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Analyzing the Relationship Between Environmental Variables, Job Demands, Emotional Fatigue, and Job Stress in the Metal Industry of Southern Peninsular Malaysia

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ABSTRACT

Occupational environmental stress significantly impacts employees' efficiency, well-being, and safety within the workplace. This study aimed to evaluate such stress in the metal workplace by scrutinizing environmental factors: temperature, relative humidity, noise, and illuminance. This study employed mixed data collection methods, combining both objective and subjective approaches. Four (4) metal workplaces were conveniently selected, and questionnaires with 159 subjective evaluation items were distributed to 60 respondents. The methods involved collecting empirical data on environmental factors. Pearson correlation and regression analysis revealed a strong correlation between occupational environmental factors and both objective physical assessments and subjective evaluations. Temperature data exhibited the highest association, followed by relative humidity, noise, and illuminance. Further, a multivariate regression analysis highlighted a robust positive correlation ($r=0.834$) and a regression value ($R^2=0.785$) between environmental variables and the job stress level. This study highlights the relationship between job stress levels and their impact on workers in the workplace. It also introduces a new model for predicting occupational environmental stress at work. In conclusion, this research provides valuable insights for stakeholders by ensuring workplaces align with standards that promote employees' well-being, safety, and physical and psychological health. Such findings facilitate the creation of conducive work environments.

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1. Introduction

It is important to ensure that the workplace is comfortable to maintain the safety and health of workers. A comfortable workplace environment also affects safety, productivity, and performance, as indicated by recent studies that environmental factors such as temperature, noise, and lighting have a significant relationship with job stress, productivity, and job performance. For instance, studies have shown that noise and temperature levels significantly impact employee productivity in industrial settings (Arminas et al., 2021). Additionally, the quality of lighting in office environments has been found to influence workers' cognitive performance and overall job satisfaction (Sun et al., 2019).

Unfavorable working conditions in manufacturing facilities, including excessive noise, poor illumination, severe temperatures, and dust, have a substantial impact on job-related stress (Yeow et al., 2012). For example, a study conducted in the metal industry highlighted those unfavorable environmental conditions, including excessive noise and poor illumination, contribute to higher levels of job-related stress (Selamat et al., 2021). Furthermore, ergonomic issues such as repetitive tasks and high cognitive demands are linked to increased stress and decreased productivity among workers (Vasileva et al., 2023). n the broader context of job performance, ergonomic environments have been found to improve productivity and reduce stress levels. A study focusing on the workplace design of office staff revealed that poor ergonomic conditions, such as improper seating and workstation design, negatively impact both physical and mental well-being, leading to higher stress and lower performance (Hernadewita et al., 2020). Moreover, the integration of ergonomic interventions, such as adjusting workstation design and implementing ergonomic training programs, has been shown to significantly reduce musculoskeletal discomfort and job-related stress, further emphasizing the importance of ergonomics in the workplace (Heidarimoghadam et al., 2020).

Furthermore, the effects of temperature stress, noise levels, and lighting are individually associated with productivity and job performance (Zhang et al., 2021), environmental comfort (Roskams & Haynes, 2020) (Sun et al., 2019) and environmental well-being (Yang & Moon 2019, Wu et al., 2019). Therefore, this physical assessment can be specifically focused on three ergonomic environmental factors: temperature stress (temperature and relative humidity), noise levels, and lighting levels in the workplace. Meanwhile, subjective assessment is used to identify industrial job stress levels, including assessments of job comfort, job performance, and work productivity.

Job demands among workers encompass the physical, emotional, and cognitive requirements of their roles, significantly influencing their well-being and job performance. These demands are measured using various frameworks, such as the Job Demands-Resources (JD-R) model, which evaluates the balance between job demands and available resources. High job demands, such as emotional labor, repetitive tasks, and high work pace, are often linked to increased burnout, emotional exhaustion, and reduced job satisfaction (Kaiser et al., 2020). Measurement tools like the Copenhagen Psychosocial Questionnaire (COPSOQ) and other validated scales assess these demands by analyzing factors such as workload, role conflicts, and emotional strain (Husain & Mohamad, 2020). Studies have shown that addressing job demands through proper resource allocation and supportive work environments can mitigate their negative effects, improving overall employee well-being and productivity (Wemken et al., 2021).

