

Analysis of Physical Environmental Factors at Manufacturing Laboratories

Qomariyatus Sholihah^a, Annisa Yossi^b, Sylvie Indah Kartika Sari^c, Alvin Arie Wibowo^d, a,b,c,dJurusan Teknik Industri, Universitas Brawijaya, Jl. Mayjen Haryono 167, Malang 65145, Indonesia, Email: [a^aqomariyatus@ub.ac.id](mailto:aqomariyatus@ub.ac.id), [b^bannisa.yossi13@gmail.com](mailto:annisa.yossi13@gmail.com)

The physical work environment is everything that surrounds workers and that can affect the carrying out of assigned tasks, such as lighting, air temperature, movement space, security, cleanliness, etc. This study analyses environmental factors that have not met governmental standards in the laboratories in the Faculty of Engineering, University Brawijaya. Based on the Regulation of Indonesia's Minister of Health Number 70 of 2016 concerning Standards and Health Requirements for the Industrial Work Environment regarding physical factor requirements, lighting capacity must be higher than 200 lux, however, at the Faculty of Engineering, the manufacturing laboratories lights' are only 91.8 lux. Analysis is carried out with a SWOT and a Fishbone Diagram. A SWOT analysis is an evaluation of all strengths, weaknesses, opportunities, and challenges, which relate to an object, while a fish bone diagram will explain the problem and its control so that an assessment can be given to minimize the danger that exists in the Faculty of Engineering Laboratories at Brawijaya University.

Key words: *Physical work environment, fishbone, work health & safety, laboratory, SWOT.*

Introduction

The development of industry requires work activities to be carried out to process raw materials, using machinery, equipment, and other processes to obtain a useful product that can be used by the community. Consequences can arise from the use of modern technology or machinery in work activities, one of which is noise. Noise itself has quite a broad influence, starting from the disruption of communication to even experiencing disability due to loss of hearing power. Noise not only affects the quality of work but also affects the workforce. Other physical



environmental conditions also need to be considered, namely temperature, lighting and pressure in a work environment.

The Law of the Republic of Indonesia No. 13 of 2003, articles 86 and 87, explain that every worker has the right to good health, and self-protection. A company must apply K3 management techniques to create smooth and safe work activities. Inadequate physical environments can result in a lower level of work productivity, inefficient work results and the waste of funds (Widiastuti, 2011). The physical conditions of the work environment can pose direct or indirect hazards for occupational health and safety. The low quality of a work environment can cause non-productive pressure on workers that then creates events that disrupt work activities (Oesman, 2014).

A good physical environment can positively impact health, but if the environment is not ideal, it can be the cause of several disorders, namely: heat related illness caused by undue heat temperatures, air pressure that is too high which can cause oxygen poisoning or carbon dioxide, lighting that is not ideal can cause eye disorders that can also damage a person's concentration, and hearing loss due to noise (Noise Induced Hearing Loss / NIHL).

There are 65 laboratories at the Faculty of Engineering, University Brawijaya, some of which carry out work processes to process raw materials into finished goods. After a survey was conducted, the results identified that some practitioners who hot and some felt noise. Arising from this, the writer wants to examine whether the UB Faculty of Engineering laboratory has implemented ideal physical environment factors, in accordance with the Minister of Health's Regulation.

Research Purpose

This study aims to find out what the physical environmental factors are that cause the laboratory to not be in accordance with the Law.

Research Limitation

Limitations of this study are as follows:

- 1 The object of research was conducted at the Laboratory of the Faculty of Engineering, University Brawijaya
- 2 Problem was identified using the Root Cause Analysis (RCA) method.

Literature Review

This section will discuss the theories in this research.

Occupational Health and Safety

In general, accidents are always interpreted as "unexpected events". In actuality, every work accident can be predicted if the actions and conditions that led to it were not aligned with preset requirements (Bennet N. B. Silalahi, 1995: 40). Accidents were previously considered to be God's will, therefore people affected by the accident accepted it as fate or destiny. Heinrich was the first to observe an accident, he concluded that accidents have certain sequences (Syukri Sahab, 1997: 7).

