# HUBUNGAN MASA KERJA, POSTUR KERJA, IKLIM KERJA, DAN KEBISINGAN DENGAN KELELAHAN KERJA PADA PEKERJA INDUSTRI BRIKET ARANG

# THE RELATIONSHIP BETWEEN WORK PERIOD, WORK POSTURE, WORK CLIMATE, AND NOISE WITH WORK FATIGUE AT CHARCHOAL BRIQUETTE INDUSTRY

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## ABSTRACT

*Work fatigue is a problem that can affect all workers in carrying out their work. Workers in the charcoal briquette industry are at risk of experiencing work fatigue. This study was conducted to analyze the relationship between work period, work posture, work climate, and noise with job fatigue in charcoal briquette industry workers. The study was an observational analytic type with a cross sectional approach. The sample of this study was determined by purposive sampling technique with sample criteria, namely workers not in the curing section, totaling 30 people. The research instruments were a respondent data sheets, IFRC questionnaire, RULA sheet, Angle Meter application, Area Heat Stress Monitor, and Sound Level Meter. The statistical test used was the Spearman Rank correlation test. The results showed that most of the respondents had a new working period, very risky work posture, work climate exposure above the NAB (>28ºC), noise exposure below the NAB (≤85 dBA), and mild fatigue. The Spearman Rank Correlation test results showed that there was a relationship between work posture (p-value = 0.022), work climate (p-value = 0.045), and noise (p-value = 0.000) with work fatigue. In contrast, work period was not associated with work fatigue (p-value = 0.0486).*

*Keywords: work climate, noise, work fatigue, work period, work posture*

## INTRODUCTION

Briquettes are a type of renewable energy that has high export potential, especially briquettes from coconut shell charcoal. Charcoal briquette making workers are at risk of work fatigue. Previous research on briquette making workers found that out of 42 workers, 23 workers (54.8%) experienced work fatigue. (Saptadi et al., 2022).

Work fatigue is a sign that workers are no longer able to carry out their activities (Soedirmas & Prawirakusumah, 2014). Fatigue becomes a form of protection to prevent further damage to the body so rest is needed for recovery (Suma'mur, 2014a).

Workers who insist on continuing to work when they feel tired will experience increased fatigue and disruption to the smooth running of work and will have negative impact on workers' health (Suma'mur, 2014b). Work fatigue will reduce productivity and increase work failure which creates opportunities for work accidents in industry (Harwanti et al., 2016). Department of Manpower and Transmigration data shows that 414 work accidents occur every day in Indonesia with 27.8% caused by high fatigue. (Susanti & Amelia, 2019).

The period of work will influence the length of exposure of workers to work environmental hazards (Ramdan, 2018). An awkward working posture makes the muscles inefficient at working so that they require more strength to complete the work (Linoe et al., 2022). A hot work climate will reduce performance and agility, thinking ability, reaction time, sensory and motor coordination, which are some of the symptoms of work fatigue. Exposure to noise will have a psychological impact in the form of decreasing worker efficiency and performance, which can be called work fatigue. (Suma'mur, 2014a)

Posture when doing work can influence the occurrence of work fatigue. Different working postures will place a load on different muscles during activities. Working posture was found to determine differences in workers' trunk muscle activity. Therefore, safe work methods must be implemented to protect workers and improve workers' health, prevent fatigue and work-related diseases. (Yang et al., 2022)

The charcoal briquette industry is a manufacturing industry that produces semi-finished goods in the form of coconut shell charcoal into finished goods, namely briquettes. The briquette production process starts from grinding the coconut shell charcoal using a machine until it becomes flour, then mixing the charcoal flour with adhesive using a mixer machine, after that it is blended and printed using a printing machine and cut to size. At this stage the briquettes produced are still wet, then dried using a wood-fired oven for 30 hours at a temperature of 80-90$^0$ Celsius.

Based on the results of a preliminary study, workers in the Coconut Shell Charcoal Briquette Industry work 6 days with Sundays off. Workers work from 8 am to 4 pm and take a 1 hour break during the day. However, the oven unit has 9 working hours because it applies work shifts. The results of interviews with 5 workers showed that all workers experienced symptoms of work fatigue, including fatigue (80%), drowsiness (40%), difficulty concentrating (40%), weakness when working (80%), headaches (20%) , lack of enthusiasm (40%), and back pain (60%). Apart from that, it is known that the length of service of workers in this industry varies from 2 to 10 years.

