), and Lighting. Ministerial Regulation No. 5 of 2018 sets the Noise Limit (TLB) at 85 dBA for 8 hours of exposure per day. Exposure exceeding this limit is a serious threat that can cause irreversible Noise Induced Hearing Loss (NIHL), as well as non-auditory effects such as work stress and decreased concentration. In the context of Hyperkes, noise control must prioritize Engineering Control over Personal Protective Equipment (PPE) to ensure effective prevention.

High noise levels exceeding the of 85 dBA in some production areas pose a serious threat that can lead to irreversible Noise-Induced Hearing Loss (NIHL) (Steven, 2023). Studies also show that excessive noise exposure triggers non-auditory effects, including work stress and decreased concentration, which can increase the risk of accidents (Permatasari, 2023; Pradhana, 2024). Noise control should prioritize engineering controls over Personal Protective Equipment (PPE) to ensure effective prevention.

Next, WBGT measures the working environment, where the TLV varies depending on the workload, with the goal of preventing heat stress. While WBGT's TLV may be adhered to, areas with values close to the maximum limit still require strengthened administrative controls, such as implementing a work-rest cycle and providing adequate drinking water, in line with the Hiperkes principle for worker adaptation. Finally, lighting is measured to prevent visual ergonomic hazards such as eye fatigue and an increased risk of occupational accidents. Areas that do not meet the TLV (e.g., 100 lux for manual work) require engineering interventions such as adding luminaires to ensure a safe working environment. The company's failure to comply with the TLV and the mandatory measurement frequency (only once a year versus six months) creates a risk gap that violates the legal and

operational basis of OHS management.

RESEARCH METHODOLOGY

This research is a qualitative descriptive study that focuses on an in-depth evaluation of the implementation of occupational health and safety (OHS) in the work environment. The purpose of this study is to evaluate the level of conformity of the results of measurements of physical factors of the work environment with the TLV of Permenaker No. 5 of 2018, as well as to formulate control strategies to prevent Occupational diseases in the agribusiness sector. The location of this research was carried out at one of the well-known agribusiness companies with a relevant case for the analysis of occupational diseases prevention.

The population of this study comprised all data and documents related to occupational health and safety (OHS) issues issued by the agribusiness companies located in the study area. The sample used purposive sampling, using data from measurements of physical factors in the work environment, including noise, and WBGT (Steel Barriers to Energy), and lighting, issued by accredited testing institutions in 2024 and 2025 (Envilab, 2024, 2025).

The measuring instruments used in this study were primarily measurements from standard instruments such as a sound level meter (for noise) in accordance with methods recognized by the Minister of Manpower Regulation. Data analysis was conducted using a descriptive and evaluative approach. The results were then interpreted to identify gaps (gap analysis) between the company's workplace OHS implementation practices and national regulatory standards. This interpretation resulted in recommendations for improvement and control based on a hierarchy of controls (elimination, substitution, engineering, administration, and PPE) (Gucci & Nalendra, 2022).

RESEARCH RESULT

This research was conducted at an agribusiness company, a leading agribusiness corporate entity operating in the animal feed processing industry. The scope of the evaluation focused on the results of measurements of physical and chemical factors of the work environment in 2024 and 2025, which prioritized the main hazards according to Permenaker No. 5 of 2018, namely noise and organic dust. The evaluation was conducted comparatively against the Threshold Limit Value (TLV) and administrative requirements (frequency of measurement) as mandated by national regulations. The research results are presented based on secondary data from measurement reports issued by accredited laboratories (Envilab, 2024, 2025) and are supported by qualitative data from interviews with the company's OHS office.

Table 1. Evaluation of noise measurement results

No	Measurement Area (Example)	2024 (dBA)	2025 (dBA)	TLV (dBA)	Compliance with TLV
1.	Buhler Bagging Off Production	90.2	90	85	It is not in accordance with
2.	Workshop/Maintenance Area	73.6	90	85	It is not in accordance with

Noise evaluations revealed compliance issues with the TLV of 85 dBA in both areas. Buhler Production consistently performed Non-Compliant (90.2 dBA in 2024 and 90 dBA in 2025), exceeding the safety limit. The Workshop area showed a critical jump, from Compliant (73.6 dBA in 2024) to Non-Compliant (90 dBA in 2025). Both results in the most recent year (2025) require immediate and mandatory noise control measures to protect workers' health from hearing risks.

