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Research Article

The Influence of Noise and Hot Work Climate on Fatigue through Work Pulse on Workers of Production Division at PT. Maruki International Indonesia Makassar in 2019

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Abstract: Fatigue is a natural signal given by the body due to a decrease in bodily functions caused work processes that will affect work capacity or endurance and it can reduce one's work productivity. The wood processing industry has various risks due to work environment factors around it. This study aimed to determine the Influence of Noise and Hot Work Climate on Fatigue Through Work Pulse on Workers of Production Division at PT. Maruki International Indonesia Makassar in 2019. This type of research was quantitative with a cross-sectional study design. The collection of 120 samples carried out using the Proportionate Stratified Random Sampling method. The Path Analysis test used to determine the direct and indirect factors of fatigue. The results showed that 17.5% of respondents experienced severe fatigue, the analysis test showed there was a direct effect of noise, hot work climate, and work pulse on fatigue (p = 0.000) meaning that if noise, hot work climate, work pulse increased by one point then fatigue increased, there is a direct effect of noise and hot work climate on work pulse (p = 0.000) meaning that if the noise and hot work climate has increased by one point, work pulse has increased, while the path analysis coefficient and hypothesis that there is an indirect effect between noise on fatigue through work pulse with indirect effect value of 0.795> from direct effect value of 0.795, there is an indirect effect between hot work climate on fatigue through work pulse with indirect effect value of 2.086> of direct effect value of 0.678. The company should provide standard personal protective equipment.

Keywords: Noise, Hot Working Climate, Work Pulse, Fatigue.

INTRODUCTION

Surveys in developed countries report that 10-50% of the population experiences fatigue. The prevalence of fatigue is around 20% among patients who come in need of health services. Data from the ILO mentions that almost two million workers die almost every year due to work accidents caused by fatigue. The study stated that of 58,115 samples, 32.8% of them or 18,828 samples suffered from fatigue (Baiduri, 2008). Therefore, policies on occupational safety and health are regulated in Law No. 1 of 1970 concerning work safety whose scope is related to machinery, workplace foundation, work environment, how to prevent accidents and occupational diseases, paying attention to sources sources of production so as to increase efficiency and productivity (Abidin *et al*., 2008). According to the Ministry of Manpower and Transmigration, data on work accidents in 2004, in Indonesia every day an average of 414 workplace accidents, 27.8% due to fatigue is quite high, approximately 9.5% or 39 people have disabilities (Depnaker, 2004).

According to the World Health Organization (WHO), noise has been categorized as one of the occupational risk factors that is a global issue in every country, especially in developing countries. According to WHO in 2000, there were 855 per 100,000 world population experiencing health problems due to noise in the work environment. Of this number, Indonesia, Sri Lanka, and Thailand numbered 136 per 100,000 residents who experienced health problems due to noise in the work environment. In Indonesia noise is a risk factor for occupational diseases with a proportion of 50% (Buchari, 2007). The implication of this fact is that factory workers will be the first parties to be exposed to

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intense noise exposure and have the risk of being affected by it (Assunta *et al*., 2014).

Based on data from OSHA (2014), the Centers for Disease Control and Prevention in 2012-2013 there were many cases of workers exposed to heat. In 13 cases there were workers who died, 7 cases where workers experienced symptoms of heat strain with moderate and heavy workloads. One of the hazards that are often found in industry is physical hazards in the form of a hot work climate. The combined use of tools and machinery and materials in the production process has become one of the sources of hot working climate for workers that can be found in various industries (Ramli, 2013). Sudirman (2011) explained that workers exposed to heat will experience an increase in pulse rate. The pulse can change due to an increase in cardiac output or cardiac output needed by the muscles at work. This is in accordance with the theory put forward by Soeripto (2008) which states that the heat exposure received by workers in a hot environment makes the body regulate the balance of heat in the blood so that there is an increase in blood flow, the heart pumps more blood so that blood pressure rises.

PT. Maruki Internasional Indonesia is one of the companies engaged in wood furniture in the city of Makassar. The main production of this company is Butsudan which is imported directly to Japan. In the production process PT. Maruki Internasional Indonesia uses a variety of machines that cause noise that can disturb workers such as electric saws, cutting machines, sanding machines, blowers, compressors, drilling machines and others, thus requiring workers to use ear protection.

Based on data obtained from company clinics it was noted that in 2017-2018 there were 16 workers who had ear and mastoid diseases. The interviews with several workers at the factory said that they often felt tired either due to noise from the source of the machine or because of the workload that required them to concentrate highly and the production targets of each worker that had to be reached on time. This, the researcher wants to conduct research related to the effect of noise, hot work climate and work pulse on work fatigue in workers at PT. Maruki International Indonesia.

