Analyze of Fatigue Related Vibration and Noise Exposure in Weaving Departement at PT. IDtex

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Abstract. Machinery and mechanical work equipment cause vibrations which channel some power to the worker's body, objects in the workplace and the environment. Vibration and noise from weaving machines at PT. IDtex causes a resonance of organs and body tissues, leading to fatigue on workers. The purpose of this research was to determine the analysis of fatigue related vibration and noise exposure in weaving machine at the company. The research was conducted at PT. IDtex of weaving machine departments. The sample involved 31 respondents with Win Episcope 2.0. The respondents were divided into 3 groups vibration exposure < 1 m/sec^2, 1-4 m /sec^2 and > 4 m /sec^2 and noise intensity below 80 dBA, 80-85 dBA and above 85 dBA. Simple Linear Regression analysis test was used to analyze data, and the correlation test had a significant p-value of 0,000 (R = 0,749). This means that there was a significant relationship between vibration and noise exposure with fatigue. The coefficient of determination R2 = 0.560, it's mean intensity of vibrations and noise accounts for 56.0% of changes in fatigue variables.

Keywords: Vibration, Noise, Weaving Machine, Fatigue

1. Introduction

Machinery and mechanical equipment cause vibrations, which involve regular movements from objects or media with the alternating direction from the balanced position. Some of the mechanical power is channeled to the worker's body or objects or objects in the form of mechanical vibrations (Suma'mur, 2013).

Arief (2005) studied the production machinery in the plywood industry and factors affecting the level of vibration intensity in the production process room. The results showed that the vibrations had exceeded the standards with an average acceleration of 8,97 ms^2/8 hours. In case this happens continuously without control or repair, the health and safety of workers, and the durability of the production machine will be negatively affected. Noise exposure that

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exceeds the Threshold Limit Value interferes with the workforce activities. It is estimated that almost 14% of the total workforce of industrialized countries is exposed to noise, which exceeds 90 dB in the workplace. Hearing impairments and physiological disorders in the form of fatigue due to noise are common occupational diseases. These problems need to be identified earlier for prevention or control to be carried out. (Soeripto, 2002).

PT. IDtex is a textile industry that processes raw materials into fabrics. Due to the increasing demand, the company recently increased its production capacity with the weaving machine totalling 614 units. Apart from the noisy impact, the weaving machine also produces high vibrations. The weaving room has a large with 1 worker operating 6 machines for 8 hours per day. Based on data from the initial survey, 70% of workers suffer from fatigue (base on fatigue criterias by Lintje 2010). This is indicated by an average reaction time of 425 m/s along with some complaints made by workers at the interview. The measurement data of mechanical vibrations in the weaving machine was 5,7 m/s^2, and the noise intensity was 91 dBA. According to the Minister of Manpower Regulation No. 5 of 2018 on Occupational Safety and Health in the Workplace, the Threshold Limit Value (TLV) of work equipment vibration directly or indirectly exposed to the arms of the worker is set at 4 m/s^2 for 8 hours of work, while the noise intensity is 85 dBA for 8 hours per day. Therefore, the intensity of vibration and noise in the weaving machine department is inappropriate. This study is entitled "Analysis of fatigue related vibration and noise exposure in weaving at PT. IDtex"

2. Methods

This research an observational analytic study that used Cross Sectional approach. The population was obtained through simple random sampling (Win Episcope 2.0 program : Gobeirno, 1998) was divided into 3 groups, each with 31 respondents). Group 1 consisted of respondents exposed to vibration and noise less than TLV in the Ricing Room. Group 2 respondents were exposed to vibration and noise in the range of TLV in Office Space, while Group 3 was exposed to vibrations and noise more than TLV in the Weaving Room. Research data on vibration and noise (interval) with fatigue (ratio) were tested using a simple linear regression analysis test (Soekidjo, 2010).

3. Results

The location for the study was at PT. IDtex in the weaving room receiving vibration from 614 weaving machines with shuttle loom. The ricing and office room were used for comparison purposes. Based on statistical tests, the following research results were obtained:

Table 1. Respondent statistics results at PT. IDtex

	***Group* 1**	***Group* 2**	***Group 3***	**p-value**
Age (years)	37.12±4.98[a]	37,25±3,85a	39,74±1,75a	0.072
BMI	21.76±1.65a	21.40±1.53a	21.62±1.39a	0.636
Work Period	18.12±4.95[a]	18.03±4.31[a]	19.48±3.16[a]	0.321
Workload (beats/minutes)	77.41±1.65[a]	76.61±2.61[b]	78.38±1.83[b]	0.036
Lighting (Lux)	196.14±9.80[a]	222,85±48.23[a]	204,71±45,01[a]	0.433
Work climate (°C)	30.52±0.41[a]	26.48±0.38[b]	30.54±0.64[a]	0.000
Noise (dBA)	77.2	70.2	97.8	
Vibration (m/s^2)	0,22±0,07[a]	2,148±0,56[b]	5,458±0,76[c]	0.000
Fatigue	262,01±75,84[a]	339,72±86,74[b]	484,89±83,35[c]	0.000

Description : Different letters on one line indicates a real difference in the Anova test followed by the Post Hoc Test with $\alpha = 0,05$

Based on the table 1 explain that the age, Boddy Mass Index, work period and workload of the respondents did not have a significant influence in this research. Similarly, gender and work attitude was insignificant since they were controlled in this research.