Table 2. Wet Bulb Globe Temperature (WBGT) Measurement Result

No	Workspace/Section	Exposure Duration	Workload	TLV (^{0}C)	Year 2024 (^{0}C)	Year 2025 (^{0}C)	Compliance 2025
1.	Buhler Bagging Off Production	75%	Currently	28	29.8	25.1	It is not in accordance with
2.	Heavy Equipment Workshop	50%	Currently	29	29.1	26.4	It is not in accordance with
3.	Commercial Powerhouse	50%	light	32	28.9	26.4	It is not in accordance with
4.	Buhler Productions Floor 8	50%	Currently	29	30.5	30.5	It is not in accordance with
5.	Buhler Productions Floor 7	50%	Currently	29	30	25.8	It is not in accordance with
6.	Buhler Productions Floor 2	50%	Currently	29	29.7	18.1	It is not in accordance with

Analysis of the Wet Bulb Globe Temperature (WBGT) measurement results indicates that all work areas are classified as Not Conforming in 2025 compliance. This is contradictory, as the majority of areas show significant temperature improvements where their 2025 Wet Bulb Globe Temperature (WBGT) values (e.g., 25.1 oC) have fallen below the required Threshold Limit Value (TLV) (e.g., 28 oC). The only clear and consistent TLV violation occurs in Buhler Production Floor 8, where the WBGT remains high at 30.5 (TLV 29 ^{o}C). A blanket “Not

Conforming" classification, despite the temperature improvements, requires data verification or explanation regarding other non-thermal compliance criteria. Temperature control measures are mandatory on Floor 8.

Table 3. Evaluation Of Lighting Measurement Result

No	Location / Workspace (Example)	TLV (lux)	Lux Intensity Measurement Results in 2024	Lux Intensity Measurement Results in 2025	Compliance with TLV
1.	QC Lab - Open Space	300	184	245	It is not in accordance with
2.	QC Lab - AAS Room	200	215	234	It is not in accordance with
3.	QC Lab - Weighing Room	100	253	215	It is not in accordance with
4.	Buhler Production Floor 1	100	91	200	It is not in accordance with
5.	Sack Warehouse	200	121	196	It is not in accordance with

The lighting factor analysis showed that all five locations/workspaces were classified as Not Conforming to the Threshold Limit Value (TLV) for lighting, despite improvements in light intensity in most areas. The QC Lab - Open Space (TLV 300 lux) showed a significant improvement from 184 lux to 245 lux, but remained below the TLV. Similarly, the Sack Warehouse (TLV 200 lux) improved from 121 lux to 196 lux. The exception was the QC Lab - Weighing Room, where the intensity decreased from 253 lux to 215 lux, although both exceeded the TLV of 100 lux. Overall, the 2025 results indicate that despite improvements, lighting levels in almost all critical work areas still do not meet safety standards and require follow-up to achieve compliance with the TLV.

DISCUSSION

Noise

Based on the results of noise measurements in several work areas, it is known that some locations have noise levels that exceed the Threshold Limit Value (TLV) stipulated in the Minister of Manpower Regulation Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment, which is 85 dBA for exposure during 8 working hours. The measurement data shows that in 2024–2025 there was an increase in noise in several production areas, including Buhler Bagging Off Production from 90.2 dBA to 90 dBA, Workshop from 73.6 dBA to 90 dBA, and Commercial Power House from 85.1 dBA to 91 dBA. This increase is strongly

suspected to be caused by the addition of new machine installations and less than optimal machine maintenance activities in the field. This condition poses a serious risk to workers' hearing health, especially the occurrence of Noise Induced Hearing Loss (NIHL), a sensorineural hearing loss caused by continuous exposure to noise exceeding the TLV (Mayasari & Khairunnisa, 2020).

Prolonged exposure to noise with an intensity above 85 dBA has been shown to cause permanent hearing loss, and even short-term exposure can cause temporary effects such as a temporary threshold shift (Amalia et al., 2025). In addition to auditory effects, noise also causes non-auditory effects such as increased physiological stress, sleep disturbances, increased blood pressure, mental fatigue, and decreased concentration, which impact productivity and work safety (Utama, 2023).

The analysis shows that the tendency for increased noise in production and machine maintenance areas is related to a lack of technical maintenance and an increase in mechanical workload. This is in line with research by Chen, Su, & Chen (2020) which states that factors such as intensity, frequency, duration of exposure, and individual sensitivity play a major role in triggering NIHL in industrial workers.

To address this, implementing a risk control hierarchy is a strategic step. At the engineering control level, routine maintenance of machines and work tools is highly recommended, as mechanical vibration and friction between components are the main sources of noise. With routine maintenance, machine imbalance and wear can be reduced, resulting in a significant decrease in noise levels.