METHODOLOGY

Research Design

This study uses a path analysis model because there are intervening variables between exogenous and endogenous variables. This study has four variables, namely Noise (exogenous), Hot Work Climate (exogenous), Work Pulse (intervening), and Fatigue (endogenous). This research was conducted at PT. Maruki Internasional Indonesia Makassar with the type of research used is quantitative which is a design that examines the dynamic correlation or association between independent variables (noise, hot work climate and work pulse) with the dependent variable (fatigue) at the same time (point time approach).

Population and Sample

The population in this study were all production workers of PT. Maruki Internasional Indonesia as many as 172 workers and sampling in this study using proportionate stratified random sampling.

Data Collection

The data in this study were obtained from enumerators from Makassar K3 Balai who had the ability to give questions to respondents by conducting interviews and direct measurements, to measure fatigue using reaction timers, measuring noise using sound level meters, measuring hot work climate using heat stress, and measurement of work pulse manually carried out by PT. Maruki International Indonesia.

Data Analysis

Data analysis was performed using SPSS 22 and AMOS applications. The variables measured noise, hot work climate, work pulse and work fatigue are then described based on the distribution table and analyze the influence between exogenous variables (noise and hot work climate) and intervening (work pulse) to endogenous (fatigue) using path analysis.

RESULTS

Univariate Analysis

Table 1. Cross Tabulation of Noise, Work Climate, and Work Nadi for Work Fatigue at PT. Maruki Internasional Indonesia Makassar City.

Research variable	Work Fatigue						Total	
	Light		Moderate		Weight			
	n	%	N	%	n	%	n	%
Noise								
Factory 1 (83.4 dBA)	15	45.5	13	39.4	5	15.2	33	100
Factory 2 (83.2 dBA)	14	51.9	9	33.3	4	14.8	27	100
Factory 3 (81.0 dBA)	18	51.4	11	31.4	6	17.1	35	100
Factory 4 (82.5 dBA)	8	32.0	11	44.0	6	24.0	25	100
Work Climate								
Factory 1 (26.3 °C)	`15	45.5	13	39.4	5	15.2	33	100

Factory 2 (26.5 °C)	14	51.9	9	33.3	4	14.8	27	100
Factory 3 (27.4 °C)	18	51.4	11	31.4	6	17.1	35	100
Factory 4 (26.6 °C)	8	32.0	11	44.0	6	24.0	25	100
Work pulse Light	49	76.6	12	18.8	3	4.7	64	100
Moderate	5	11.9	29	69.0	8	19.0	42	100
Weight	1	7.1	3	21.4	10	71.4	14	100

Table 1 illustrates that the noise at PT. The highest Maruki International is in Factory 1 which is 83.4 dBA and the lowest is in Factory 3 which is 81.0 dBA. For the working climate at PT. The highest Maruki International is in factory 3 which is 27.4 ° C and the lowest is in factory 1 which is 26.3 ° C. While for the measurement of work pulse shows that many of the workers who have a work pulse in the light category are 64 (53.3%) respondents and there are 14 (11.7%) respondents who have a heavy work pulse and for fatigue most of the workers experience mild work fatigue that is as much as 55 (45.8%) and 21 (17.5%) experienced severe work fatigue.

Bivariate Analysis

The results of the cross tabulation showed that the number of respondents who experienced fatigue with the weight category was almost the same in every factory, namely 5 (15.2%) in factory 1, 4 (14.8%) in factory 2, 6 (17.1%) in factory 3 and 6 (24.0%) in factory 4 where the noise of each factory is still below the NAV or <85 dBA. For cross tabulation of hot and fatigue working climate the number of respondents experiencing fatigue with the same weight category in each factory is 5 (15.2%) in factory 1, 4 (14.8%) in factory 2, 6 (17.1%) in factory 3 and 6 (24.0%) in factory 4 with the value of ISBB each factory is still below the NAV or <28 ° C. The results of cross tabulation of work pulse and fatigue found that fatigue with heavy category was mostly experienced by respondents with heavy work pulse as many as 10 (71.4%) and only 3 (4.7%) with light work pulse.

Multivariate Analysis

Table 2 Effect of Coefficients and their Relation to the Direct Effect Research Hypothesis

No	Research variable	Direct Effect		
		Estimate	Value of p	Conclusion
1	Noise → Work pulse	25.295	.000	Significant
2	Hot work climate → Work pulse	66.355	.000	Significant
3	Work pulse → Fatigue	.031	.000	Significant
4	Noise → Fatigue	.182	.044	Significant
5	Hot work climate → Fatigue	.678	.003	Significant

Table 2 shows that noise has a direct influence on the pulse with p value 0,000 <0.05 with a coefficient value of 25.295, hot working climate has a direct influence on the pulse with p value 0.000 <0.05 with a coefficient value of 66.355, work pulse has a direct effect to fatigue with p value 0.000 <0.05 with coefficient value .031, noise has a direct influence on fatigue with p value 0.044 <0.05 with coefficient value .182, hot work climate has a direct effect on fatigue with p value 0.003 <0.05 with value coefficient of .678.

