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Compromise Parameters of Temperature, Light, and Noise in Confined Spaces on Work Duration and Number of Errors †

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Abstract: The physical work environment may affect worker productivity. This study simulated physical work environment parameters, such as temperature, light, and noise, in a confined space in relation to work duration and the number of errors. This study was conducted on a laboratory scale involving six operators of different genders. Results show a difference in work duration, while no difference existed in the number of errors. Female participants were better at assembly work than male participants were. On the other hand, based on the variance, light and noise affected the work duration of male operators, while temperature and noise influenced female operators. In contrast, tested parameters did not affect the number of errors. An interaction between temperature and light affected male operators. Finally, further tests showed that noise was the factor that had the most influence on participants' responses.

Keywords: temperature; light; noise; work duration; error

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1. Introduction

The physical work environment consists of the physical conditions of the working atmosphere. It can affect productivity, health, and worker comfort. The physical work environment includes several aspects, such as lighting, noise, temperature, and other physical facilities. A supportive physical work environment can help workers concentrate on doing their work. Noise, light, and temperature parameters directly impact an operator's performance [1,2]. Comfort regarding these conditions is needed by workers when interacting with their work [3]. The need for comfort is individual, according to each worker's perception [4,5]. According to [6], the physical environment has a direct influence on cognitive performance, ergonomics, and work productivity. However, sometimes this is not taken into account when designing work facilities.

One study [7] shows that the physical work environment influences operator performance, where in better quality physical work environments, operator performance increases. Conversely, an operator's performance decreases if physical work environment indicators are not good. The authors of [8] stated that the work environment positively affected the motivation of employees of the Aceh Agriculture and Livestock Service. Apart from that, it positively influences employee motivation at PT. Intraco Agroindustry [9].

Improving the physical and non-physical work environment can increase employee motivation at work. The authors of [7] state that the better the physical work environment, the more worker performance improves. In part, the physical work environment is positively correlated with company performance [10]. Likewise, high work stress reduces performance. Meanwhile, in addition to the physical work environment, occupational health and safety programs also influence worker performance [11]. If workers' discipline towards occupational health and safety increases, their performance also increases [4]. In addition, aspects of non-physical work environments, such as discipline, motivation, and communication, influence worker performance and motivation [12,13]. Along with aspects that affect individual workers, interactions between teams and the leadership of each stakeholder constitute a work environment that can influence worker performance [14,15].

Confirmed cases of the influence of the physical work environment are often found regarding production activities. One real case is the wood processing industry in Socah Village, Bangkalan Regency, East Java. Operators are frequently exposed to noise from chainsaws used to cut wood. The noise received by the operator is 106 dB during 4 working hours, even though the threshold value set by the Ministry of Manpower as per regulation no: KEP.51/MEN/1999 is 3.75 min. Other factors influencing operators' concentration level include temperature and light in the workplace. Natural lighting reaches more than 9000 lx and the temperature is 27–40 °C. Consequently, results for cut wood dimensions vary greatly. On average, cutting results have a dimensional deviation of 2–3 cm from the specified target. This work activity also causes around 29% of defective products that cannot be used. These observations support the notion that the physical work environment influences operators.

Specifically, temperature, light, and noise impact operator performance [16]. For example, [17] states that light is the most influential factor, with a coefficient value of 0.026, while [1] states that the most influential factor is temperature. Based on research results and data from field observations, it can be seen that physical work environment factors such as noise, light, and temperature are thought to influence human work. In contrast, Ref. [18] stated that the physical work environment does not significantly affect operator performance in one of the manufacturing sectors in Nigeria. This problem requires further research to determine whether the physical work environment affects operator concentration. Operators require high concentration levels to execute their work, and this can cause premature fatigue and health risks in the long term. This study evaluated the influence of temperature, light, noise, and their interaction on work duration and the number of errors. This study also aimed to investigate the factors that most influence the duration of work and the number of operator errors.