Research by Taofeek (2025) shows that the implementation of engineering controls can reduce noise levels by 10–15 dBA, significantly reducing the risk of NIHL. Furthermore, installing acoustic dampers, sound insulation, and sealing machine areas can be an effective solution to directly control noise sources, particularly in the Buhler Bagging Off Production area and Commercial Power House, which recorded results of >90 dBA.

At the administrative level, companies need to implement job rotation and limit exposure time in high-noise areas. Based on corrected exposure duration standards, areas with noise levels between 88–91 dBA are only permitted to have a maximum working time of 2–4 hours per day. Furthermore, implementing a regular audiometry screening program should be part of medical surveillance. Baseline audiometry examinations and six-monthly follow-ups can detect early changes in workers' hearing thresholds (Moroe, 2022).

Furthermore, the use of Personal Protective Equipment (PPE) such as ear plugs and ear muffs is a crucial step in protecting workers from the effects of noise. Proper use of PPE can reduce exposure by 15–30 dBA, depending on the effectiveness of the sound insulation and the fit of the device to the worker's ears (Smalt, 2022). For areas with extreme noise levels above 90 dBA, a combination of ear plugs and ear muffs (double protection) is highly recommended. For optimal effectiveness, workers should be trained in PPE use and undergo periodic fit testing every six months.

As a follow-up step, periodic noise monitoring and evaluation are required at least every six months to ensure the effectiveness of implemented control measures. Occupational health and safety

education and outreach programs should also be strengthened, encompassing an understanding of noise risks, early signs of hearing loss, and the importance of complying with PPE use. It is also recommended that companies develop standard operating procedures (SOPs) for noise control and strengthen occupational health promotion policies, such as hearing function screenings and health counseling for workers exposed to noise. By implementing a comprehensive control strategy—including technical and administrative controls, as well as the use of PPE—it is hoped that noise levels in the workplace can be reduced to below safe limits. These efforts will not only reduce the risk of noise-induced hearing loss but also improve health, safety, and productivity sustaiTLV ly (Saraswati et al., 2023).

Wet Bulb Globe Temperature (WBGT)

Based on the results of the Wet and Bulb Temperature Index (WBS) measurements in the work environment, it was found that several areas had values exceeding the Threshold Limit Value (TLV) stipulated in the Minister of Manpower Regulation Number 5 of 2018, which is 28°C for medium workloads. The measurement results showed that in 2024, the highest WBS values were found in the Heavy Equipment Workshop (29.1°C), Buhler Production Floor 4 (29°C), and Buhler Production Floor 2 (29.7°C). These values indicate a potential risk of heat stress that can affect worker health and productivity. Research by Ariyanto & Prasetyowati also suggests that WBS values above the TLV indicate working conditions that are at high risk of heat stress (Ramdan et al., 2007).

Further evaluation revealed a discrepancy between the duration of heat exposure and the workload. Several critical areas, such as PIB-Bagging Off and Buhler Production Bagging Off, had exposure durations of up to 75% of working time, which increased physiological risks such as increased body temperature, blood pressure, pulse rate, and weight loss (Sunaryo & Romadhoni, 2020). This condition can also trigger serious disorders such as heat exhaustion and heat stroke (Fathurochman, Tri Rizqi & Sarvia, 2021). However, measurement trends for 2025 showed improvements in several areas, such as the Heavy Equipment Workshop, which decreased from 29.1°C to 26.4°C, and Buhler Production Floor 2 from 29.7°C to 18.1°C. However, areas such as Buhler Production Floor 3 still showed high values of 30.5°C, requiring further intervention to ensure worker safety.

Excessive heat exposure not only reduces work productivity but can also cause long-term health problems. According to Alayyannur, Ramdhan & Tejamaya (2023), heat stress causes decreased physiological performance and increases the company's financial burden due to absenteeism and decreased productivity. Therefore, comprehensive control measures are needed through technical and administrative approaches, including the use of personal protective equipment (PPE).

In terms of technical control, the primary step is the installation of mechanical ventilation and air conditioning in areas with WET BULB GLOBE TEMPERATURE (WBGT) above the TLV. Research by Moradpour, Jafari, and Dehghan (2024) shows that proper ventilation systems can lower working temperatures by 3–5°C, improve thermal comfort, and reduce the risk of heat stress.

Furthermore, improving machine layout and increasing air circulation can help reduce radiant heat in production areas. Companies need to implement job rotation and manage rest periods using a work-rest cycle. A study by Ridwan (2023) found that a 50:10-minute work-rest ratio in hot work environments can reduce the risk of heat exhaustion by up to 60%. Acclimatization programs for new workers are also necessary to allow their bodies to adapt to high temperatures. Rahimi et al. (2019) reported that workers who underwent a 7–14-day acclimatization program had a 40% lower risk of heat exhaustion than those who did not.