The psychosocial work environment, including factors such as job demands, job control, and organizational justice, has a profound impact on employee wellbeing. High job demands coupled with low job control have been consistently linked to increased psychological distress and other health issues (Zeng et al., 2020), (Ervasti et al., 2021). Research indicates that the relationship between job stress and health outcomes is influenced by the balance of job demands, control, and social support. High demands and low control significantly contribute to job strain, which in turn affects mental health indicators such as anxiety, depression, and psychological distress (Jachens & Houdmont, 2019), (Gilbert-Ouimet et al., 2019).

Emphasizing the comfort of the workplace environment is crucial for enhancing health, safety, and overall performance and productivity. Another investigation was focused on the impact of environmental stress, specifically noise, on workers' heart rates conducted by Mohd Said et al., (2022). In addition to these studies, various researchers have conducted past investigations to assess the influence of individual environmental stress factors on worker satisfaction, health, or productivity by Geng et al., (2017). Job stress is a prevalent issue in modern workplaces, affecting a significant proportion of workers across various industries. Studies have shown that job stress is a major contributor to both physical and psychological health problems, including burnout, anxiety, and depression. For instance, research conducted among industrial workers in China found that occupational stress affected up to 10.3% of workers in the manufacturing sector, leading to significant health risks and decreased productivity (Yan et al., 2022). Similarly, job stress has been identified as a critical factor influencing mental well-being, with a notable impact on workers' overall quality of life (Mensah, 2021). The prevalence and impact of job stress highlight the urgent need for effective interventions to mitigate its effects and promote a healthier work environment.

Previous literature highlights the significant association between environmental stress, job demands, and job stress. Environmental stressors such as noise, temperature, and inadequate lighting in the workplace can exacerbate job demands, contributing to heightened job stress among employees. Studies have demonstrated that high job demands, including excessive workload, role ambiguity, and cognitive challenges, are closely linked to increased stress levels and negative health outcomes (Pecino et al., 2019). Furthermore, the Job Demands-Resources (JD-R) model indicates that without sufficient job resources to mitigate these demands, employees are more likely to experience burnout and reduced job satisfaction (Vandiya & Hidayat, 2019).

However, there has been a limited number of studies that have examined the collective impact of all environmental stress variables on job performance of workers in the workplace as discussed by Ángeles López-Cabarcos et al., (2022). This emphasis on performance criteria is necessary because there are currently no specific key performance indicators available for evaluating employee performance as highlighted by Attia et al., (2018).

The present study was conducted in a small-medium metal industry in Southern Peninsular Malaysia to investigate the impacts of occupational environmental stress variables, job demand, and psychological factors on the level of occupational stress among workers in the metal workplace. The study focuses on evaluating occupational environmental stress by examining environmental factors such as temperature, relative humidity, noise, and lighting. The predicted equation was developed to measure the physical assessment and subjective assessments of environmental factors with job (occupational) stress levels. The results of this study are presented in the paper.

2. Methodology

The study design and setting are divided into two parts: subjective approach, which is an assessment of the level of occupational environmental stress and environmental factors in the selected metal workplace using a questionnaire, and objective approach, which is a physical assessment of environmental factors such as temperature, noise, and lighting.

2.1 Data Collection

2.1.1 Participant

This study involved 60 respondents from four selected small-medium metal workplaces. Each workplace contributed 15 participants, all aged between 20 and 60. The participants took part in a subjective assessment consisting of a set of questionnaires. Since the study was conducted in small to medium-sized metal workplaces, it seemed that 60 participants were sufficient to meet the research objectives. The appropriate sample size for studies can be influenced by factors such as effect size, participant homogeneity, and acceptable error risk, which optimize the likelihood of finding clinically and statistically meaningful results (Burmeister & Aitken, 2012). Other researchers suggest that anywhere between 10 and 50 participants can be adequate based on the research type and specific questions being investigated. For instance, a study in the neuromarketing field showed that sample sizes between 16 and 32 participants were sufficient to obtain meaningful results in certain experimental conditions (Vozzi et al., 2021).

