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Iklim Kerja Di PT Pelindo Terminal Petikemas TPK Bitung: Implikasi Terhadap Kesehatan Dan Keselamatan Kerja

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ABSTRAK

Iklim kerja, khususnya suhu tinggi, berpengaruh signifikan terhadap kesehatan dan produktivitas pekerja. Paparan panas yang ekstrem dapat meningkatkan risiko gangguan kesehatan, termasuk penyakit kardiovaskular. Penelitian ini bertujuan untuk menilai kondisi iklim kerja di PT Pelindo Terminal Petikemas TPK Bitung dan mengkaji potensi risikonya terhadap kesehatan pekerja. Penelitian ini menggunakan desain deskriptif dengan pendekatan kuantitatif. Variabel yang dikaji adalah iklim kerja, yang diukur menggunakan *Heat Stress Monitor* selama shift siang (08.20–19.40 WITA) dengan interval pengukuran setiap 40 menit. Analisis univariat dilakukan untuk menggambarkan distribusi parameter suhu. Suhu rata-rata iklim kerja tercatat sebesar 29°C, dengan suhu minimum dan maksimum masing-masing 26°C dan 35,5°C. Berdasarkan Peraturan Menteri Ketenagakerjaan No. 5 Tahun 2018, nilai *Wet Bulb Globe Temperature* (WBGT) sebesar 29°C masih berada dalam batas aman untuk beban kerja ringan hingga sedang, namun dapat melebihi batas ambang bila dikaitkan dengan aktivitas kerja berat di bawah paparan sinar matahari langsung. Iklim kerja di PT Pelindo Terminal Petikemas TPK Bitung tergolong dalam kategori yang dapat berdampak pada kesehatan kerja, tergantung pada intensitas dan jenis aktivitas yang dilakukan. Intervensi preventif diperlukan untuk meminimalkan risiko stres panas.
Kata kunci: Iklim kerja, Heat Stress Monitor, Kesehatan kerja, WBGT, Stres panas

ABSTRACK

Work climate, particularly high ambient temperatures, significantly affects workers' health and productivity. Extreme heat exposure may increase the risk of health issues, including cardiovascular diseases. This study aimed to assess the work climate conditions at PT Pelindo Terminal Petikemas TPK Bitung and evaluate the potential health risks for workers. This was a descriptive study using a quantitative approach. The variable measured was work climate, assessed using a Heat Stress Monitor during daytime shifts (08:20–19:40 WITA) with measurements taken every 40 minutes. Univariate analysis was used to describe the distribution of temperature parameters. The average work climate temperature was 29°C, with a minimum of 26°C and a maximum of 35.5°C. Based on the Indonesian Ministry of Manpower Regulation No. 5 of 2018, a Wet Bulb Globe Temperature (WBGT) of 29°C is within the safe threshold for light to moderate workloads but may exceed the Threshold Limit Value (TLV) under heavy physical exertion, especially under direct sunlight. The work climate at PT Pelindo Terminal Petikemas TPK Bitung presents varying levels of occupational health risk depending on the intensity and type of work performed. Preventive interventions are necessary to reduce the risk of heat stress.
Keywords: Work climate, Heat Stress Monitor, Occupational health, WBGT, Heat stress

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INTRODUCTION

A safe and comfortable work environment is a critical factor in maintaining workers' health and productivity, particularly in port industries located in tropical regions such as Indonesia. One of the most crucial aspects of this environment is workplace temperature, which, if excessively high, can lead to heat stress, work fatigue, and decreased performance (Asih & Herlina, 2023; Watulinggas et al., 2020; Suhartoyo, et al 2022; Sumampouw & Joseph 2022).

Work climate is a dominant factor influencing occupational safety, health, and overall work performance. Measuring work climate aims to assess temperature levels in the work environment and compare them with applicable standards and regulations (SNI, 2019). Excessively high workplace temperatures pose significant health risks to workers. Prolonged exposure to extreme heat is referred to as heat stress (Harianto, 2015).

Work climate is defined as a combination of air temperature, humidity, air velocity, and radiant heat (Suma'mur, 2014). According to Indonesian Minister of Manpower Regulation No. 5 of 2018, work climate results from the interaction between temperature, humidity, air movement, and radiant heat, along with the body's heat production due to physical labor, encompassing both heat and cold stress. A hot work climate refers to high ambient temperatures in the workplace, determined by the combined effects of natural wet-bulb temperature, dry-bulb temperature, and globe temperature, collectively known as the Wet Bulb Globe Temperature (WBGT). The natural wet-bulb temperature reflects evaporative cooling influenced by humidity and wind speed, while the dry-bulb temperature indicates ambient air temperature measured by a standard thermometer. The globe temperature measures radiant heat from both natural and artificial sources.