Permenaker No. 03 / MEN / 1998, regarding procedures for reporting and examining accidents, states that an accident is an unexpected event that can cause human casualties and/or damage to property (Association of Occupational Safety and Health Regulations, 2004: 88). According to M. Sulaksomo (1997) in Gempur Santoso (2004: 7) accidents are unexpected and undesirable events that disrupt the process of an activity that has been arranged. Another definition of accidents is an unexpected event, they are unexpected because there was no intention behind the incident, especially in the form of planning (Suma'mur PK., 1989: 5).

Work accidents are those related to work relationships. A work relationship can mean that the accident occurred because of work or when carrying out work. Work-related accidents can be expanded in scope, so sometimes they can include labor accidents that occur during travel, or transport to and from work (Suma'mur PK., 1989: 5).

Occupational Health

According to the Joint ILO / WHO committee in Syamsuddin (2004), occupational health is defined as efforts to: maintain the highest degree of physical, mental and social conditions of workers in all types of work, prevention of work disruption, and protection of workers from factors that interfere with the health and maintenance of the worker.

Work Safety

Philosophically, K3 is an effort and thought to guarantee the wholeness and perfection of the body or the human spirit in general and the workforce in particular as well as the work and culture of humans.

Scientifically K3 is defined as the science of applying technology about the prevention of work accidents and occupational diseases. From the legal aspect, K3 is a collection of laws and regulations governing the protection of occupational health and safety. Through clear rules and strict sanctions, OSH protection can be upheld, for this reason laws and regulations governing

OSH are needed. Even at the International level, it has been agreed that there are conventions that regulate OHS universally in accordance with the development of Science and technology, both issued by world organizations such as the ILO, WHO, and at the regional level.

Environmental Work

According to (Simanjuntak, 2003; 39) the work environment can be understood as the overall tasks faced, surrounding work environment, work methods, and the effects of the work. According to Mardiana (2005; 78) the work environment is an environment where employees do their daily work. According to Sedarmayanti in Wulan (2011; 21), in general the type of work environment is divided into two categories, namely physical work environment factors and non-physical work environment factors.

Physical Environmental Factor

According to Munandar (2001), physical working environment conditions include everything from parking facilities outside the company building, location and design of the building, and the amount of light or sound that impacts the work space. Specific physical work environment factors include:

- **Illumination (illumination)**
Dazzling rays are a factor that reduces visual efficiency and increases eye strain. Some factors that need to be considered in illumination are the level (intensity) of light, distribution of light, and dazzling rays.

- **Colors**
The use of the right color or color combination, will increase production, reduce accidents and errors, and increase morale.

- **Noise (noise)**
In today's life, too much noise is a complaint that is commonly heard. According to McCormick (Munandar, 2001), noise affects the level of work performance on tasks that require high alertness, multiple mental tasks, tasks that require skill and speed, and tasks that require high level of perceptual ability.

- **Music at work**
Music has a good influence on jobs that are simple, routine and monotonous, whereas in jobs that are more diverse and require high concentration on the job the effect can be very negative.

- **Lighting**

Proper lighting is an important consideration in a hospital's physical facilities. Successful execution of work requires good lighting. Sunlight cannot be perfectly arranged according to people's desires, especially in large buildings with less windows, natural light cannot penetrate completely. If arranged properly, lighting will provide appropriate conditions in dark work spaces or night work. Man-made lighting can be divided into four types, namely:

- **Direct light**

This light emits directly from the source towards the surface of the table. When using ordinary lights, this light is very sharp and the shadows that are caused are very firm. This light quickly tires the eyes and dazzles the workers. The radiance is high, the shadows are sharp and the ceiling generally becomes dark. Usually this is the least preferred light.