Furthermore, supporting facilities such as cooled rest areas, cooling stations, and access to cold drinking water are mandatory in high-risk areas. Regular health checks, such as measuring body temperature, blood pressure, and other vital signs, should be conducted routinely (Lee et al., 2021). Workers should also be educated on the signs of heat stress, the importance of hydration, and the use of PPE such as breathable workwear and reflective headgear. By implementing comprehensive, hierarchical controls, the work environment can be maintained safely and comfortably. These measures are expected to not only reduce the risk of heat stress and fatigue but also improve worker safety, productivity, and well-being in industrial workplaces with a high potential for heat stress.

Lighting

Based on the results of lighting intensity measurements in several work areas, it was found that all locations did not meet the lighting Threshold Limit Value (TLV) stipulated in the Minister of Manpower Regulation Number 5 of 2018 concerning Occupational Safety and Health in the Work Environment. The recommended TLV value for work spaces varies according to the type of activity, for example, 300 lux for open laboratory spaces, 200 lux for analytical laboratories, and 100 lux for production or warehouse areas. However, the measurement results showed that almost all locations had values below the TLV standard in 2024, with an insignificant increase in 2025.

Data shows that in the QC Lab – Open Space, lighting intensity increased from 184 lux (2024) to 245 lux (2025), but is still below the TLV of 300 lux. The QC Lab – AAS Room recorded an increase from 215 lux to 234 lux, but has not yet reached the ideal standard of 200 lux stably due to fluctuations in light distribution. Meanwhile, the QC Lab – Weighing Room showed results of 253 lux in 2024 and decreased to 215 lux in 2025, even though the minimum standard is only 100 lux. Similar conditions also occurred in the Buhler Production area on Floor 1 (91→200 lux) and Sack Warehouse (121→196 lux). Although there have been improvements from year to year, the entire area is still zoned"it is not in accordance with"against TLV because it has not yet achieved an even and optimal level of lighting at all work points.

This discrepancy indicates a problem with the lighting system, whether in terms of light intensity, distribution, or lighting equipment maintenance. Inadequate lighting can significantly impact worker health and productivity. Inadequate light intensity can cause visual fatigue, decreased concentration, and an increased risk of workplace accidents. Furthermore, uneven lighting can create harsh shadows and glare that impair work accuracy, especially in laboratory areas that

require high precision (Nugroho & Sulistyowati, 2024).

In the context of technical control, improving lighting systems should be a top priority. The use of high-intensity, energy-efficient LED lamps is recommended to replace conventional lamps. The lighting layout should also be adjusted to provide more even lighting distribution, with the addition of reflectors or diffusers to reduce glare. Routine maintenance, such as cleaning lamps and replacing ballasts every six months, can help maintain stable light intensity (Setiawan et al., 2025).

Administrative controls can be implemented through work schedules that prioritize natural lighting. Work areas with low lighting should be utilized during the day when there is sufficient sunlight. Companies should also establish a periodic lighting inspection program at least twice a year, in accordance with Ministry of Manpower guidelines, to ensure compliance with the TLV. Furthermore, employee education on the importance of good lighting and prompt reporting of damaged or dim lights is essential.

In addition to technical and administrative aspects, ergonomically designing a workspace can help maximize natural lighting. Light, reflective, and clean wall colors can increase light reflection by 20–30% (Jelly Tan et al., 2023). The combination of natural and artificial lighting will support a more comfortable and productive working atmosphere.

With the implementation of comprehensive and continuous control, the lighting intensity in all work areas is expected to reach or exceed the TLV according to the standards of Permenaker No. 5 of 2018. This will not only reduce the risk of eye fatigue and work errors, but also increase energy efficiency, safety, and worker productivity in the work environment.

CONCLUSION

Based on the evaluation of the results of the work environment measurement in this agribusiness industrial company, it shows that the company has not fully fulfilled the comprehensive Occupational Safety and Health (OHS) requirements as mandated by the Minister of Manpower Regulation Number 5 of 2018. The main problems were identified in two critical aspects.

There is a clear non-compliance with physical factors, particularly noise, where vital production areas such as bagging off areas consistently show exposure levels exceeding the Threshold Limit Value (TLV) of 85 dBA. This directly poses a high and immediate risk of Noise-Induced Hearing Loss in workers. Furthermore, WBGT and lighting factors also need to be improved in accordance with SOPs to optimally prevent occupational diseases. Immediate corrective actions and engineering controls must be implemented to mitigate these hazards and ensure worker safety compliance.

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