2.1.2 Questionnaire

The subjective assessment method employs a set of questionnaires comprising 159 questions, which is broken down into six sections: (1) general respondent information, (2) job-related information, (3) health status, (4) work condition information, (5) workplace environment, and (6) job stress level. This questionnaire has undergone assessment by an expert panel and pilot assessment. The reliability of the questionnaire items is considered acceptable when the Cronbach's Alpha value exceeds 0.7 (Bland & Altman 1997; George and Mallery 2003; Shahbazi et al. 2019). The results of Cronbach's Alpha analysis indicate that the developed questionnaire is reliable and relevant with values of 0.890 and 0.864 for sections 4 (work condition) and 5 (workplace environment) respectively. This questionnaire measures job demands in Section (2), which includes variables such as workload, time pressure, and physical demands; working comfort in Section (4), assessed through variables like ergonomic conditions, temperature, lighting, and noise levels; workplace environment in Section (5), covering variables such as make decision, knowledge, training, perceived stress, anxiety levels and job stress level in Section (6).

2.1.3 Physical Assessment

In this study, the objective method or Physical assessment method, consists of measuring temperature, noise levels, and lighting levels in the metal workplace. In this study, three physical assessment instruments were used, namely the Elitech RC-4HC as temperature meter and relative humidity meter, the UT382 as light level meter, and the Center 322 as sound level meter, were placed nearby, within a 1-meter radius from the machinery and at a height of 1 meter from the floor level. This physical assessment was taken simultaneously while recording video using the Decibel X app on a smartphone, with the assessment being captured at a standing height. The positioning of the meters for the physical assessment is shown in Figure 1. The instruments used in this study are shown in Figure 2. The physical assessment was taken in four selected metal workplaces. Figure 3 shows the physical assessment in a metal workplace.

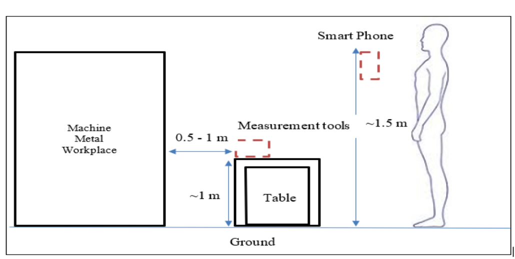

Figure 1. Physical measurement setup at metal workplace

(a) (b) (c)

Figure 2. Physical measurement instruments (a) Elitech RC-4HC and (b) Light Meter Uni-T UT382 (c) Center 322 Sound Level Meter

(a) (b)

Figure 3. Physical measurement in metal workplace (a) worker at the metal workplace and (b) with decibel X apps

2.2 Statistical Method

The main data gathered from the subjective and objective assessment methods was to indicate the relationships between the level of occupational environmental stress and environmental factors. All these data were analyzed using IBM SPSS Statistic version 22. This analysis seeks to establish the correlation between occupational stress levels based on subjective assessments and environmental factors based on both subjective assessments and physical assessments using the Pearson correlation method. Furthermore, a multi-variable regression analysis is conducted to identify the dependent and independent variables, specifically the relationship between job stress levels and subjective assessments, physical assessment, and the optimal values of temperature, relative humidity, noise level, and lighting, which can be derived from the equation obtained in this study to achieve the lowest job stress levels.

3. Results and Discussions

In this results and discussions section, the results were tabulated from the subjective and objective assessments. The data were analyzed to indicate the relationship.

3.1 Participant and Descriptive Data

Demographic data of studied populations are presented in Table 1. As shown in Table 1, when considering the gender, age, and the study place, most of the respondents are males 90% with the most age of 25-29 years old. The feeling of comfort in the workplace environment is 71.6%. As for safety precautions, 91.6% of respondents know about safety and wearing Personal Protective Equipment (PPE), and about 15% of them experienced minor accidents in the workplace environment.

The factors considered were gender, age, employment conditions, overtime work, adherence to safety measures such as Personal Protective Equipment (PPE), and occurrence of minor workplace incidents. Most respondents are men, accounting for 90% of the total. Additionally, the largest age group among the respondents is 25-29 years old.

3.2 Working Discomfort

Regarding the workplace environment, the demographic results show in table 1, the level of working comfort is 71.6%, with 43 respondents indicating they are comfortable and 17 respondents indicating they are not very comfortable. This assessment is based on subjective responses collected through a questionnaire. In terms of safety measures, 91.6% of participants (55 respondents) are aware of safety protocols and the need to wear PPE. Additionally, approximately 15% of participants (9 respondents) reported encountering minor incidents on the job in the workplace.

