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The impact of hot work climate on textile industry productivity

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Abstract. Climate change phenomenon, especially indicated by air temperature increase, affects the economic sector which becomes obstacles for industry productivity, including textile. According to the data from the Central Bureau of Statistics Republic of Indonesia in 2016, the growing production of the textile industry in Indonesia decreased by 7.65%. It also decreased the IT Co. Ltd productivity in recent years, especially at the weaving department. The weaving department occupied with high-temperature environment among the production processes, which can impact to the health and productivity of workers. The purpose of this study was to determine the relationship between hot work climate to textile industry productivity from weaving section at IT Co Ltd. The research used the analytic observational designs with a cross-sectional study. The samples were 32 workers from totally 50 workers in the weaving department. The data were analyzed using Spearman's correlation test. The results of the hot work climate measurement show that 3 from 5 measurement points exceed NAB 29^{o}C, and most of the workers are productive. Spearman's correlation test showed that hot work climate significantly correlated with productivity (p =0.033) at the textile industry of IT Co. Ltd, Surakarta, Indonesia.

1. Introduction

Industrial development will always be followed by the application of technology, the use of increasingly complex materials and work equipment. If this is not balanced with human availability and adequate facilities, it can hamper the production process, one of which is the textile industry. In a work environment of the textile industry, companies and workers will face various obstacles in increasing their productivity, one of which is caused by the work environment. Surakarta is one of the cities in Indonesia, which is famous for textile industry business. This industry triggers some environmental changes, both ecosystem and temperature changes, and lead to temperature increase year by year [1]. Climate change phenomenon, especially indicated by air temperature increase, affects the economic sector which becomes obstacles for industry productivity, including textile. According to the data from the Central Bureau of Statistics Republic of Indonesia in 2016, the growing production of the textile industry in Indonesia decreased by 7.65% [2]. It also decreased the IT Co. Ltd productivity in recent years, especially at the weaving department. The weaving department occupied with high-temperature environment among the production processes, which can impact the health and productivity of workers. The aims of this study were to determine the correlation between hot work climate towards textile industry productivity in the weaving section. The hot work climate in the weaving section comes from the use of machines, weaving, roofs of factories made of zinc, lack of

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ventilation, lack of air exchange and narrow working area. The previous study said the hot work environment interferes with the metabolic process of the human body which results in an increase in the amount of sweat in the body, dehydration, an increase in heart rate so as to make the workforce easily fatigued and less productive at work [3]. But until now, no one has examined the correlation of the heat work climate to the productivity of workers in the weaving section, where weaving machines produce heat for 24 hours with limited workspace and lack of air ventilation. Hot work climate is one of the working conditions of physical factors which in certain circumstances can cause losses. Therefore the work environment must be made as comfortable as possible by regulating and controlling air temperature, air humidity and airspeed, which aims to increase productivity and reduce heat pressure.

2. Subject and method

The research used the analytic observational designs with a cross-sectional study. This study held at IT Co Ltd Surakarta. The samples were 32 workers from totally 50 workers in the weaving department. The measurement of hot work climate using Quesstemp Heat Stress Monitor with Wet Ball Temperature Index (WBTI) as an indicator. This tool can measure combinations of wet temperature, dry temperature and radiation. This hot work climate measurement is carried out in 5 points of the weaving section by placing the tool at a height of 1.2 m. The selection of measurement points based on the area of workers that is close to the location of the weaving machines, and there are 5 rows of weaving machines used by workers mobilization in workplaces (Figure 1). When the measurement is done, the quesstemp tendon is filled with distilled water with an adaptation time of 30 minutes. Textile industry productivity was calculated using productivity formula (P) = output (O)/input (I). The calculation of output and input is the number of rolls of fabric that can be produced by each workforce in one day. The data were analyzed using Spearman's correlation test.

