

Effect of Occupational Safety and Health Procedures on Fabric Dyeing Process in Reducing Worker Fatigue at the TBS Textile Factory

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ABSTRACT

Introduction: TBS textile factory is one of several textile factories where the process of fabrics dyeing takes place. In the process, workers lift and transport cloth loads manually, and thus work routines make their body bend. TBS textile factory ignored the health and safety aspects of work procedures which could cause worker fatigue. Safe work behaviour may prevent occupational sickness if the company applies appropriate occupational safety and health procedures. The purpose of this study was to determine the reduction of worker fatigue in the dyeing process of woven fabrics by applying occupational safety and health procedures. **Methods:** This study used treatment by subject design, where all samples were subjected to control and treatment, in different time periods. In this design, the interval between the time periods required washing out and adaptation, to eliminate the effects of previous work. The research population were workers in charge of dyeing section at TBS textile factory located in Gianyar regency. This study was conducted in July 2021 by involving 20 samples selected through purposive sampling technique. Data were collected from occupational safety and health procedures (how workers lifted and transported loads), legal limitations, and worker postures. Data analysis was carried out using t-independent test. **Results:** There was a decrease in scores of worker fatigue. The two different tests showed the scores after the study were significantly different ($p < 0.05$). **Conclusion:** Occupational safety and health procedures can reduce fatigue among workers in charge of fabrics dyeing by 40.77%.

Keywords: occupational safety and health procedures, posture, worker fatigue

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INTRODUCTION

Indonesia has various types of diversity from Sabang to Merauke. Bali is one of the islands that has enormous potential in all sectors, such as art and culture that makes it famous in foreign countries. Bali also has great potential in the textile sector such as woven fabrics. Woven fabrics are also often used by Balinese people in various aspects of activities.

The textile industry in Bali has grown rapidly as more textile entrepreneurs and woven fabric processing factories try to reach the market. The annual production of woven fabrics in Bali has increased due to both local and national demands as well as for export demands. TBS textile factory is one of several factories that produces woven fabrics.

The production begins with preparing raw materials, dyeing, washing, and drying. In the dyeing process, TBS textile factory uses organic raw materials to colour fabrics such as ketapang leaves, mahogany leaves, indigo leaves, and secang wood (Dewi, 2021). The use of natural materials in the colouring process produces colours that are more exotic and have different characteristics from synthetic dyes and most importantly are more environmentally friendly so that the waste generated from the colouring process is not harmful to the environment.

The colouring process using natural dyes takes a long time and extra energy in the process. The fabric colouring process in TBS textile factory is carried out before the fabric is given motifs and patterns; the fabric colouring is done by preparing the dye, where the dye is stored in a special pool, then the workers manually insert the fabric into the pool which already contains the dye with the desired natural ingredients. After the cloth is put

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into the dye pool, then it will be transferred to the holding pool for further processing, in the process of transferring the cloth from the dye pool it is transported manually.

During the process, workers dye cloth loads of 10kg-60kg, which needs a lot of energy. Then, the workers need to repeat the same process three times to produce the desired colour. In addition, workers need to stand and squat while dyeing the clothes. They work from 08.00 am until 17.30 pm and take a rest for one hour at 12.00 until 13.00 pm. Every week workers get one day off on Sundays, so that in one week each worker works for 57 hours. Working time should be seven hours of work a day or 40 hours of work a week for six working days in a week (Julia, 2017). The maximum additional efficient working time is 30 minutes, and if it is more than this provision there can be a decrease in work speed, absenteeism increases due to health problems and can lead to low work productivity (Aini, 2019).