Table 1. Demographic for preliminary study

Category	Categories	No of Respondent	%
Gender	Male	54	90%
	Female	6	10%
Age	20 - 24 years	4	6.7%
	25 - 29 years	34	56.7%
	30 - 34 years	14	23.3%
	35 - 39 years	6	10.0%
	40 - 50 years	2	3.4%

Category	Categories	No of Respondent	%
Workplace Environment	Comfort	43	71.6%
	Not really Comfort	17	28.4%
Safety Precautions (PPE)	Yes	55	91.6%
	No	5	8.4%
Experienced minor Accident	Yes	9	15%
	No	47	85%

3.3 Exposure Towards Temperature and Relative Humidity

Around 56.7% of respondents are regularly exposed to hot temperatures in the metal workplace as shown in Table 2. The average scale value for exposure to hot temperatures is about 1.67 with a standard deviation of 0.837 which indicates that most respondents are exposed to this hot environment regularly. The exposure to humid areas shows that 51.7% of respondents are exposed to humid areas while working in a metal workplace. The average scale value for exposure to humid areas is 1.7 with a standard deviation of 0.801 which indicates that the majority of respondents are exposed to this environment sometimes.

Table 2. Temperature and Relative Humidity Exposure Activity

Activity	Exposure	No of Respondent	%
Exposed to hot temperatures	Regularly (2-3 times per week)	34	56.7%
	Always (4-5 times per week)	12	20%
	Very often (>5 times per week)	14	23.3%
Exposed to humid areas	Regularly (2-3 times per week)	31	51.7%
	Always (4-5 times per week)	16	26.7%
	Very often (>5 times per week)	13	21.6%

3.4 Noise and Light Visual Exposure

The exposure to noise and light visual analysis is shown in Table 3, the exposure to hot temperatures shows that 36.7% of respondents are regularly exposed to high noise levels in the metal workplace. The average scale value for exposure to high noise levels is about 1.97 with a standard deviation of 0.843 indicating that the majority of respondents are exposed to this high-level noise environment regularly. Exposure to high noise levels for an extended duration (>2 hours continuously) shows that 51.7%. The average scale value for exposure to high noise levels is about 1.68 with a standard deviation of 0.791 indicating that the majority of respondents are exposed to more than 2 hours of this high-level noise environment. Working in inadequate lighting conditions shows that 65% of respondents are working in inadequate light in the metal workplace. The average scale value (standard deviation) for working in inadequate lighting conditions, is 1.43 (0.647) indicating that the majority of respondents are working with inadequate light intensity in this workplace environment.

Table 3. Noise and Light Visual Exposure Activity

Activity	Exposure	No of Respondent	%
Exposed to high noise levels	Regularly (2-3 times per week)	22	36.7%
	Always (4-5 times per week)	18	30%
	Very often (>5 times per week)	20	33.3%
Exposed to high noise levels for an extended duration (>2 hours continuously)	Regularly (2-3 times per week)	31	51.7%
	Always (4-5 times per week)	17	28.3%
	Very often (>5 times per week)	12	20%
Working in inadequate lighting conditions	Regularly (2-3 times per week)	39	65%
	Always (4-5 times per week)	16	26.7%
	Very often (>5 times per week)	5	8.3%

3.5 Environment Factors at Workplace

There are four environmental workplace variables: temperature, humidity, noise level, and illuminance (lighting). All these physical assessment data are examined in conjunction with subjective assessments using values for temperature, relative humidity, noise level, and lighting for all the selected metal workplaces that take place in this study. The results show that the highest temperature level is in the Gas Metal Arc Welding Machine at 32°C, the highest relative humidity in the Lathe Machine at 74%, and the highest levels of noise and the highest level of lux were in the Plasma Cutting Machine at 106 dBA and 495 lx respectively shown in Table 4.

Table 4. Results of physical measurement of the workplace environment

Metal Workplace	Temp (°C)	Relative Humidity (%)	Noise (dBA)	Lux Level (lx)
Lathe Machine	29	74	96	265
Gas Metal Arc Welding Machine	32	63	92	273
Shielded Metal Arc Welding Machine	31	65	88	389
Plasma Cutting Machine	30	69	106	495