2. Methods

This study examined the effects of temperature, light, and noise simultaneously on work duration and the number of operator errors. This study conducted work simulations, whereas [19] used a questionnaire method. The ambient conditions of this study were designed to replicate the actual work atmosphere, and participants performed tasks as if working in the real system.

The simulation was performed using a 2^3 factorial design to determine the effect of 3 factors with 2 levels individually and simultaneously. The experiment was performed in 8 treatments. Each treatment was repeated 4 times according to the Federer formula; therefore, the number of samples required was 32 samples for each response variable. Simulations used the Purdue Pegboard tool. This tool can measure gross movements of the hand, fingers, and forearm, as well as fingertip dexterity, as required in assembly tasks. This tool is suitable for simulating complex assembly work and has small parts [20]. Simulation data were processed using the independent sample *t*-test method to determine whether there were significant differences in responses of work duration and number of errors between male and female operators. Two-way ANOVA (analysis of variance) was used to determine whether there was a significant influence of studied factors on responses of work duration and the number of operator errors, then a post-hoc test or follow-up test using the Fisher LSD method was performed in the event of an influence, as shown in Figure 1.

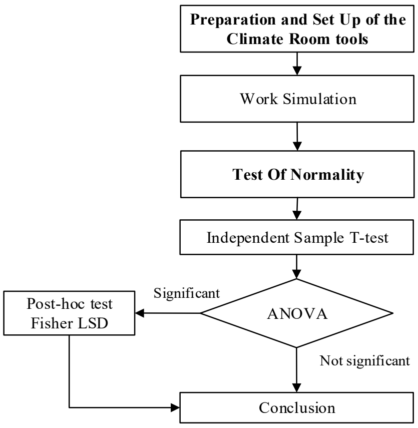
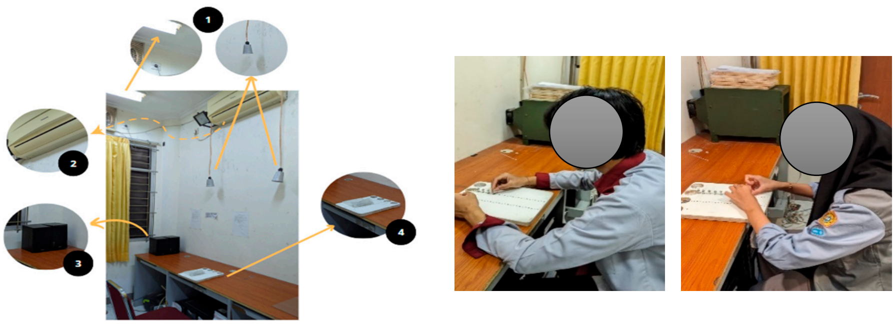


Figure 1. Data processing.

This study involved 6 ergonomics and work system design (EPSK) laboratory assistants at Universitas Trunojoyo Madura. There were 3 male assistants and 3 female assistants. Selected participants must have experienced using the Purdue Pegboard at least 5 times. This consideration aligns with research [21] confirming that the Purdue Pegboard can determine dexterity for jobs requiring fine and gross motor skills. This suits assembly work in the cigarette, woven, beaded, and similar industries.

The research equipment used was sound for noise factors, air conditioning (AC) for controlling temperature factors, lights for lighting, sound meters for measuring noise, digital hygro-thermo meters for measuring temperature, illuminance meters for measuring light, the Purdue Pegboard for assembly work simulation, and Minitab 19 software for data processing. Figure 2 (i) shows some equipment such as (1) lights, (2) the air conditioner, (3) sound, and (4) the Purdue Pegboard and worktable. Figure 2 (ii) shows the simulation conditions for male and female operators as participants.



(**i**) (**ii**)

Figure 2. (**i**) Laboratory equipment, (**ii**) Simulation condition.

In this study design, there were two temperature levels, namely 24 °C and 28 °C, based on research conducted by [22]. There were two light levels, namely 200 lx and 750 lx, based on research conducted by [23,24] Kepmenkes Number 1405 of 2002. In addition, there were two noise levels, namely 80 dB and 90 dB, according to research conducted by Nasution [22].