Based on observations, it is known that workers in the Charcoal Briquette Industry predominantly work in standing, bending, sitting, reaching, static positions and repetitive movements. Apart from that, the Charcoal Briquette Industry has quite high levels of noise and a hot working climate. Even though exhaust fans are used, the work environment still feels hot resulting from production machines and factory walls and roofs that use zinc. Noise is generated from the machines used for production, especially charcoal grinding machines (crushers). This is supported by the results of interviews with 5 workers, where all workers complained about the noise from the machines and felt stifling and hot in the work environment.

Lack of study in informal briquette industry means there was a lack of data regarding fatigue and factors that influence fatigue. However, with this data, steps can be

taken to prevent worker fatigue. The aim of this research was to analyze the relationship between work period, work posture, work climate and noise and work fatigue in Charcoal Briquette Industry workers.

## METHOD

This research is a quantitative, observational analytical type with a cross sectional approach. The research population was 34 people who were workers in the Briquette Industry. This research used a total sampling technique but there were 4 workers who did not come to work during the research so the sample obtained was 30 workers.

The data collection conducted on April 2023 in Sayung subdistrict, Demak regency. Data was collected through interviews with workers using a questionnaire to determine identity and length of service, and an Industrial Fatigue Research Committee (IFRC) questionnaire to measure the level of work fatigue felt by workers. Observation and documentation of worker activities to measure work posture risks using the RULA sheet. Body posture angles are measured with the Angle Meter application. The work environment climate is measured by Area Heat Stress Monitor and Sound Level Meter for noise. Measurements were carried out at 6 points, namely at the milling unit, mixing unit, blending unit, printing unit, cutting & trimming unit, and holding tank. This research has been asked to pass the code of ethics (No: 105/EA/KEPK-FKM/2023) by the Undip FKM Health Research Ethics Committee. The data that has been obtained is analyzed using a statistical test in the form of the Spearman Rank correlation test.

## RESULT AND DISCUSSION

### 1. Univariate Analysis

Table 1. Results of Univariate Analysis of Charcoal Briquette Industry Workers Variables

| Variable | f | Percentage (%) |
|---|---|---|
| **Length of Work** | | |
| New (≤5 yrs) | 19 | 63,3 |
| Old (>5 yrs) | 11 | 36,7 |
| **Work Posture** | | |
| High Risk (5-6) | 12 | 40,0 |

| | | |
|---|---|---|
| Very High Risk (7) | 18 | 60,0 |
| **Work Climate** | | |
| Under Treshold Value (≤28ºC) | 13 | 43,3 |
| Above Treshold Value (>28ºC) | 17 | 56,7 |
| **Noise** | | |
| Under Treshold Value (≤85 dBA) | 24 | 80,0 |
| Above Treshold Value (>85 dBA) | 6 | 20,0 |
| **Work Fatigue** | | |
| Mild Fatigue | 16 | 53,3 |
| Moderate Fatigue | 8 | 26,7 |
| High Fatigue | 6 | 20,0 |

Table 1 shows that the majority of workers have new work period or ≤5 years, namely 20 workers (63.3%). This is because production depends on orders and the work does not require special skills so that when there are orders and production is running, new workers can be recruited.

Work postures were dominated by very high risk work postures with a RULA score of 7 for 18 workers (60%). Workers tend to adopt awkward body postures such as bending, reaching, looking down, body tilting to the side, wrist flexion and extension.

Table 1. also shows that the majority of workers are exposed to a work climate above NAB (>28ºC) as many as 17 workers (56.7%) and more workers were exposed to noise below NAB (≤85 dBA) as many as 24 workers (80%). The majority complained of fatigue in the mild fatigue category, namely 16 workers (53.3%).