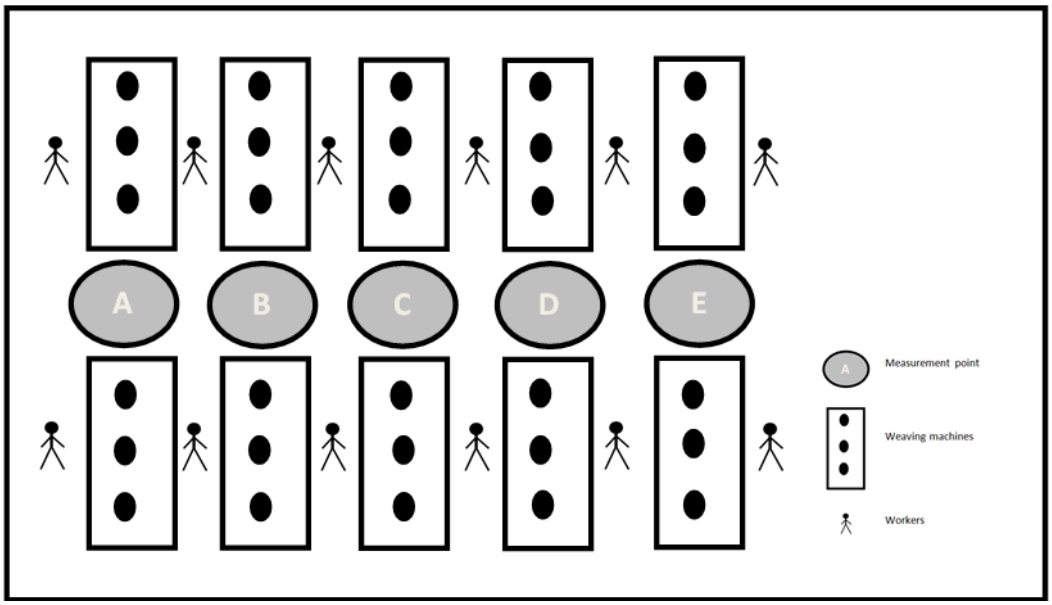

Figure 1. Sketch map measurements in weaving Section IT Co Ltd

3. Results

IT Co. Ltd is one of the many textile companies that process raw materials into raw cloth (grey), which then increases the type of production in the form of patterned fabrics or better known as batik printing. Labor in a hot environment, such as around a weaving machine with limited room ventilation can cause heat stress. When wet temperature, dry temperature and radiation is too high, it will cause a decrease in productivity due to disruption of the body's physiological functions including increased

heart rate and blood pressure, decreased digestive organ activity, increased body temperature, and increased sweat production. Based on the Minister of Manpower and Transmigration Regulation No. 5 of 2018 which talks about work environment, the division of work time per hour is 75% - 100% and it's included in the category of moderate workload, the permissible hot work climate is 29.0 °C [4], and based on the measurement results of the work area, obtained measurement results that exceeded the allowed limit can be seen in table 1. While in table 2 it can be seen that the temperature and work productivity are significant (p-value = 0.033) with a strong enough correlation with the direction of negative correlation (-0.378).

Table 1. The results of hot work climate measurements using Wet Ball Temperature Index in the IT Co. Ltd weaving section.

Measurement Location	Wet ball temperature index(°C)	Explanation
Point A	29.1	Exceeded the threshold value
Point B	29	Exceeded the threshold value
Point C	29.2	Exceeded the threshold value
Point D	28.9	Below the threshold value
Point E	28.5	Below the threshold value

Table 2. Correlation between hot work climate and work productivity of weaving workers with the Spearman's correlation test

Variable		Work Productivity		N	P value	R
		Less Productive	Productive			
Temperature	Exceeded the threshold value	2 (6.3%)	10 (31.3%)	12 (37.5%)	0.033	-0.378
	below the threshold value	11 (34.4%)	9 (28.1%)	20 (62.5%)		

4. Discussion

According to Indonesian Minister of Manpower Regulation No. 5 of 2018, the threshold value of the hot work climate is 29^0C for a medium workload with an exposure time of 8 hours/day, 40 hours per week [4]. Based on table 1, points A, B, C and D in IT Co Ltd exceed the threshold value of the allowed hot work climate. Hot work temperature that exceeds the threshold value can cause the body to experience excessive heat, the skin temperature will rise, which could lead to heat loss in the body by convection and radiation. Heat will transfer from inside to the pores and lost as a result of evaporation, then blood vessels dilatation will occur and causes sweat to come out, so that energy reserves will decrease with strength or ability to work to produce products decreased as well. Finally, it can lead to a decrease in labor productivity [5]. In addition, heat exposure can also cause additional burden on the blood circulation. When doing heavy physical work in a hot environment, the blood will get an additional burden, because it must carry oxygen to the part of the muscle that is working [6]. Besides that, blood must also bring heat from the body to the surface of the skin which causes the heart to pump more blood so that it can increase the pulse rate which results in the body becoming tired easily. Fatigue is a functional reaction of the center of consciousness (cortex cerebral) which is influenced by two antagonistic systems namely the inhibiting system (inhalation) and the driving system (activation). The inhibitory system works against the thalamus which is able to reduce the human ability to react and tends to make humans sleep [7]. The drive system (activation) functions to stimulate the body's organs to work. If the inhibiting system is in a position that is stronger than the driving system, a person in a tired state will tend to be lazy so that they are not productive at work [8].

Based on the Spearman correlation test (Table 2), it was found that the hot work climate was significantly associated with work productivity at IT Co. Ltd (p-value = 0.033, r = -0.378). The direction of correlation showed the negative direction, which means that the higher the hot work climate, the lower the level of work productivity. This research is in line with some study that there is a significant relationship between work climate and work productivity in the textile industry. High heat pressure will increase the temperature of the human body due to the body's metabolism that adapts to ambient temperature, so if this process does not run in balance it will cause health problems and decrease work performance [9]. Based on several other studies and theories, it also states that hot work climate is the most influential hazard factor on work productivity, because hot working temperatures will provide additional workload which results in functional changes in the body's organs resulting in fatigue and sleepiness, reducing body stability, increasing number of errors in doing work [10]. To reduce the hot work climate at work, especially at IT Co. Ltd, can be done by identifying heat sources in the workplace so that appropriate control techniques can be carried out. Heat control techniques that can be carried out, including reducing the factor of heat radiation load by lowering the air temperature from work processes that produce heat, relocation of heat sources, the use of shields and protectors that can reflect heat, increase ventilation, mechanical cooling, work time regulation [11].

5. Conclusion

Hot work climate significantly correlated with productivity in the textile industry of IT Co. Ltd, Surakarta, Indonesia. The higher the hot work climate, the lower the level of work productivity. The hot work climate measurement shows that 3 of 5 measurement points exceed NAB 29^{o}C. Hot work climate will increase the temperature of the human body due to the body's metabolism that adapts to ambient temperature cause health problems and decreases work performance. It's also will provide additional workload which results in functional changes in the body's organs resulting in fatigue, sleepiness and reduces the worker's productivity.

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