The initial stage of the experiment was the randomization of treatment combinations. Treatment combinations were randomized by randomizing treatment numbers in Excel software. The next stage was a 15 min pre-experiment briefing. Participants entered the experimental room in the climate room before the test. Participants were told the assembly work simulation procedures that would be carried out. Next, participants entered their identity on the sheet provided. Participants entered the climate room one by one. Participants performed a simulation test of assembly work using a Purdue Pegboard. The average simulation time required per treatment was 212 s. The experimental procedure was as follows: (1) Insert the long pin into the hole in the Purdue Pegboard using the right hand, then insert the ring into the long pin with left hand, and continue by inserting the cylinder onto the ring with the right hand, then insert the ring again onto the cylinder with the left hand. (2) Execute this activity on the Purdue Pegboard by spacing out one hole for each subsequent process and complete the entire process in the right hole of the Purdue Pegboard until finished, then continue to the left of the Purdue Pegboard hole. (3) Determine the operator's errors during assembly work. (4) Repeat the assembly process 4 times and record times and errors.

The measurement procedure for time was based on the time needed to start inserting pins into the holes until all holes in the Purdue Pegboard were filled. Meanwhile, errors were assessed based on the number of parts that were not installed or failed to be installed perfectly.

3. Results

Before assessing data, validity and reliability tests were conducted to confirm that the instrument was well-designed. The validity of the test was estimated by correlation. A correlation test compared the results of the Purdue Pegboard test (PPT) with the Hand Questionnaire [25]. Pearson correlation results showed that response duration and error had a strong correlation. Meanwhile, test–retest reliability was assessed using a one-way ANOVA as in the research of Gonzalez [26]. Results showed test–retest ANOVA for temperature to the error (F = 0.000; $p > 0.05$), light to the error (F = 0.372; $p > 0.05$), and sound to the error (F = 0.092; $p > 0.05$). Results also showed test–retest ANOVA for temperature against duration (F = 1.007; $p > 0.05$), light against duration (F = 0.191; $p > 0.05$), and sound against duration (F = 34.887; $p > 0.05$). These results indicated that there was no variance, which showed that the instrument was reliable.

Meanwhile, simulation results were based on the independent sample *t*-test and two-way ANOVA. However, data needed to be tested for normality to determine whether it was normally distributed or not. Table 1 shows results of the data normality test for two responses and two genders. All variables produced a value of more than 0.05, so that a decision could be made to accept H_0, and it could be concluded that these data were normally distributed.

Table 1. Normality test results.

Description	df	*p*-Value
Work duration of male operators	32	0.731
Work duration of female operators	32	0.342
Number of errors by male operators	32	0.271
Number of errors by female operators	32	0.318

The independent sample *t*-test was needed to evaluate differences in operator performance based on gender. This was because physical and mental performance between males and females differ, as in [27]'s research regarding the concentration index between men and women. Table 2 shows independent sample *t*-test results. Work duration produced a significant value of 0.000, which is less than 0.05, so the decision was to reject H_0. In conclusion, there were differences between male and female operators in their response work duration. On the other hand, the number of errors produced was 0.181; as this value is less than 0.05, the decision to accept H_0 meant that there was no difference between male and female operators in their response number of errors. This is in agreement with [14], which reported that men tend to make mistakes easily when carrying out the Stroop test.

Table 2. Differences in responses of male and female operators.

Response	*t*-Test (2-Tailed)
Work duration	0.000 **
Number of errors	0.181

Note: ** $p < 0.01$.

In addition, ANOVA was proposed to analyze the variance in the mean simultaneously. Table 3 shows the factors that influenced the response of work duration. Light, noise, and an interaction of temperature and light were significant for male operators. The R-square correlation was 0.85, which is in the range of a very strong relationship level. This means that the factor strongly influenced the response of male operators to work duration. Meanwhile, female operator simulation data show that temperature and noise significantly influenced work duration. However, the overall response variable was not found to be significant. The R-square correlation was 0.91, which is in the range of a firm relationship level. This means that the factor strongly influenced the response of work duration for female operators. This was also shown by [1], which reported that temperature and noise affect operators.