Table 3 Effect of Coefficients and their Relationships to the Indirect Effect Research Hypothesis

Hipotesis (Path)	Indirect Effect	Total Effect
Noise → Work pulse → Fatigue	.795	.614
Iklim Kerja→ Work pulse → Fatigue	2.086	1.409

Table 3 shows the influence of the path analysis coefficient and the hypothesis that there is an indirect effect between noise on fatigue through the pulse of work with an indirect effect value of 0.795> value of the direct effect of 0.795 with a total effect value of 0.614, for the work climate there is also an indirect effect between the hot work climate to fatigue through the pulse of work with an indirect effect value of 2.086> of a direct effect value of 0.678 with a total effect value of 1,409.

DISCUSSION

Work activities at PT. Maruki International is inseparable from the noise exposure in every factory of the production section, this is because the working tools from wood cutting to finishing make a pretty big noise. Based on research results from 4 (four) factories, the biggest noise level is factory 1, namely 83.4 dBA with work activity in this factory in the form of cutting wood using a machine. According to Sucipto (2014) in general, noise with high intensity is very disturbing, especially if it is intermittent or sudden. Disturbances

can be in the form of increased blood pressure (approximately 10 mmHg), increased pulse, constriction of peripheral arteries especially in the hands and feet, and can cause pale and sensory disturbance. Noise is one of the environmental factors that greatly influences the pulse rate of Assunta *et al*., (2014). The results of this study show there is a relationship between noise and work pulse at PT. Maruki International. The results of this research are in line with research by Basner *et al*., (2014) which states that noise not only impacts hearing loss but also non hearing.

The results of this study found the prevalence of working pulse of respondents in the heavy category was 11.7% with an average of 99.0 beats / minute which, if categorized as in the mild category (75-100 beats / minute) with noise intensity <85 dBA. In research Retnani e al., (2016) measurements of working pulse in the Weaving section totaling 10 people obtained an average of 110 beats / minute and measurement of work pulse with noise intensity of 98.25 dBA.

The noise level at PT. Maruki International in each factory is still in accordance with the NAB set by Permenakertrans No. 13 of 2011 which is <85 dBA. Although the NAV at PT. Maruki International is still appropriate, but still noise causes the number of beats per minute felt by workers to increase and will affect the worker's activities while on the move, because an increase in pulse will result in narrowing of the arteries and depletion of energy in completing work, thereby stimulating it to become faster tired (Hariyati, 2009).

Multivariate analysis results in this study found that noise affects fatigue both directly and through the pulse of work. The results of cross tabulation showed that heavy fatigue was experienced in every factory with a prevalence of 14.8% -24.0%. In theory, the workforce exposed to noise will increase in pulse, increase blood pressure, and narrow blood vessels so that they feel tired quickly, causing disruption of concentration, communication, and thinking ability (Bahar, 2008).

The results of this study are in line with the research of Laziardy (2017) which states that there is an effect of noise (p = 0.001 with a coefficient value of 2.481) on work fatigue in metal workers in the production section. However, the results of research by Faiz (2014) and Nuraini & Warno (2018) showed different things which explained that there was no effect of noise on fatigue, one of the reasons was due to the effective use of earplugs at the study site.

Noise control has been carried out by the company by providing personal protective equipment in the form of earmuffs on every operator of the machine which is directly exposed to the source of noise, however, not to other workers who are also active in the same room, where workers have difficulty in communicating due to noise very disturbing noise. Another step Hazard control that can be done is to isolate sources of noise, maintenance and lubrication of the machine regularly. According to Fachrul *et al*., (2011) an effective way to reduce static engine noise above 99.6 dBA is by combining dampening material with the composition of playwood, foam, tray and coir, this modification can reduce the noise intensity up to 67.9%.

The results of this study show that the working climate at PT. Maruki International Indonesia in each factory ranges from 26.3 ° C - 27.4 ° C, this temperature is still below the allowable NAV of 28 ° C, but according to Mukhlish *et al*., (2013) the recommended temperature at work should be 24-260C. Temperature or climate in the workplace must be maintained as it will affect the health of workers, because extreme work climate can trigger various health problems.

Statistical analysis in this study shows the influence of work climate on the work pulse (p value = 0.000). The results of this study are in line with the research results of Rahadian (2017) where it is explained that the results of the statistical tests show that there is a positive significant relationship between heat stress and pulse of workers in the BRF work area at PT X.