TBS textile factory has not paid attention to the health and safety aspects of work. Unsafe postures during the work can trigger fatigue. For example, such as lifting or carrying heavy cloth loads during the dyeing process may lead to a similar problem. Workers, furthermore, will take extended work hours from two to three hours per day if the demands for woven fabrics increase. As a result, they might suffer more fatigue. Fatigue will decrease concentration at work which then causes work accidents (Negara, Sutjana and Adiputra, 2019)

Data from the International Labor Organization (ILO) 2010 state that almost every year as many as two million workers die due to work accidents caused by work fatigue (International Labor Organization, 2010). The study stated that from 58.115 samples, 32.8% or about 18.828 samples experienced work fatigue. Cases of work accidents that occur in the workplace have continued to increase since 2012. From the reported cases, it is known that around 32% are musculoskeletal injuries and fatigue due to work activities such as lifting weights (43%) (Karbito and Oksandi, 2020). The result of a 2018 survey by the National Safety Council (NSC) found two thirds of the US workforce experience burnout at work which means, nearly 107 million of the 160 million US workers are affected by work burnout (Muller, 2020). The incidence of musculoskeletal complaints and fatigue can be exacerbated if the position or posture of the worker in carrying out his work activities does not comply with the rules or standards (Tjahayuningtyas, 2019).

Excessive workload levels can cause work fatigue (Agustinawati, Dinata and Primayanti, 2019).

Fatigue is a natural mechanism of the body which shows that the body needs rest time to recover the stamina and energy that has been used during work (Tarwaka, 2010). Fatigue that arises in workers can cause a decrease in work efficiency and performance, as well as weakening of physical strength and endurance so that the body is unable to continue its work. Fatigue is also related to physical and mental general fatigue which cause a decrease in physical performance, feeling tired, decreased in motivation and productivity (Setyawati, 2010). Work fatigue can also affect work productivity in addition to work accidents.

The results of initial observations at TBS textile factory conducted in May 2021 showed workers in the dyeing section moved fabrics manually, and their body bended over time. They often complain of pain in their upper arms, back, and waist. Four of the workers interviewed mentioned that the pain occurred in several parts of their body, thus making them take some time off to massage their body at home. The percentage of pain complaints felt by workers is shown in Figure 1.

Some types of work involve certain postures and positions that are sometimes inconvenient. According to Iridiastadi and Yassierli, there are seven main risk factors for disorders of the musculoskeletal system, one of which is work positions, such as stooping, squatting, or moving wrists, neck up, and other body parts to bend (Iridiastadi and Yassierli, 2014). These postures often make workers tired. It was found that workers did not apply occupational health and safety procedures while dyeing the clothes. They often lifted goods which exceeded maximum capacity. This activity has a potential hazard to the health and

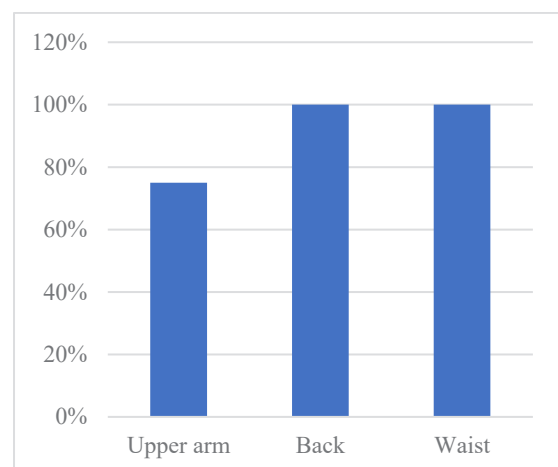


Figure 1. Complaints of Pain in Workers

safety of workers. Having safe behaviour can boost work safety. It needs to be applied in all sectors, especially industry (Nibel and Freivalds, 2014).

Occupational health and safety procedures at work aim to prevent work accidents and occupational diseases. The procedures can also improve productivity (quality goods and services) and safety and simplify heavy work that could jeopardize workers to suffer fatigue and musculoskeletal complaints (Nibel and Freivalds, 2014). According to Peraturan Menteri Tenaga Kerja Transmigrasi dan Koperasi No. PER.01/Men/1978, male adult workers are allowed to lift loads of 15-18 kg, while female adult workers are allowed to lift loads of 6-9 kg. According to Tarwaka, while lifting and carrying loads needs, workers should comply with some postures: (1) body position as upright as possible; (2) a straight back position; (3) knee at a strong point; (4) burden on the legs, not the waist; (5) the position of the load close to the body (Tarwaka, 2014).