Table 3. ANOVA for work duration.

Factor	Male			Female		
	F Value	Decision	Variance	F Value	Decision	Variance
Temperature	2.83	Accept H_0	No	11.87 **	Reject H_0	Yes
Light	8.12 **	Reject H_0	Yes	1.89	Accept H_0	No
Noise	46.57 **	Reject H_0	Yes	97.95 **	Reject H_0	Yes
Temperature and light	4.29 *	Reject H_0	Yes	0.14	Accept H_0	No
Temperature and noise	0.66	Accept H_0	No	0.47	Accept H_0	No
Light and noise	0.32	Accept H_0	No	2.29	Accept H_0	No
Temperature, light, and noise	0.04	Accept H_0	No	0.21	Accept H_0	No
	$R^2 = 0.85$			$R^2 = 0.91$		

Note: ** $p < 0.01$; * $p < 0.05$.

Further, Table 4 shows that light at levels 200 lx and 750 lx were in the same grouping, so the two light levels were not different in the male operators' work duration. Noise factors with levels of 80 dB and 90 dB were in different groupings, so the two noise levels provided a difference in the male operators' work duration. So, it can be seen that noise was the most influential on work duration for male operators. This is in agreement with [1], which states that noise influences operator performance. Additionally, temperatures of 24 °C and 30 °C were in the same grouping, so that the two temperature levels did not significantly affect the working duration of female operators. Noise with levels of 80 dB and 90 dB were in different groupings, so the two noise levels provided a difference in the response of female operators' work duration. As with male operators, noise was also the most influential on work duration for female operators. This is also in agreement with [2], which reported that noise affects an operator's psychological parameters.

Table 4. Post-hoc test results for work duration.

Grouping Information Using the Fisher LSD Method and 95% Confidence Male				Female			
Light (lx)	N	Mean	Grouping	Temperature (°C)	N	Mean	Grouping
750	16	216.38	A	24	16	197.67	A
200	16	207.23	A	30	16	188.52	A
Noise (dB)	N	Mean	Grouping	Noise (dB)	N	Mean	Grouping
90	16	222.75	A	90	16	206.23	A
80	16	200.85	B	80	16	179.96	B

In addition, ANOVA results for the number of errors for male operators are shown in Table 5. The ANOVA for male operators showed that no factors influenced the number of errors. Therefore, there was no need to test further. The R-square correlation was 0.43, a value within the range of a sufficient level of relationship. This means that no factor influenced the number of errors of male operators. Meanwhile, for female operators, it was observed that the only factor that influenced the number of errors was the interaction of temperature–light–noise. None of the other factors significantly influenced female operators, so further tests were not required. The R-square correlation obtained in the test results was 0.36, which is in the range of low levels of relationship. This means that the factors did not have much influence on the number of errors of female operators.

Table 5. ANOVA for error responses.