Nasution Research (2018) suggests that the results of statistical tests show that the relationship of heat pressure to the pulse of workers in Pak Ponimin's tofu business unit based on the measurement point shows a significant result of 0.042 (p <0.05) with the highest temperature at 12:45 WIB reached 38.3ºC and the lowest temperature at 08.30 WIB reached 37.9ºC, while the highest temperature at 12.45 WIB reached 37.7ºC, and the lowest temperature reached 37.4ºC. The pulse in the tofu business unit of Pak Ponimin was found by workers who experienced an increase in pulse rate of 22 people (78.6%), and workers with a normal pulse rate of 6 people (21.4%).

The theory of heart rate in the Physiology of Bases of Exercise explains that prolonged exercise in a hot environment causes the heart rate to be higher than exercise at low temperatures Siswantara & Setya, (2006). A person's pulse will continue to increase when body temperature rises unless the worker concerned has acclimatized to high air temperatures. The work climate is very hot and workers have not been able to adapt will cause a lot of sweat but normal or subnormal body temperature, decreased blood pressure, faster pulse so that the patient will feel weak and may faint (Suma'mur, 1997).

An extreme work climate not only impacts the rapid pulse but can also affect fatigue. The results of this study show there is an influence of work climate on fatigue either directly or through the pulse. Statistical test results based on path analysis, work climate has a direct and indirect influence on work fatigue, the results of cross tabaya shows that there are 14.8-24.0% or 4-6 respondents in each factory experiencing fatigue in the weight category and exposed to temperatures of 26.3 ° C -27.4 ° C, this figure is experiencing a lot of heavy fatigue, it could be because the Indonesian people can generally adjust the tropical climate where temperatures around 28-32 ° C, climate acclimation (weather) can be interpreted as an adjustment that occurs in a person to the climate (weather) to get used with certain conditions and do not experience the adverse effects of conditions (Suma'mur, 2013).

Previous research conducted by Rahman *et al*., (2019) at PT. Maruki International Indonesia uses the chi square test that there is a relationship between heat stress and work fatigue. Dewi's research (2016) which states that of the 10 workers who experienced mild fatigue, 6 workers had a work climate above NAV and 4 workers had a work climate below NAV. Of the 31 workers who experienced moderate fatigue, 25 workers had a work climate above the NAV and 6 workers had a working climate below the NAV, while 2 workers who experienced severe fatigue all had a work climate above the NAV.

The Venugopal study (2016) in India states that there is an influence of heat temperature on the health problems of outdoor workers, in which 442 workers from 18 Indian workplaces participated (22% and 78% of the organized and unorganized sectors, respectively). Overall 82% and 42% of workers were exposed to WBGT which was higher than recommended by the local government, decreased work productivity due to many complaints due to fatigue. Cutsem *et al*., (2017) states that the hot climate will have an impact on mental fatigue and decreased performance. While the results of other studies differ where there is no effect of work climate (28.4 ° C) on work fatigue (Mustofani *et al*., 2019).

In theory, according to Guyton (1991) due to high environmental temperatures, body temperature will increase. As a result the hypothalamus stimulates the sweat glands so that the body secretes sweat, which contains sodium chloride salt. The release of sodium chloride with sweat will reduce levels in the body, thereby inhibiting the transportation of glucose as an energy source. This causes a decrease in muscle contraction so that the body experiences fatigue.

PT. Maruki International Indonesia has frozen its work climate control with ventilation in each production room to facilitate air circulation, only it needs regular cleaning. Not only that, the company also provides a fan close to each worker's desk, but the fan that is rarely cleaned will cause breathing problems considering that there is a lot of wood dust scattered. PT Maruki PT. Maruki International Indonesia has also implemented a time discipline where the break at 12.00-13.00 is marked by the ringing of the bell, at which time the workers leave the workspace and rest. This is an effort to minimize fatigue.

Work climate must be regulated so that it remains comfortable and in accordance with the type of work performed, while continuing to use natural methods such as natural ventilation. NIOSH recommends that workers drink as much as 150-200 cc every 15-20 minutes. Drinking water should be stored in a cool place and placed close to the workplace so that labor can take without leaving the workplace environment. For workers who have not acclimatized, drinking water should contain salt with a content of 0.2%, while for workers who have acclimatized the salt content in drinking water is 0.1%.

CONCLUSION

Finally, this study shows there is a direct effect of noise, hot work climate, and work pulse on work fatigue and there is an indirect effect of noise and hot work climate on work fatigue through work pulse. Suggestions for companies and workers are expected by the company to continually increase efforts to control noise hazards by providing PPE and engine modifications as well as cleaning ventilation and fans on a regular basis to reduce exposure to hot working climates. For workers to always use ear protection (earmuff) when working and wear clothes that do not cause heat and consume more water when working.

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