Research on these issues is necessary to overcome the occurrence of fatigue at work as work fatigue is part of occupational health. Occupational health and safety in the informal sector has not been a concern of the government, but is something that must be obtained for every worker. This research was conducted as an effort to pay attention to workers, especially the informal sector.

METHODS

This study used a treatment by subject design, where all samples were subjected to control and treatment, in different time periods. In this design, the interval between the time periods required washing out and adaptation, to eliminate the effects of previous work (Bakta, 2000). In this study, workers were given treatment in the form of only being allowed to lift a load weighing 15-18 kg, with the body position as upright as possible, the back straight position, the knees at the strong point, the load on the legs, not the waist and the load position close to the body. This research has passed the ethical test by the Bali International University Research Ethics Commission with the ethical permit certificate number 01.030/UNBI/EC/VII/2021. The research population were workers in the dyeing process at TBS textile factory located in Gianyar regency. The research was conducted in July 2021 by involving 20 samples of workers chosen through a purposive sampling technique from a total population of 40 workers.

Data were collected in one month by comparing before and after the occupational health and safety procedures were applied. Worker fatigue was measured using 30 items of rating scale questionnaire. The analysis also was associated with the limitations of heavy loads handling as ruled in the Peraturan Menteri Tenaga Kerja Transmigrasi dan Koperasi No. PER.01/Men/1978, which says if the worker is male and the work is carried out continuously, the load that is allowed to be transported is 15-18 kg.

In this research workers were divided into two groups, each group had the opportunity to apply conventional work procedures and occupational health and safety procedures. Occupational health and safety procedures are that workers are only allowed to lift a load weighing 15-18 kg, with body position as upright as possible, a straight back position, knee at a strong point, burden on the legs, not the waist and the position of the load close to the body. Work fatigue measurement is carried out when workers work with conventional procedures and work with occupational health and safety procedures. The result is compared to find out whether occupational health and safety procedures can reduce worker fatigue.

RESULTS

Characteristics of Research Subjects

In this study, the number of research subjects was 20 male workers. The respondent data include age, weight, height, body mass index (BMI), and work period (see Table 1).

The average age of the subjects is 23.30 ± 3.16 years, and the average weight is 67.30 ± 10.68 kg. On average, the respondents had height of 169.7 ± 5.99 cm and BMI of 23.32 ± 3.27 kg/m². They mostly had worked there for 310 ± 2.24 years. Based on age, weight, height, and BMI, the respondents are

Table 1. The Results of the Characteristic Test of Research Subjects at TBS Textile Factory in 2021

Variable	Mean	SD
Age (years)	23.30	3.16
Weight (Kg)	67.30	10.68
Height (Cm)	169.7	5.99
BMI (kg/m ²)	23.32	3.27
Work experience (years)	3.10	2.24

in a normal category. They are in moderate category if seen from the work period.

Fatigue before Occupational Health and Safety Procedures Applied

To determine the distribution of the data, the Shapiro Wilk test was utilised. Since the data were abnormal ($p < 0.05$), then the Wilcoxon Signed Ranks test was used. The results of the testing are presented in Table 2.

The average fatigue level before work without occupational health and safety procedures was 52.05 ± 0.846 . Meanwhile, the average level of fatigue before work with occupational health and safety procedures applied was 51.06 ± 0.846 .

Fatigue after Occupational Health and Safety Procedures Applied

The Shapiro Wilk test showed abnormal data ($p < 0.05$), and then the Wilcoxon Signed Ranks test was used to figure out the level of fatigue (see Table 3).