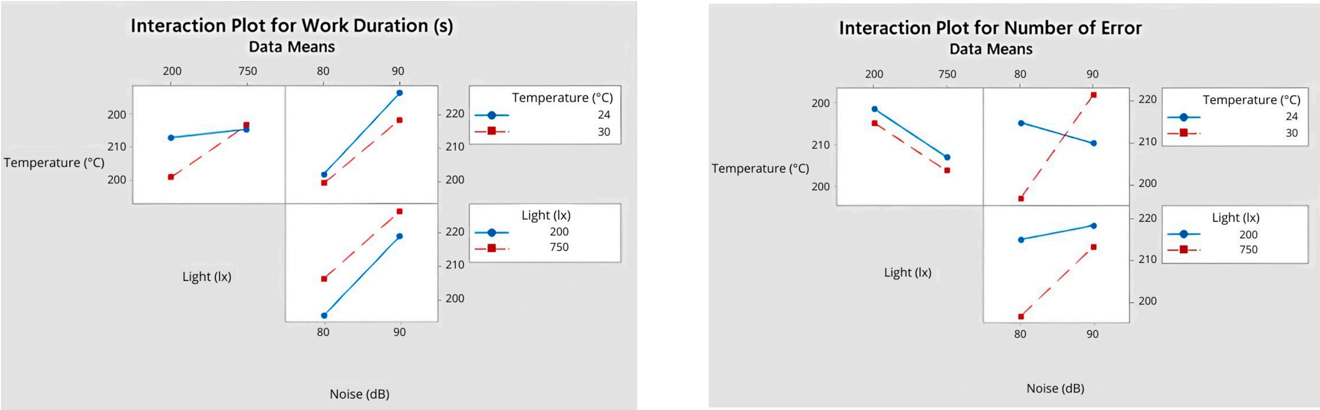
Factor	Male			Female		
	F Value	**Decision**	**Variance**	**F Value**	**Decision**	**Variance**
Temperature	0.01	Accept H_0	No	0.08	Accept H_0	No
Light	0.52	Accept H_0	No	0.98	Accept H_0	No
Noise	0.17	Accept H_0	No	0.70	Accept H_0	No
Temperature and light	1.29	Accept H_0	No	0.00	Accept H_0	No
Temperature and noise	0.00	Accept H_0	No	1.58	Accept H_0	No
Light and noise	3.46	Accept H_0	No	0.31	Accept H_0	No
Temperature, light, and noise	0.00	Accept H_0	No	0.02 *	Reject H_0	Yes

Note: * $p < 0.05$.

4. Discussion

A significant study result was related to the interaction between factors. Figure 3a shows the interaction between factors at each level on male operators' work duration. This figure shows that a combination of factors mutually influenced work duration. Meanwhile, Figure 3b shows the interaction between factors at each level in the number of errors of female operators. This figure shows that a combination of factors influenced the number of errors, even though the influence of each factor was not significant.

Finally, the overall assessment of duration and error performance was analyzed between male and female participants. Indeed, the effectiveness of the error between men and women was sensitive except for the temperature–light–noise interaction for female participants. However, there were differences in temperature, lighting, noise, and the interaction between temperature and lighting on duration, as shown in Table 6.



(**a**) (**b**)

Figure 3. (**a**) Interaction plots for work duration (male), and (**b**) interaction plots for number of error (female).

Table 6. Compromised trade offs.

***t*-Test**	**Duration**		**Error**	
	Male	**Female**	**Male**	**Female**
	Yes		No	
ANOVA	Male	Female	Male	Female
Temperature (°C)	No	Yes	No	No
Lighting (lx)	Yes	No	No	No
Noise (dB)	Yes	Yes	No	No
Temperature (°C) * Lighting (lx)	Yes	No	No	No
Temperature (°C) * Noise (dB)	No	No	No	No
Lighting (lx) * Noise (dB)	No	No	No	No
Temperature (°C) * Lighting (lx) * Noise (dB)	No	No	No	Yes
POST-HOC TEST	Noise	Noise	-	-

Note: * = interaction.

The results of this study imply that a supportive physical work environment can help operators concentrate on their work so that the results of their work are effective. Parameters related to noise, light, and temperature influence operator performance [28], and several studies have obtained the same results. Ref. [29] studied the influence of physical and non-physical work environments on employee performance in archives and library services. The same results were obtained by [30] regarding the influence of the physical work environment on employee performance at the Regional Financial Agency in Tabanan Regency. However, excessive lighting can cause problems such as glare, light reflections, excessive shadows, and eyestrain. The level of lighting required depends on the type of work being carried out. For example, for work that requires detailed inspection and quality control, as well as work that involves fine details and low contrast, a higher level of illumination is needed, ranging from 500 lx to 1000 lx, as per research by [23]. In contrast to [18], which states that the physical work environment does not influence employee performance, this study has proven that it influences operators.