## 2. Bivariate Analysis

Table 2. Variable Cross-tabulation of Briquette Worker

| Variabel Bebas | Kelelahan Kerja | | | | | | Total | | *p-value* |
|---|---|---|---|---|---|---|---|---|---|
| | Mild | | Moderate | | High | | | | |
| | f | % | f | % | f | % | f | % | |
| **Length of Work** | | | | | | | | | |
| New (≤5 yrs) | 9 | 47,4 | 6 | 31,6 | 4 | 21,1 | 19 | 100 | 0,486 |
| Old (>5 yrs) | 7 | 63,3 | 2 | 18,2 | 2 | 18,2 | 11 | 100 | |
| **Work Posture** | | | | | | | | | |
| High Risk (5-6) | 9 | 75 | 3 | 25 | 0 | 0 | 14 | 100 | 0,022 |
| Very High Risk (7) | 7 | 38,9 | 5 | 17,8 | 6 | 33,3 | 6 | 100 | |
| **Work Climate** | | | | | | | | | |
| Under Treshold Value (≤28ºC) | 9 | 69,2 | 4 | 30,8 | 0 | 0 | 24 | 100 | 0,045 |
| Above Treshold Value (>28ºC) | 7 | 41,2 | 4 | 23,5 | 6 | 35,3 | 6 | 100 | |
| **Noise** | | | | | | | | | |
| Under Treshold Value (≤85 dBA) | 16 | 66,7 | 7 | 29,2 | 1 | 4,2 | 24 | 100 | 0,000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Above Treshold Value (>85 dBA) | 0 | 0 | 1 | 16,7 | 5 | 83,3 | 6 | 100 |

**Relationship between Length of Work and Work Fatigue**

Table 2 shows that the Charcoal Briquette Industry workers who experienced high work fatigue were mostly workers with a new work experience category or ≤5 years (21.1%). The Spearman Rank test shows that there is no relationship between length of service and work fatigue in workers (p: 0.486)

This research is in line with research on tempeh craftsmen which revealed that work experience was not related to work fatigue (p:0.465). This is because most tempe craftsmen have had a long working period so they have sufficient experience and are able to adapt to their work (Bagaskara, 2022).

Workers with long periods of work tend to have mild work fatigue. This is because workers with long service periods have longer experience than workers with new service periods. Work experience can reduce the occurrence of work fatigue because you can organize work more efficiently, regulate the amount of energy expended and know the most comfortable work position to maintain productivity so that work fatigue is reduced (Ramdan, 2018).

**Relationship between Work Posture and Work Fatigue**

Table 2 shows that Charcoal Briquette Industry workers with high work fatigue are dominated by workers with very high risk category work postures (33.3%). Based on the results of the Spearman Rank test, a significance value of 0.022 (p-value < 0.05) was obtained, so there is a relationship between work posture and work fatigue in Charcoal Briquette Industry workers.

This research is in line with previous research on container crane operators which stated that work posture was related to work fatigue (p-value = 0.0001) because an awkward work posture will easily cause fatigue (Amalia et al., 2017).

Workers carry out many activities with extreme bent work postures, such as lifting sacks, collecting charcoal flour, and putting briquette mixture into buckets using shovels. The risk of muscle fatigue increases as the body position moves further away from the center of gravity (Daryono et al., 2016).

Charcoal Briquette Industry workers work with static work postures and repetitive movements which cause work fatigue. Static body postures have a big potential to cause health complaints. Fatigue is caused by the buildup of lactic acid in the muscles during work which can occur due to lack of muscle stretching. (Hijah et al., 2021).

In contrast with research result on laundry worker, there was no relationship between work posture and health complaints especially on complaints of musculoskeletal disorders. (Fuadah et al., 2022)

Workers can stretch their muscles independently for 5 minutes by relaxing the muscles of the back, neck, shoulders, hands and feet. Companies can implement Workplace Stretching Exercise which is a stretching program in the workplace to achieve elasticity, flexibility and comfort in muscles (Hastuti, 2013).

**Relationship between Work Climate and Work Fatigue**

Table 2 shows that workers with high work fatigue are dominated by workers who are exposed to a work climate above NAB or >28ºC (35.3%). The Spearman Rank test shows that there is a relationship between work climate and work fatigue in workers (p: 0.045).

This research was in line with research on Tempe Craftsmen at the Primkopti Lenteng Agung Tofu and Tempe Center which revealed that work climate is related to work fatigue (p-value = 0.010). In this research, it was found that 66.7% of workers complained about work fatigue due to exposure to the work climate (Bagaskara, 2022).

Most workers were exposed to a work climate above treshold value (>28ºC). Work climate that exceeds the treshold value will trigger work fatigue because the body's process of retaining heat reduces the oxygen supply needed by the body (Suryaningtyas & Widajati, 2017).