Table 2. Fatigue before Occupational Health and Safety Procedures Applied at TBS Textile Factory in 2021

Subject Group	N	Mean	SB	Different Mean	Value Z	Value P
Pre WO OHS	20	52.05	0.846	0.00	-1.267	0.205
Pre OHS	20	51.06	0.846	0.00	-1.267	0.205

*WO OHS : Without Occupational Health and Safety Procedure

*OHS: Occupational Health and Safety Procedure

Table 3. Fatigue after Occupational Health and Safety Procedures Applied at TBS Textile Factory in 2021

Subject Group	N	Mean	SB	Different Mean	Value Z	Value P
Post WO OHS	20	81.74	2.56	17.81	-3.92	0.00
Post OHS	20	63.93	1.85	17.81	-3.92	0.00

*WO OHS : Without Occupational Health and Safety Procedure

*OHS: Occupational Health and Safety Procedure

The average level of fatigue after work without occupational health and safety procedures applied was 81.74 ± 2.56 , and the average level after work with occupational health and safety procedures was 63.93 ± 1.85 .

Difference in Levels of Fatigue before and after Occupational Health and Safety Procedures Applied

The overall data were tested using the Shapiro Wilk test. It showed that the data were normally distributed ($p > 0.05$). Thus, the t-independent test was used to find the difference in levels of fatigue (see Table 4).

The average difference in level of fatigue before occupational health and safety procedures applied is 30.59 ± 2.57 , and the average difference in level of fatigue after occupational health and safety procedures applied is 12.87 ± 2.15 . From these two results, there was a decrease in levels of fatigue by 17.72 or 40.77%. In other words, levels of fatigue before and after occupational health and safety procedures applied were significantly different ($p < 0.05$).

DISCUSSION

Characteristics of Research Subjects

A mean age of the respondents was 23.30 ± 3.16 years which are the productive age. Performing activities needs optimal physical strength. A person's physical capacity is directly proportional to age, especially at 25 years. When a person reaches the age of 50-60 years, muscle endurance decreases by

Table 4. Difference in Level of Fatigue before and after Occupational Health and Safety Procedures Applied at CV. TBS in 2021

Subject Group	N	Mean	SB	Different Mean	Value t	Value P
Difference PrePost WO OHS	20	30.59	2.57	17.72	33.70	0.00
Difference PrePost OHS	20	12.87	2.15	17.72	33.70	0.00

*WO OHS : Without Occupational Health and Safety Procedure

*OHS: Occupational Health and Safety Procedure

25%, and sensory ability decreases by about 60% (Prawajianto, Hartanti and Ma'rufi, 2016). Workers observed were in the productive age and still capable of doing work at its finest.

The average body weight was 67.30 ± 10.68 kg, and the average height was 169.7 ± 5.99 . Body weight is one aspect of anthropometry that determines the capability of doing activities. Fulfilling the nutritional needs of workers could be realised by implementing occupational health and safety procedures at work. With ideal body weight, workers can perform activities optimally, especially physical ones. Having said that, age and weight could be factors contributing to the risk of fatigue.

The mean body mass index (BMI) of the respondents was 23.32 ± 3.27 kg/m². According to the Ministry of Health Republic of Indonesia (2003), the normal BMI for men is around 18.5 to 25 kg/m². Several factors, namely age, gender, genetics, diet, and physical activity, can affect BMI (Asil *et al.*, 2014). According to the Asia Pacific criteria, overweight people have a BMI of 23-24.9 kg/m², and obese people have a BMI of 25 kg/m². Meanwhile, according to the Indonesian Ministry of Health, a person is categorised as overweight if their BMI > 25 and obese if their BMI > 27 (Ministry of Health Republic of Indonesia, 2003). BMI is an indicator of body fat. If BMI is below 18.5 kg/m², it will be categorised as very thin (underweight). Above 25.0 kg/m², it is said to be obese (overweight) due to excessive accumulated fat. Waldani stated that bus drivers who experience more fatigue have an abnormal BMI (86.1%). To conclude, age, weight, height, and BMI could trigger the risk of fatigue (Waldani, 2020).