Despite the above arguments, there are many hand dexterity test media. The Purdue Pegboard test is one medium used to evaluate finger dexterity [31]. This dexterity measurement application has been applied for medical purposes when using gloves [32] or for surgical simulation purposes [33]. Another application is predicting the performance of novice welders [34]. This study is similar to that of Tseng et al. [35], which reported that the learning process can influence the actual assessment results. This study looked at the correlation between the results of the Purdue Pegboard test and participants' error rates. In real cases, this application can also be found in smartphone assembly processes.

This study sought to refine previous research wherein which the learning process was considered. As in Tseng et al.'s study [35], this research aimed to determine the effect of reflecting the operator's actual assembly capacity. This study evaluated the precision of assembly tasks with the Purdue Pegboard, which is claimed to be effective for assessing manual dexterity. In addition, it accommodates how to evaluate one's assembly performance and integrate this assessment into learning. The implementation context for using the Purdue Pegboard test can be used as a medium for patient rehabilitation intervention, evaluation of patient cognition, or assessment of manual dexterity. In particular, this pegboard was developed to function as a psychomotor medium for hand function, attention, and cognitive rehabilitation [36].

This study had a weakness in that it did not incorporate the sound factor relating to the type of noise (voice or music). So, further research is advised to add differences in noise types as a factor to find out whether the type of noise also influences the duration of work and the number of operator errors. Factors used in this research were only physical work environment factors, while many other factors can influence operator performance, such as leadership [12], communication, motivation [13], and so on.

5. Conclusions

Reaction time based on work duration showed differences between male and female operators. Female operators worked faster than male operators did. In contrast, in the response number of errors, there was no difference between male and female operators. However, based on the mean of time execution, female operators tended to make fewer mistakes than male operators did. This proves that female operators were more eligible as workers in industries that assemble small parts requiring high precision. In regards to the working duration of male operators, light and noise factors influenced these operators' working duration. For female operators, temperature and noise factors both influenced these operators' work duration. Fisher LSD follow-up test results show that the factor that most influenced the response of male and female operators' work duration was noise.

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References

1. Sepehri, S.; Aliabadi, M.; Golmohammadi, R.; Babamiri, M. The effects of noise on human cognitive performance and thermal perception under different air temperatures. *J. Res. Health Sci.* **2019**, *19*, e00464.
2. Chao, P.C.; Juang, Y.J.; Chen, C.J.; Dai, Y.T.; Yeh, C.Y.; Hu, C.Y. Combined effects of noise, vibration, and low temperature on the physiological parameters of labor employees. *Kaohsiung J. Med. Sci.* **2013**, *29*, 560–567. [CrossRef] [PubMed]