The hot working climate arises from the walls and roof of the factory which are made of zinc. Zinc is a good heat conductor so that the sun's heat absorbed by the zinc will be radiated towards the surroundings, thereby increasing the factory temperature. Giving zinc a bright color will affect the absorption of solar heat on the zinc. A study concluded that white tin roofs had the lowest solar absorption, while black tin roofs were the roofs that absorbed the highest solar heat (Nazaruddin et al., 2020).

Production machines and ovens also increase the temperature in the work area. Insufficient ventilation can improve the working climate in the room even though the Charcoal Briquette Industry has used exhaust fans at several points in the work area. Therefore, it is necessary to add an exhaust fan in the work area so that each work unit has an exhaust fan installed as artificial ventilation so that the heat in the room can flow out smoothly (Wahyuni et al., 2020). Research shows that adding ventilation by installing 3 exhaust fans can reduce the temperature from 33.6ºC to 26.8ºC (Fakhruddin, 2022).

In the Charcoal Briquette Industry, drinking water facilities are provided for workers, but based on interviews, workers only drink if they feel thirsty. Workers who work in hot climates are advised to drink at least 1 glass of water every 15-20 minutes even if they don't feel thirsty. This is done so that workers get used to drinking enough and regularly so that fluid needs while working are met (Awwalina et al., 2022).

**Relationship between Noise and Work Fatigue**

Table 2 shows that workers in the Charcoal Briquette Industry who experience high work fatigue are dominated by workers who are exposed to a work climate above NAB or >85 dBA (83.3%). The Spearman Rank test shows that there was a relationship between noise and work fatigue in workers (p:0.000).

This research was in accordance with research on production workers in metal industry centers which shows that there was a relationship between noise and work fatigue and workers who are exposed to noise are 10.485 times more likely to get tired than those who do not experience noise. Research results show that workers with exposure to high intensity noise experience high levels of fatigue (Laziardy, 2017).

Of the 6 measurement points, only 1 point had a noise intensity exceeding NAB, namely the milling unit with a noise intensity of 87.8 dBA. The noise in this grinding unit comes from the charcoal grinding machine and exhaust fan which are fully operational for 7 working hours. When noise exceeds the Threshold Limit Value (NAB), work productivity will be disrupted because workers feel disturbed and cause a decline in psychological conditions which results in work fatigue (Suma'mur, 2014b).

Even though there was only 1 work unit area where the noise intensity exceeds the NAB, fatigue is still felt by workers in other units because in other units there are also sources of noise in the form of production machines and exhaust fans which cause noise close to the treshold value. Exposure to noise in the workplace causes physiological changes in the body because it can increase pulse rate, blood pressure, and constrict blood vessels, resulting in workers becoming tired easily (Safitri et al., 2023).

The Charcoal Briquette Industry has several production

machines but has never carried out regular maintenance on these machines. Based on observations, there was 1 blending machine that was damaged because it had not been regularly maintained. Regular maintenance on production machines needs to be carried out to reduce the intensity of noise generated by machines due to wear and tear on components that rub against each other and damage to machine components. Therefore, regular maintenance is required on the machine by lubricating and repairing damaged machine parts (Maghfiroh, 2021).

Apart from maintaining the charcoal briquette machine, workers also need to equip themselves by wearing ear plugs when working. This means that if the impact of maintenance is not optimal, workers can still be protected by using protective equipment (Morata et al., 2024).

This research only involved a small sample so the results may not represent all the facts in this industry. However, it is still possible to use the results of this research to design measures to prevent work fatigue in similar industries.

## CONCLUSION AND RECOMMENDATION

It can be concluded that the Charcoal Briquette Industry workers are dominated by new workers (≤ 5 years) (63.3%), very high risk work posture (60%), working in an environment with a work climate above treshold value (>28ºC) (56.7 %), and working in environments with noise below treshold value (≤85 dBA) (80%). Most workers complained of work fatigue with a mild fatigue category of 53.3%. There was a relationship between work posture, work climate, and noise with work fatigue and work experience was not related to work fatigue.

Companies need to implement Workplace Stretching Exercises, provide bright colors to the zinc, add exhaust fan units in the work area, carry out regular maintenance on production machines. Workers are advised to stretch their muscles independently for 5 minutes and drink water regularly.

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