3.6 Relationship Between Job Demand Variables with Job Stress Level

It was demonstrated that the highest correlation between job demand variables and job stress levels ranged from ±0.4 to ±7.0, indicating a significant relationship between these factors shown in Table 5. The strongest correlation is between the ability to make decisions and job demands that require decision-making, with a correlation coefficient of r=0.645 (p<0.001). This is followed by the correlation between the ability to work with high concentration and focus and job demands that require knowledge or foundation for work processes, with a correlation coefficient of r = 0.583 (p <0.001). Additionally, there is a correlation between the self-confidence at work and job demands a high level of job-related skills, with a coefficient of r=0.487 (p=0.000), and a correlation between the willing to learn new things and job demand that require training and knowledge, with a coefficient of r=0.453 (p<0.001). These findings are consistent with previous studies, where job stress can arise from job and task demands such as job type, career development, workload, and job insecurity (Quick & Henderson, 2016). Therefore, this finding highlights the importance of addressing job demands and job tasks to reduce job stress and improve overall employee well-being in the workplace.

Table 5. Relationship between Job Demand, Emotional Fatigue, Environmental and Score of Workplace with Job Stress Level Variables

Job Demand Variables	Job Stress Variables	Correlation	Significant (2-tailed)	Correlation Strength
Your job requires you to make independent decisions.	Ability to make decisions	.645**	0.000	High
Your job requires knowledge, or a foundation related to your work processes.	Ability to work with high concentration and focus	.583**	0.000	High
Your job demands a high level of job-related skills.	Self-confidence at work	.487**	0.000	Moderate
Your job requires training and knowledge.	Willing to learn new things	.453**	0.000	Moderate
Emotional Fatigue Variables				
Your work is very exhausting and tiring	Feeling unable to control important things in life	.578**	0.000	High
Your work is very exhausting and tiring	Feeling anxious (nervous) and stressed	.526**	0.000	High
Your work is very exhausting and tiring	Feelings of sadness (depression) caused by unexpected events	.477**	0.000	Moderate
Environmental Variables				
Exposed to hot temperatures	Job Stress Level Score	.574**	0.000	High
Exposed to humid areas	Job Stress Level Score	.403**	0.001	Moderate
Exposed to high noise levels for an extended duration (>2 hours continuously)	Job Stress Level Score	.481**	0.000	Moderate
Working in inadequate lighting conditions	Job Stress Level Score	.339**	0.008	Moderate
Workplace Environmental Variables				
Score for Temperature Level	Job Stress Level Score	-.468**	0.000	Moderate
Score for Relative Humidity Level	Job Stress Level Score	-.431**	0.001	Moderate
Score for Noise Level	Job Stress Level Score	-.300*	0.020	Moderate
Score for Lighting Level	Job Stress Level Score	-.302*	0.019	Moderate

*. Correlation is significant at the 0.05 level (2-tailed)

**. Correlation is significant at the 0.01 level (2-tailed)

3.7 Relationship Between Emotional Fatigue with Job Stress Level

The highest correlation between emotional fatigue and job stress levels is high, ranging from ±0.4 to ±0.6 shown in Table 5. The strongest correlation is between feeling unable to control important things in life with highly exhausting and tiring job demands, with a correlation coefficient of r=0.578 (p<0.001). This is followed by the correlation between feelings of anxiety and stress and highly exhausting and tiring job demands, with a correlation coefficient of r=0.526 (p<0.001). Additionally, the relationship between feelings of highly exhausting and tiring job demand with job stress level score, with coefficients of r=0.477 (p<0.001) is moderate. The findings reveal that feeling unable to control important aspects of life is a key factor in job stress related to emotional fatigue. Psychological states, such as sadness or depression, often arise as a result of job pressure. This effect is particularly pronounced when unexpected events disrupt one's sense of stability and control, thereby intensifying emotional fatigue and contributing to overall job-related stress. According to Quick & Henderson (2016), these psychological states are not only a consequence but also a cause of job pressure, stemming from task demands, role ambiguities, and interpersonal factors. Furthermore, industrial job scope is closely associated with job pressure, as demonstrated by this finding was consistent with the previous research.

3.8 Relationship Between Environmental Variables with Job Stress Level

The highest correlation between psychological environmental variables and job stress levels is moderate to high, ranging from ±0.3 to ±0.6 shown in Table 5. The highest correlation is between exposure to hot temperatures and job stress level score, with a correlation coefficient of r=0.5748 (p<0.001). This is followed by the moderate correlation of exposure to humid areas, exposure to high noise levels for an extended duration more than 2 hours continuously) and working in inadequate lighting conditions with a correlation coefficient of r=0.403 (p<0.001), r=0.481 (p<0.001), and r=0.339 (p<0.001) respectively.