There is no relationship between age and fatigue. This is probably due to the average age of respondents being below 40 years. According to Hidayat (2003), workers aged 40-50 years suffer from fatigue more quickly than relatively young individuals.

Based on the results of the statistical regression tests, the following results were obtained:

Table 2. Simple Linear Regression Analysis Test Results

Ry (1,2)	**R^2y (1,2)**	**Df**	**F value**		**Description**
			Count	**Table**	
0,749	0,560	2:92	57,364	3,09	There is a relationship between vibration and noise exposure with fatigue

Respondents have normal nutritional status based on BMI criteria, according to Tarwaka (2014), since their BMI mean value is 18,5-25. In general, a worker with proper nutrition has a

better work capacity and endurance, and vice versa (Budiono et al., 2003). Statistical test results showed that there is no relationship between nutritional status and fatigue.

The work period of respondents more than one year. According to Burke and Peper (2002), if the work period is long, workers are likely to be exposed to work equipment every day. Due to the vibration intensity, they are likely to suffer health problems, including discomfort during work. The results of the analysis showed that there is no relationship between the work period and fatigue.

Based on the workload criteria in Tarwaka (2014), the respondent has a light workload because, in each group, they have between 75-100 work pulses/minute. Although the workload in the three groups is light in this study, there are different results from the level of fatigue. This is in line with Setyaningsih (2009), which established that workload has a significant influence on fatigue in porters at the Klewer Market.

The lighting intensity at PT. IDtex did not have a significant effect in this research since the average was still within work activities standards. According to Grandjean (2003), bad lighting cause visual disturbances or fatigue during work. It also results in general fatigue, which leads to reduced power and work efficiency.

The analysis result showed that there is a relationship between work climate and fatigue. This is because the source of heat comes from the operation of the weaving machine. Individuals work efficiently and productively in case the work environment is comfortable (Mc Curney, 1999).

Descriptively, the value of noise intensity between groups shows different and increasing results, and this is significant in this research. Weaving machine with high vibrations and noise intensity cause fatigue. This is in line with Agustian and Samiadi (1993), who stated that there was a hearing disturbance in the frequency of conversation due to the length of noise exposure in textile factory workers. Huang and Griffin (2012) reported that vibration masked the discomfort of noise but only when the magnitude of vibration was greater than the highest magnitude used in the present study.

Based on table 1, the intensity of vibrations between groups is different. This is indicated by the exposure in the weaving room exceeding the TLV. In general, mechanical vibrations in the body interferes with comfort at work, accelerate the occurrence of fatigue and health problems (Suma'mur, 2013). Similarity with Luke and Tresna (2016) with analysis calculation with Spearman and Pearson correlation is $p<0,05$ is that mean there is real relationship exists between the machine vibration and vibration exposure received by workers with systolic blood pressure and reaction time as an indicator of physiological fatigue.

Test results obtained between groups have a significant difference. This is evident in the measurement results, which show that fatigue increase due to exposure to vibration intensity in all the three groups. Although the respondents are exposed to vibrations under the TLV, other factors lead to fatigue.

The equation of the regression line on the effect of vibration and noise on fatigue is stated by :

$Y = 296,377 + 35,678\ X1 - 0,384\ X2$. The equation showed that the coefficient value of X1 is 35,678, meaning that if the intensity of vibration (X1) increases by 1 point, fatigue (Y) increases by 35,678 points, assumed X2 remains constant. The close relationship between

vibration and noise with fatigue = 0,749 showing the relationship is significant. The influence of vibration and noise on fatigue is 56%, and therefore other factors account for 44%. This is in line with Supriyadi and Yohanes (2007) which stated that there is a very significant relationship between exposure to vibration, noise, and Occupational Safety and Health (OHS) knowledge on fatigue, precisely reaction time and fatigue feelings ($p < 0.010$).

Application of high strength steel sheets to automotive bodies requires evaluation technologies of fatigue and noise-and-vibration properties with high accuracy. In designing a vehicle body structure, it is common practice to first meet the requirements for crashworthiness and then provide the vehicle body structure panels with damping sheets and sound insulators to reduce vibration and noise. However, the addition to features such as dampers tends to increase vehicle body structure weight significantly (Atsusi, et.all, 2013).

Other researchers performed Akira, et.all (1991) that noise at 100 dB(A) showed only an initial effect on skin sympathetic nerve activity (SSA), whereas when combined with local vibration at 60 Hz, a pronounced increase in neural activity was noticed, indicatingfect of vibration and noise.

The same research by Pyoung (2013) shows that total annoyance caused by combined noise and vibration was considerably greater than the annoyance caused by noise alone. The contribution of noise annoyance to total annoyance is dependent on the magnitude of noise stimuli.

4. Conclusions

This study established that there is a relationship between vibration and noise exposure with fatigue in weaving workers at PT. Idtex. Therefore, there is need for work rotation, using personal protective equipment, and routine monitoring, especially on the intensity of vibration and noise as an evaluation material

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