The average work period of the respondents was 3.10 ± 2.24 years. It is very influential on workers' careers since their competence in doing work is dependent on their work experience. According to Kasmir, performance is the result of a person's work and work behaviour in one period (Kasmir, 2016). The longer a person works, the more developed their rational thinking is (Ramdan, Candra and Fitri., 2018). In other words, workers who have worked for longer years are familiar with the work procedures and how to tackle work problems. Performance can be measured from its ability to complete the tasks and responsibilities. Work experience has also been shown to have a positive effect to employee performance (Situmeang, 2017). Laniwidyanti stated the same thing that the experience of work

has a positive effect on employee performance (Laniwidyanti, 2010).

Fatigue before Occupational Health and Safety Procedures Applied

Fatigue is a significant problem in modern society, largely because of high workplace demands, long duty periods, disrupted circadian

rhythms, social and societal demands, and insufficient sleep (Sadeghniaat-Haghighi and Yazdi, 2015). Fatigue is a subjective, unpleasant symptom which incorporates total body feelings ranging from tiredness to exhaustion, creating an unrelenting overall condition which interferes with an individual's ability to function in their normal capacity (Bridger, 2017).

The average fatigue level before work without occupational health and safety procedures was 52.05 ± 0.846 . Meanwhile, the average level of fatigue before work with occupational health and safety procedures applied was 51.06 ± 0.846 . This shows that there is no significant difference before work on the aspect of worker fatigue either work with conventional procedures or with occupational safety and health procedures. It can also show that before the research was conducted, worker fatigue was in same range.

Fatigue at TBS textile factory is caused by monotonous manual and physical work. Perwitasari and Tualeka stated that monotonous work that is done repeatedly causes fatigue (Perwitasari and Tualeka, 2017). Fatigue can be overcome in various ways according to the cause. Tarwaka said that one way to overcome fatigue is by ensuring how each fatigue that appears does not become chronic (Tarwaka, 2015). The chosen way to deal with work fatigue that occurs in the workforce at TBS textile factory is by applying work methods based on occupational health and safety.

Fatigue after Occupational Health and Safety Procedures Applied

The average level of fatigue after work without occupational health and safety procedures applied was 81.74 ± 2.56 , and the average level after work with occupational health and safety procedures was 63.93 ± 1.85 .

This shows that there is a difference in fatigue after work between occupational safety and health procedures and conventional procedures. Fatigue after working with the application of

the occupational health and safety procedures is lower than working with conventional procedures. Statistical analysis shows occupational health and safety procedures is able to reduce worker fatigue.

There are several factors that affect worker fatigue, one of which is work procedures. Choosing the right work procedures during work can reduce musculoskeletal complaints and work fatigue, so that workers can be more productive at work (Negara, Suadnyana and Astutik, 2021). Increased productivity will be achieved if all components in the work system are designed properly (Negara, Adiputra and Sutjana, 2020).

Difference in Levels of Fatigue before and after Occupational Health and Safety Procedures Applied

The difference in levels of fatigue before and after work without occupational health and safety procedures is 30.59 ± 2.57 , and the difference in levels of fatigue before and after work with occupational health and safety procedures is 12.87 ± 2.15 . Overall, it indicates a decrease in levels of fatigue by 40.77%. The difference in levels of fatigue was significant ($p < 0.05$). It implies that occupational health and safety procedures can reduce worker fatigue. Differences in work performance with or without occupational health and safety procedures are presented in the Figures 2 until Figure 5.

Work fatigue is part of common problems that are often encountered in the workforce. Fatigue

can affect the health of the workforce and reduce productivity (Indrawati and Nufus, 2018). Fatigue and musculoskeletal complaints are the results of improper postures during work. Choosing the right work procedures during work can reduce musculoskeletal complaints and work fatigue, so that workers can be more productive at work (Negara, Suadnyana and Astutik, 2021). In order to conduct physical activities, workers need to consider occupational health and safety procedures which reduce the risk of work sickness, long work hours, and slow production.