These findings indicate that the higher the exposure to hot temperatures, the higher the level of job pressure, which aligns with and corroborates previous studies by Yeow et al. (2012), especially in the metal industry as stated by Quick & Henderson (2016). Furthermore, the results show that the more frequently one works in inadequate or dark lighting conditions and is exposed to high noise levels for an extended duration, the higher the level of occupational stress which is consistent with the previous research reported by Yeow et al. (2012).

3.9 Relationship Between Workplace Environmental Variables with Job Stress Level

In this analysis, the workplace environmental scores are divided into four scores: (1) environmental temperature level score, (2) environmental relative humidity level score, (3) environmental noise level score, and (4) environmental lighting level score. Findings indicate that the highest correlation between workplace environmental scores and job stress levels is moderate, ranging from ±0.3 to ±0.5 shown in Table 5. The strongest correlation is between the environmental air level score and job pressure level, with r= -0.468 (p< 0.01). This is followed by the correlation between the relative humidity level score and job pressure level, with r= -0.431 (p<0.01). Additionally, there is a relationship between the environmental lighting level score and job pressure level, with r= -0.302 (p = p< 0.05), and a correlation between the environmental noise level score and job pressure level, with r= -0.300 (p< 0.05). Pearson correlation values show that as the environmental air level, musculoskeletal factor level, environmental lighting level, and environmental noise level decrease, job pressure level increases. This aligns with research reported by Hosseinabadi et al. (2019) for noise level, Stefan Holmstrom (2008) for musculoskeletal factors, Yeow et al. (2012), and Quick & Henderson (2016) for environmental air level and lighting.

3.10 Multivariate Regression Analysis

In this multivariate regression analysis, Table 6 shows the relationship analysis between the combined data of subjective assessments and physical assessment of environmental factors with job stress level shows the highest correlation value, R = 0.834, and the regression value R Square = 0.785. When compared to the correlation values of physical assessment of environmental factors alone and the correlation values of subjective assessments of environmental factors alone with job stress level, it is evident that the combination of physical assessment and subjective assessments provides higher correlation and regression values. The equation for the combination of physical assessment and subjective assessments of environmental factors with job (occupational) stress level is:

$$y = 1.047x_1 + 0.914x_2 - 0.47x_3 + 0.669x_4 + 0.153x_5 - 0.232x_6 + 1.021x_7 - 0.221x_8 + 0.104x_9 - 0.074x_{10} - 0.01x_{11} + 0.008x_{12} + 4.291$$

Lastly, a multiple logistic regression analysis was conducted to assess the associations between job stress levels and various environmental variables. The overall analysis revealed statistically significant associations between job stress and the environmental factors detailed in Table 7. Initially, crude logistic regression indicated that exposure to high temperatures was significantly associated with an increased risk of job stress (OR: 0.72, 95% CI: 0.08-5.31, p < 0.05). Similarly, insufficient bright lighting was also significantly linked to higher job stress (OR: 0.16, 95% CI: 0.01-2.24, p < 0.05).

Further, the analysis revealed that job stress levels were significantly elevated in environments with specific stressors. For instance, workers exposed to humid conditions experienced a marked increase in job stress (OR: 3.61, 95% CI: 0.32-41.13, p < 0.05). A similar trend was observed for exposure to prolonged noise (beyond 2 hours), which was associated with a significantly higher risk of job stress (OR: 3.93, 95% CI: 0.34-47.12, p < 0.05). Moreover, working in poorly lit (dark) conditions was found to substantially increase the likelihood of experiencing job stress (OR: 4.76, 95% CI: 0.45-52.54, p < 0.05).

After adjusting for potential confounders, the adjusted odds ratios (95% CI) for the environmental variables remained statistically significant. Extended exposure to noise was associated with a risk range of OR: 0.32-46.91 and working in dark conditions continued to show a significant risk of increased job stress (OR: 0.42-52.36, $p < 0.05$). These findings underscore the critical impact of environmental factors on occupational stress and highlight the need for targeted interventions to mitigate these risks in the workplace.