3. Budie, B.; Appel-Meulenbroek, R.; Kemperman, A.; Weijs-Perree, M. Employee satisfaction with the physical work environment: The importance of a need based approach. *Int. J. Strateg. Prop. Manag.* **2019**, *23*, 36–49. [CrossRef]
4. Perkasa, D.H.; Susiang, M.I.N.; Parashakti, R.D.; Rostina, C.N. The Influence of the Physical Work Environment, Work Motivation, and Work Discipline on Employee Performance. *KnE Soc. Sci.* **2023**, *2023*, 286–295. [CrossRef]
5. Harry, J. Stress management and employee performance. *Eur. J. Hum. Resour. Manag. Stud.* **2020**, *4*, 57–71. [CrossRef]
6. Aisyah, S.; Deswindi, L.; Indrajaya, D. Are Physical and Non-Physical Working Environment Effect Employees Productivity with Motivation as an Intervening Factor? *Adv. Econ. Bus. Manag. Res.* **2020**, *149*, 242–247. [CrossRef]
7. Alam, S. The Role of Physical Work Environment and Work Stress in Affecting Employee Performance. *Int. J. Multicult. Multireligious Underst.* **2020**, *7*, 529–535.
8. Iis, E.Y.; Wahyuddin, W.; Thoyib, A.; Ilham, R.N.; Sinta, I. the Effect of Career Development and Work Environment on Employee Performance With Work Motivation As Intervening Variable At the Office of Agriculture and Livestock in Aceh. *Int. J. Econ. Bus. Account. Agric. Manag. Sharia Adm.* **2022**, *2*, 227–236. [CrossRef]
9. Sigalingging, H.; Pakpahan, M.E. the Effect of Training and Work Environtment on Employee Performance With Motivation As an Intervening Variable At P.T Intraco Agroindustry. *South East Asia J. Contemp. Bus. Econ. Law* **2021**, *24*, 130–139.
10. Nucki, P. Analysis of physical and non-physical work environment pt. kakiatna indonesi to company performance. *J. Econ. Bus. UniSadhuGuna Bus. Sch.* **2019**, *8*, 73–81.
11. Harini, S.; Sudarijati, S.; Yani, M.A. Occupational Health Safety and Physical Work Environment Conditions on Employee Performance. *Indones. J. Soc. Res.* **2019**, *1*, 1–9. [CrossRef]
12. Nardo, R.; Evanita, S.; Syahrizal, S. The Effect of Transformational Leadership and Non Physical Work Environment on Innovative Behavior with Work Motivation as a Mediation For Employees of Tour And Travel Companies In West Sumatera. *Adv. Econ. Bus. Manag. Res.* **2019**, *64*, 1052–1059. [CrossRef]
13. Kurniawati, A.T.; Putu, N.; Paramananda, P.N.; Istri, K.G.D.A.A. The Effect of Communication, Work Motivation and Physical Work Environment on Employee Work Spirit at Puri Sukawati Tourism Destination. *J. Econ. Financ. Manag. Stud.* **2023**, *6*, 1596–1599. [CrossRef]
14. Sari, T.A.; Indartono, S. The Influence of Emotional Intelligence and Perception of Leadership Effectiveness Toward Perception Team Performance. In Proceedings of the International Conference on Ethics of Business, Economics and Social Science, Jakarta, Indonesia, 28–29 June 2017; pp. 149–156.
15. López-Cabarcos, M.Á.; Vázquez-Rodríguez, P.; Quiñoá-Piñeiro, L.M. An approach to employees' job performance through work environmental variables and leadership behaviours. *J. Bus. Res.* **2022**, *140*, 361–369. [CrossRef]
16. Hamidi, N.N.E.B.; Mansor, F.A.; Hashim, M.Z.; Muhammad, N.; Azib, W.N.H.W. The Relationship Between Physical Workplace Environment and Employees' Performance. *J. Contemp. Soc. Sci. Res.* **2020**, *4*, 128–2697.
17. Rosyidah, M.; Oktarini, D.; Madagaskar; Azhari. Optimalization Physical Environment Effects on Work Productivity for Assembly Operator with Response Surface Methodology. *J. Phys. Conf. Ser.* **2019**, *1198*, 042004. [CrossRef]
18. Samuel, O.O. Effect Of the Physical Work Environtment On Employees Performance in selected Manufacturing Firms in Nigeria. *Gusau J. Bus. Adm.* **2022**, *1*, 1–10.
19. Taheri, R.H.; Miah, M.S.; Kamaruzzaman, M. Impact of Working Environment on Job Satisfaction of Employees. *EPRA Int. J. Multidiscip. Res.* **2020**, *5*, 403–406. [CrossRef]
20. Ansori, N.; Widyanti, A. The Role of Safety Silence Motives to Safety Communication and Safety Participation in Different Sectors of Small and Medium Enterprises Investigation Results on Two Kinds of Industries in Indonesia. *Saf. Health Work* **2021**, *12*, 192–200. [CrossRef] [PubMed]
21. Hinkle, J.T.; Pontone, G.M.; Program, S.T.; Sciences, B. Psychomotor processing and functional decline in Parkinson's disease predicted by the Purdue Pegboard test. *Int. J. Geriatr. Psychiatry* **2022**, *36*, 909–916. [CrossRef] [PubMed]
22. Nasution, R.H. Analisis Pengaruh Temperatur dan Kebisingan Terhadap Kerja Sistem Cardiovascular di CV. Bintang Terang Medan. *J. Surya Tek.* **2017**, *5*, 1–7. [CrossRef]
23. Rahmayanti, D.; Artha, A. Analisis Bahaya Fisik: Hubungan Tingkat Pencahayaan dan Keluhan Mata Pekerja pada Area Perkantoran Health, Safety, and Environmental (HSE) PT. Pertamina RU VI Balongan. *J. Optimasi Sist. Ind.* **2016**, *14*, 71. [CrossRef]
24. Riadyani, A.P.; Herbawani, C.K. Systematic Review Pengaruh Intensitas Cahaya Terhadap Kelelahan Mata Pekerja. *J. Kesehat. Masy.* **2022**, *10*, 167–171. [CrossRef]
25. Sigirtmac, I.C.; Oksuz, C. Determination of the optimal cutoff values and validity of the Purdue Pegboard Test. *Br. J. Occup. Ther.* **2022**, *85*, 62–67. [CrossRef]
26. Ahlqvist, O. Reliability and Validity. *Int. Encycl. Hum. Geogr.* **2009**, *1-12*, V9-320–V9-323. [CrossRef]
27. Mariyono, J.; Kuntaniringsih, A.; Suswati, E. Ketimpangan Jender Dalam Akses Pelayanan Kesehatan Rumah Tangga Petani Pedesaan: Kasus Dua Desa Di Kabupaten Tegal, Jawa Tengah. *SOCA Socioecon. Agric. Agribus.* **2008**, *8*, 1–14.
28. Novi, N.; Darmawan, A.; Pattipawaej, O.C. Analisis Pengaruh Getaran Terhadap Konsentrasi Pekerja. 2016. Available online: https://jurnal.umj.ac.id/index.php/semnastek/article/view/746 (accessed on 22 January 2025).