- **Half direct light**

This light emanates from its source through a lampshade which is usually made of glass that is colored like milk. This light is scattered, so the shadows that are generated are not so sharp. However, most of the light still directly falls to the surface of the table and bounces back toward the worker's eyes, so this is still not satisfying even though it is better than direct light.

- **Half indirect light**

This illumination occurs from light which is largely reflected from the ceiling and walls of the room, partly emitted through a glass covering. This light is better than half indirect light because the nature and shadows created are not so

- **Indirect light**

This source of light emits towards the ceiling of the room, then is reflected toward the table. This gives soft light and does not provide sharp shadows. In fact, the ceiling is a source of light for the workspace, therefore the ceiling has high reflections. The nature of this light is really soft, it does not cause eye fatigue because the light is spread evenly in all directions. This lighting system is the best lighting system (Gie, 2000).

Sound

Sound is a form of energy that can be heard. Sound is produced by objects that vibrate. All vibrations can produce sound. Example of sound sources include, engine sound (eg motor vehicle engines, diesel engines), collisions between objects, and human sounds.

The narrow definition of sound is something that can be heard. More specifically, sound is a longitudinal wave that propagates through solid, liquid and gas mediums. Sound can be divided into three categories based on frequency, namely:

1. Infrasound

Infrasonic sound is sound whose vibrational frequency is below 20 Hz ($f < 20 \text{ Hz}$). This sound cannot be heard by humans but can be heard by animals.

2. Audiosonik

Audiosonic sound is sound that can be heard by humans. It is within the frequency range of 20 Hz to 20,000 Hz ($20 \text{ Hz} < f < 20,000 \text{ Hz}$)

3. Supersonic

Sounds in the frequency range above 20,000 Hz ($f > 20,000 \text{ Hz}$). Only a few animals can hear these sounds; humans cannot hear it.

Decibels (dB)

Decibels are often used as reinforcement scales in electronic circuits such as circuits in audio and communication equipment. Decibel reinforcement scales include power, voltage, current and sound intensity. Decibels are units that describe a ratio. Decibels are often abbreviated as "dB", and can be interpreted as "a comparison of two logarithmic scales".

Loud level

According to the Decree of the Minister of the Environment number 48 of 1996, "unwanted noise is noise from the air or activities in a certain level and at a time that can cause disruption of human health and environmental comfort". Noise level is a measure of sound energy expressed in decibels (dB). Noise has a standard which prescribes the maximum noise level that is allowed to be discharged into the environment from businesses or other activities, so as not to cause disruption to human health and environmental comfort.

Temperature

According to (Wignjosoebroto; 2008), a good temperature range in the workplace, one which provides high work productivity, is 24°C - 27°C. The effect of temperature levels on the human body are as follows:

± 49°C: Temperature can be held for about an hour, but is far above the level of normal physical and mental abilities

± 30oC: mental activity and responsiveness begin to decrease and there is a tendency to make mistakes.

± 24o C: Optimum Conditions.

± 10oC: Extreme physical behavior begins to emerge.

Research method

Data collection was carried out by interviewing students of the Department of Engineering, University Brawijaya.

Retrieval of data was done through a lux meter in the laboratory. The data that was taken is then compared with the Minister of Manpower Regulation number 5 of 2018, concerning occupational safety and health in the work environment.

Result and Discussion

The following is the data obtained from Laboratory X at the Faculty of Engineering, University Brawijaya.