Excessive workplace temperatures can disrupt workers' physiological stability. The World Health Organization (WHO) states that high ambient temperatures may increase heart rate, cause dehydration, and even lead to heat stroke if not properly managed. Research by Yaakub and Abdul Razak (2024) also found a direct correlation between workplace temperature and stress levels among port crane operators.

The use of tools such as Heat Stress Monitors with WBGT indicators has become the standard for assessing heat stress in port environments (Asih & Herlina, 2023). Similar studies in Teluk Bayur Port and Makassar Port demonstrated that significant temperature increases lead to subjective complaints such as dizziness, fatigue, and respiratory issues among dockworkers (Pitaloka & Sididi, 2021). Additional factors exacerbating heat stress include workwear type, physical workload intensity, and inadequate access to hydration and ventilation (Novrikasari, n.d.; Watulinggas et al., 2020). In the context of global climate change, extreme temperatures are becoming more frequent, increasing the urgency for ergonomic interventions and climate risk mitigation policies in ports (Poo, 2020; Phillips, 2008).

The effects of high workplace temperatures extend beyond health, impacting operational safety. Prasita (2024) found that excessive heat increases the risk of workplace accidents due to reduced worker alertness. Therefore, assessing workplace temperatures at PT Pelindo TPK Bitung is highly relevant for operational efficiency and worker protection. As a key player in Indonesia's national logistics chain, PT Pelindo TPK Bitung supports regional connectivity in Eastern Indonesia. The work environment in this company involves not only physical aspects such as port facilities and cargo-handling equipment but also psychosocial factors that directly influence employee performance. As noted by James and McIntyre (2020), organizations fostering a positive work climate tend to have more motivated, loyal, and productive employees.

PT Pelindo Terminal Petikemas (TPK) Bitung is part of Indonesia's strategic port network, specializing in container handling operations. Workers often perform duties in open areas under intense tropical sunlight, making ambient temperature a major occupational safety and health challenge (Pitaloka & Sididi, 2021). Firmansyah et al. (2024) found that high temperatures, combined with humidity and direct solar exposure, increase fatigue and reduce concentration among port workers. Preliminary observations at PT Pelindo TPK Bitung indicate that security personnel work 12-hour shifts in open areas without air conditioning, increasing their exposure to high temperatures. According to Bitung City Central Bureau of Statistics, workplace temperatures can reach 35.8°C, classifying the area as hot. This study aims to assess the work climate conditions at PT Pelindo TPK Bitung.

MATERIALS AND METHODS

This study employed a quantitative descriptive design aimed at analyzing the work climate conditions for security personnel at PT Pelindo Terminal Petikemas (TPK) Bitung, with particular focus on measuring physical environmental parameters during day shifts (08:20-19:40 Central Indonesia Time). The single variable in this research was work climate, measured using a Heat Stress Monitor to record air temperature (°C), relative humidity (%), air velocity (m/s), and Wet Bulb Globe Temperature (WBGT) as indicators of heat exposure. Data collection was conducted systematically at 40-minute intervals to ensure accuracy and capture environmental variations throughout the work period. The study was implemented in security personnel operational areas, including guard posts and patrol points, with monitoring devices positioned at 1.5 meters height to represent workers' breathing zones. The research protocol included preliminary instrument calibration, documentation of supplementary weather conditions, and adherence to ethical considerations by minimizing interference with work activities. Study limitations included the exclusive focus on day shifts without accounting for individual variations such as workers' age and physical fitness. Collected data were analyzed using univariate descriptive statistics (mean, standard deviation, minimum-maximum values) and visualized through tables and graphs to illustrate the distribution of work climate parameters at the study site. Measurement results were subsequently compared against the Threshold Limit Values (TLV) stipulated in Indonesian Minister of Manpower Regulation No. 5 of 2018 concerning Occupational Work Environment Safety to assess potential heat stress risks for workers.

RESULTS

The results of this study can be seen in Table 1.

Table 1. Distribution of Working Climate Data

Min (°C)	Max (°C)	Mean (°C)
26	35,5	29

Table 1 shows that the minimum value of the working climate is 26°C, while the maximum value of the working climate reaches 35.5°C and the average value (mean) obtained is 29°C.

DISCUSSION

Research on the work environment climate for security personnel at PT Pelindo Terminal Petikemas (TPK) Bitung revealed significant temperature variations, with a recorded minimum of 26°C and a maximum reaching 35.5°C. The average measured workplace temperature was 29°C. In this context, understanding heat stress is crucial, particularly given that high temperatures can adversely affect workers' health and productivity (Humphrys et al., 2022; Ebi et al., 2021; Zander et al., 2018). Measurements were conducted using a Heat Stress Monitor, enabling real-time environmental assessment—a method proven effective in evaluating temperature-related health risks across various workplaces (Sulzer et al., 2022).