Figure 3. Work Performance without Occupational Health and Safety Procedures



Figure 2. Work Performance without Occupational Health and Safety Procedures



Figure 4. Work Performance without Occupational Health and Safety Procedures

Lerman *et al.* (2012) also stated safety and productivity in the workplace are intimately related to worker health. A workplace may have chemical, physical, biological, and/or psychosocial hazards that have the potential to impact physical and psychological wellbeing. How these hazards are managed in the workplace is key. A workplace in which these hazards are well-controlled, with an active culture of health and a supportive work environment, can enhance worker health and



Figure 5. Work Performance without Occupational Health and Safety Procedures

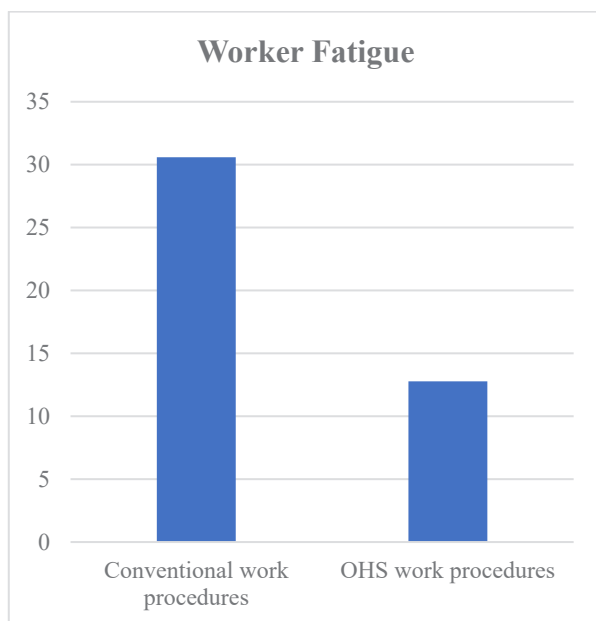


Figure 6. Decreased Worker Fatigue in TBS Textile Factory

wellbeing, both on and off the job. Healthier employees result in fewer health claims, better safety records, and greater productivity (Lerman *et al.*, 2012)

Research conducted by Susanta, Purnawati and Adiatmika shows redesign of ergonomic X-ray tube handle can significantly reduce general fatigue by 22.38% in radiographers at Sanglah Hospital (Susanta, Purnawati and Adiatmika, 2017). Suarjana, Adiatmika and Adnyana also found a similar finding that redesign of coconut grater could reduce fatigue by 25.98% (Suarjana, Adiatmika and Adnyana, 2018). Another study also found it reduces fatigue up to 25.91% by ergonomic-based redesign of broomsticks of street sweepers in Denpasar city (Palilingan *et al.*, 2009). Kodrat recommends to promote an ergonomic work environment to reduce worker fatigue (Kodrat, 2011). Fatigue score reduction data are presented in Figure 6:

Well-rested and alert employees are essential to a safe and productive operation. Almost everyone experiences some degree of fatigue from time to time. However, excessive fatigue at work is an important condition where the interplay between health, safety and productivity can create a vicious or virtuous cycle (Lerman *et al.*, 2012). To avoid this, one of the things that can be done is to apply proper work methods so that employees can work productively and healthily. The procedure applied in this study, especially for workers in the dyeing section of woven fabrics at TBS textile factory is the application of occupational health and safety procedures, where the results statistically reduce worker fatigue in the dyeing process by 40.77%.

CONCLUSION

Based on the result of application of occupational health and safety procedures it can significantly reduce worker fatigue in the dyeing process by 40.77%. From these results, the researchers hope that the management of the TBS textile factory can apply occupational safety and health procedures to the fullest, so that workers' rights, especially informal workers, to a safe working environment and good occupational health can be fulfilled.

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