29. Marlius, D.; Sholihat, I. Pengaruh Lingkungan Kerja Fisik Dan Non Fisik Terhadap Kinerja Pegawai Pada Dinas Kearsipan Dan Perpustakaan Provinsi Sumatera Barat. *J. Bina Bangsa Ekon.* **2022**, *15*, 703–713. [CrossRef]
30. Rastana, I.; Mahayasa, I.; Permayani, N. Pengaruh Lingkungan Kerja Fisik dan Disiplin Kerja Terhadap Kinerja Pegawai pada Badan Keuangan Daerah di Kabupaten Tabanan. *J. Manaj. Kewirausahaan Dan Pariwisata* **2021**, *1*, 834–843.
31. Berger, M.A.M.; Krul, A.J.; Daanen, H.A.M. Task specificity of finger dexterity tests. *Appl. Ergon.* **2009**, *40*, 145–147. [CrossRef]
32. Nelson, J.B.; Mital, A. An ergonomic evaluation of dexterity and tactility with increase in examination/surgical glove thickness. *Ergonomics* **1995**, *38*, 723–733. [CrossRef]
33. Waters, R.L.; Sie, I.H.; Gellman, H.; Tognella, M. Functional hand surgery following tetraplegia. *Arch. Phys. Med. Rehabil.* **1996**, *77*, 86–94. [CrossRef]
34. Byrd, A.P.; Stone, R.T.; Anderson, R.G. Dexterity: An Indicator of Future Performance in Beginning Weledrs. *Career Tech. Educ. Res.* **2018**, *43*, 195. [CrossRef]
35. Tseng, Y.C.; Chang, K.Y.; Liu, P.L.; Chang, C.C. Applying the purdue pegboard to evaluate precision assembly performance. *IEEE Int. Conf. Ind. Eng. Eng. Manag.* **2017**, *2017*, 1179–1183. [CrossRef]
36. Chien, S.Y.; Wong, A.M.K.; Wu, C.Y.; Beckman, S.L. Interactive Electronic Pegboard for Enhancing Manual Dexterity and Cognitive Abilities: Instrument Usability Study. *JMIR Hum. Factors* **2024**, *11*, e56357. [CrossRef] [PubMed]