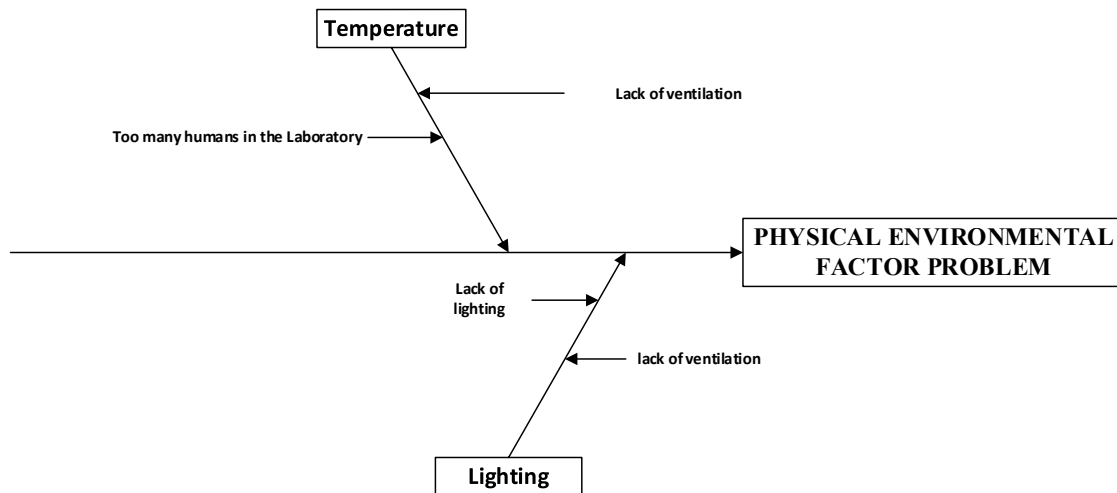
Table 6.1: Measurement of the physical working environment of the engine parts

Physical Working environment	Measurement	NAB	Information
Lighting	91,8 Lux	100 Lux	Under NAB (Too Dark)
Temperature	30° Celsius	28°C	Above NAB (Too Hot)

From the data obtained it can be seen that Laboratory X is too dark and the temperature is too high. In Laboratory X, adding lighting lamps can increase lighting. For temperature, work shifts at Laboratory X at University Brawijaya, should allow for recovery and should be no more than four hours.

From these considerations a fish bone diagram is made as shown below:

Gambar 6.1. Fishbone Diagram



After the fishbone diagram was made then a swot analysis is completed to find out what are the strengths, weaknesses, opportunities, and threads.

Table 6.3: SWOT Analysis

<p>Strength There is already lighting and air circulation.</p>	<p>Weakness Lighting installations and air circulation media are inadequate and do not reach national standards.</p>
<p>Opportunity There is room to be able to add installations to achieve national standards</p>	<p>Thread Filing complicated funding. The time that must be allocated for renovation is difficult to obtain because active laboratories are used daily.</p>

Conclusion

Laboratory X at University Brawijaya is too dark and the temperature is too high. In Laboratory X, adding lighting lamps can increase lighting. For temperature, work shifts at Laboratory X at University Brawijaya, should allow for recovery and should be no more than four hours. The addition of air circulation can also be done to reduce humidity levels. These suggestions can be applied to reduce problems in the laboratory.



REFERENCE

- Ali, H. E. (2017). Phase Transfer Synthesis of Novel Based Surfactants: Role of Biocorrosion Inhibition. *Global Journal of Social Sciences Studies*, 3(1), 43-55.
- Al-Faritsy, Ari. & Nugroho, Yohannes. (2017). Effect of Physical Work Environment and Operators for Determining Work Break Time. *JITI*, Vol. 16 (2), Dec 2017, 108-114
- Ata, Seda. Deniz, Aysegul & Akman, Berrin. (2012) The physical environment factors in preschools in terms of environmental psychology: a review. *Procedia - Social and Behavioral Sciences* 46 (2012) 2034 – 2039
- Sholihah, Qomariyatus (2015). Analysis of Work Shift, Working Period, and occupational Health and Safety Culture with Lung Function of Coal Mine Workers. *Jurnal Kesehatan Masyarakat Nasional* Vol. 10 No. 1
- Sholihah, Qomariyatus (2018). *Construction Safety and Health*. Poor; UB Press
- Yazdanfar, Seyed & Nazari, N. (2015) Proposed Physical-Environmental Factors Influencing Personal and Social Security in Residential Areas. *Procedia - Social and Behavioral Sciences* 201 (2015) 224 – 233