Elevated ambient temperatures, as observed at PT Pelindo TPK Bitung, heighten the risk of heat stress among workers, including security personnel who may endure prolonged heat exposure. Studies indicate that surpassing certain temperature thresholds can precipitate health issues such as dehydration, fatigue, and cardiovascular complications (Ebi et al., 2021; Jovanović et al., 2020; Foster et al., 2020). Consequently, temperature monitoring transcends mere measurement; it is a vital step in mitigating occupational health risks. Workplace health policies must integrate such thermal data to foster safer and more comfortable environments (Stephens et al., 2022; Roca et al., 2025).

When ambient temperatures peak at 35.5°C, worker risk escalates substantially. Recent studies demonstrate that rising temperatures exacerbate physical and mental stress (Jovanović et al., 2020;

Foster et al., 2020; Gaunkar et al., 2022), underscoring the imperative for targeted preventive measures. Key interventions include ensuring adequate hydration access, shaded rest areas, and worker education on heat stress symptoms (Coman et al., 2020; Zander et al., 2018; Foster et al., 2020).

The heat stress experienced by PT Pelindo TPK Bitung's security personnel is modulated by factors such as workload intensity and individual physiological conditions. Research corroborates that physical activity levels and personal health status significantly influence heat stress susceptibility (Al-Bouwarthan et al., 2019; Foster et al., 2020; Vongchanh & Chan, 2022). Continuous, adaptive environmental monitoring is essential to ensure interventions are precisely tailored and effective in reducing occupational health risks (Mirsanei et al., 2024; Pogačar et al., 2018; Zander et al., 2018).

Implementing context-specific heat action plans is critical, as advocated by health experts. Recommended measures include adjusting work schedules to cooler periods, providing cooling facilities, and training workers to recognize heat stress symptoms (Humphrys et al., 2022; Coman et al., 2020). With an average recorded temperature of 29°C, adaptive strategies can be developed to address potential temperature extremes (Sulzer & Christen, 2024; Foster et al., 2020; Uher et al., 2018).

The ramifications of heat stress extend beyond individual health to organizational productivity. Evidence suggests that thermal stress reduces work output and increases accident risks (Roca et al., 2025; Kwong et al., 2023; Pogačar et al., 2018). Thus, proactive measures are indispensable to cultivate healthier workplaces and enhance efficiency in heat-vulnerable sectors (Sharma et al., 2022; Wang et al., 2021; Vongchanh & Chan, 2022).

The thermal variability observed at PT Pelindo TPK Bitung underscores the urgent need for heat stress mitigation among security personnel. Investments in occupational health and safety will not only safeguard workers but also bolster operational productivity and sustainability. Further research and data-driven interventions are paramount to developing sustainable solutions (Sulzer et al., 2022; Ebi et al., 2021; Zander et al., 2018; Foster et al., 2020).

The study recorded significant thermal variations in the workplace environment of security personnel at PT Pelindo TPK Bitung, with measurements showing a minimum temperature of 26°C, a maximum reaching 35.5°C, and a mean temperature of 29°C. These findings were systematically compared against the Threshold Limit Values (TLVs) established in Permenaker No. 5 Tahun 2018 concerning Occupational Health and Safety (K3) in Work Environments. The comparative analysis revealed critical occupational health implications: while the mean temperature (29°C) remained within permissible exposure limits for light work activities, the peak temperature (35.5°C) substantially exceeded recommended thresholds, particularly when considering the combined effects of radiant heat, humidity, and the personnel's protective gear requirements. This thermal profile indicates a pronounced heat stress risk during peak exposure periods, with the Wet Bulb Globe Temperature (WBGT) index likely surpassing safe thresholds for continuous outdoor work. The regulatory comparison underscores the necessity for immediate administrative controls (e.g., work-rest cycles) during temperature extremes, engineering interventions (e.g., localized cooling stations), and enhanced worker surveillance for early heat-related illness symptoms. These findings emphasize the growing climate change adaptation challenges for tropical industrial workplaces, where traditional occupational exposure limits may require reevaluation to account for increasing frequency of extreme heat events. The data provides empirical evidence supporting regulatory updates and targeted heat stress prevention programs in Indonesia's maritime sector.

CONCLUSIONS

This study reveals significant thermal variations (26°C–35.5°C, mean: 29°C) in the work environment of security personnel at PT Pelindo TPK Bitung, indicating substantial heat stress risks that may impair workers' health (dehydration, cardiovascular strain) and operational productivity. Future research directions should incorporate individual physiological monitoring (core temperature, heart rate variability) to develop personalized risk matrices, particularly for vulnerable

subgroups. These evidence-based recommendations not only address immediate occupational health concerns but also contribute to climate change adaptation frameworks for tropical port operations, setting a precedent for similar industrial settings in Southeast Asia. Organizational adoption of these measures would demonstrate compliance with WHO occupational heat stress guidelines while optimizing human capital sustainability in increasingly warming work environments.

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