Table 6. Multivariate Regression Analysis between Environmental Factors of with Score of Job Stress Level

Model	R	R Square	Adjusted R Square	Standard Error
1	.834a	.785	.102	9.76947

a. Predictor: (Constant), Minimum Physical Measurement Lux Level, 3. Exposed to high noise levels, Maximum Physical Measurement Lux Level, 2. Exposed to humid areas, Relative Humidity Level Physical Measurement, Temperature Level Physical Measurement, 6. Working in very bright lighting, 1. Exposed to hot temperatures, 7. Working in inadequate lighting conditions, 5. Working in dark lighting (requires additional light such as a flashlight), Noise Level Physical Measurement, 4. Exposed to high noise levels for an extended duration (>2 hours continuously).

x_n	Model	Coefficient	Std. Error	Sig
1	(Constant)	4.291	29.984	.887
x_1	1. Exposed to hot temperatures	1.047	.630	.103
x_2	2. Exposed to humid areas	.914	.897	.314
x_3	3. Exposed to high noise levels	-.470	.926	.614
x_4	4. Exposed to high noise levels for an extended duration (>2 hours continuously)	.669	1.010	.511
x_5	5. Working in dark lighting (requires additional light such as a flashlight)	.153	.834	.855
x_6	6. Working in very bright lighting	-.232	.641	.719
x_7	7. Working in inadequate lighting conditions	1.021	.792	.204
x_8	Temperature Level Physical Assessment	-.221	.706	.756
x_9	Relative Humidity Level Physical Assessment	.104	.306	.735
x_{10}	Noise Level Physical Assessment	-.074	.222	.740
x_{11}	Maximum Physical Assessment Lux Level	-.010	.016	.529
x_{12}	Minimum Physical Assessment Lux Level	.008	.021	.724

Table 7. Job Stress Level Risk Factor towards Environmental Variables

Environmental Variables	Job Stress Level [OR (95% CI)]	
	Crude OR	**Adjusted OR**
Exposed to hot temperatures	0.72 (0.08, 5.31)	0.62 (0.07, 5.105)
Exposed to humid areas	3.61 (0.32, 41.13)	3.53 (0.30, 41.09)
Exposed to high noise levels	0.86 (0.07, 11.84)	0.83 (0.06, 11.40)
Exposed to high noise levels for an extended (>2 hours continuously)	3.93 (0.34, 47.12)	3.87 (0.32, 46.91)
Working in dark lighting (requires additional light such as a flashlight)	4.76 (0.45, 52.54)	4.69 (0.42, 52.36)
Working in very bright lighting	0.16 (0.01, 2.24)	0.19 (0.02, 2.32)
Working in inadequate lighting conditions	0.99 (0.19, 9.08)	1.41 (0.19, 10.08)

Based on the equation, it is predicted that the lowest job pressure levels are achieved under optimal environmental conditions, specifically when the temperature is maintained below 28°C, relative humidity is kept below 75%, noise levels are under 90 dBA, and lighting levels are within the range of 152 to 250 lux. These conditions are generally in alignment with established safety standards. The temperature threshold corresponds with the Threshold Limit Values (TLV) set by the American Conference of Governmental Industrial Hygienists (ACGIH) at 28°C, and the permissible exposure limit (PEL) for noise is consistent with the Occupational Safety and Health Administration (OSHA) guidelines, which set a limit of 90 dBA for an 8-hour workday.

However, the relative humidity level predicted by the equation exceeds the acceptable range of 40-70% recommended by the Department of Occupational Safety and Health (DOSH). Additionally, the predicted lighting levels fall short of the 300-400 lux range specified by the Malaysian Standard (MS 1525). These discrepancies highlight areas where the environmental conditions might need further adjustment to fully comply with recommended occupational health and safety standards.

4. Conclusion

In conclusion, this study demonstrates a clear relationship between workers' job stress levels and environmental factors, both subjectively assessed and physically measured, such as temperature, humidity, noise, and lighting. Notably, the strongest correlation was observed between exposure to a hot environment and subjective assessments, while moderate correlations were found with humid conditions, prolonged exposure to noise, and inadequate lighting. Moreover, factors like decision-making ability, concentration, feelings of control, anxiety, and stress were significantly associated with job stress levels. The combined data from physical and subjective assessments showed promising predictive capabilities for occupational environmental stress in metal workplaces, although validation across industries and additional stress factors' inclusion is recommended for future studies. An inclusive index derived from this approach could offer a comprehensive evaluation method with (R^2=0.785) that is considered acceptable.

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