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Lighting Factor Analysis to Reduce Employee Eye Fatigue Using an Ergonomic Approach

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ABSTRACT

PT Semen Gresik is a company that produces cement with various units. The problem that exists in production planning and control of office space is that the intensity of lighting in the office space does not comply with the SNI Lighting standards. 16-7062 2004 for 350 lux office space. This can cause eye fatigue which can affect the condition of employees at work. Measurement of eye fatigue using the Visual Fatigue Index (VFI) questionnaire. The purpose of this study was to determine the factor of lighting intensity on employee eye fatigue. The analysis used is quantitative. The subjects of this study were all employees of the production planning and control work unit of PT Semen Gresik, totaling 5 people. The independent variable is the intensity of lighting in the work environment, and the dependent variable is eye fatigue, and the results of calculating the need for lamps require 8 lamps with a power of 36 watts and a white/daylight color temperature to achieve standard room lighting.

INTRODUCTION

One of the qualities of a company is influenced by employee performance. Employee performance is influenced by 2 factors, including internal and external factors. Internal factors are knowledge, skills, abilities, work motivation, personality, attitude, and comfort at work. External factors are the nature of management, the relationship between superiors and subordinates, and the work environment in which employees work (Novriani Gultom and Nurmaysaroh, 2021). According to data on changes in the working population based on employment in 2021 (Statistics, 2021) workers in Indonesia, especially in the processing industry, increased by 1.22 million people. Based on the increase in the number of workers, employee productivity needs to be considered. One of the factors that influence is the comfort factor, namely the comfort of the eyes in the room sourced from lighting (Widiyantoro, Mulyadi, and Vidiyanti, 2017). A comfortable situation makes workers feel healthy, and feel at home doing activities (Nurmianto, 1996) and (Mutia, 2016).

The intensity of lighting is divided into two, namely, natural lighting and artificial lighting. Natural light

comes from direct sunlight, diffused light from the sky, and reflected light from the environment. While artificial lighting is lighting that does not include natural light sources such as candles, gas lamps, oil lamps, etc. (Isfiaty, 2015). According to (Irianto, 2006), each room requires a different intensity of lighting according to the use and activities in the room. According to (Juningtyastuti, 2012) the quantity and quality of good lighting, among others, are determined by the ratio of lighting in the room and light reflection.

According to Pheasant (1991) and (Fadhillah, 2013), eye fatigue is eye strain or visual effects caused by the use of the eyes at work that requires the ability to see for a long time, accompanied by an uncomfortable view. Fatigue of the eye muscles and nerves is caused by excessive tension, can increase workload, get tired easily, lose working hours, take frequent breaks, decrease job satisfaction, decrease production quality, increase error frequency, inhibit concentration and reduce labor productivity. One of the effects of eye fatigue is stress load because poor lighting can result in eye fatigue with reduced work effectiveness (Suma'mur, 1993) and (Septiansyah, 2014).

PT. Semen Gresik is a company that produces cement. PT Semen Gresik has various units, one of which is a production plan and control unit whose task is to plan and evaluate work processes. The problem that exists in the production plan and control office space is the intensity of the lighting in the office space is not under the SNI Lighting Standard. 03-6197-2000 for an office space of 350 lux.

Lighting problems in the production plan and control room of PT Semen Gresik that are not under SNI standards can cause eye fatigue which can affect the condition of employees at work. Because the effect of low light intensity on worker performance is the decrease in employee productivity at work. Therefore, eye fatigue was measured using a Visual Fatigue Index (VFI) questionnaire to determine the intensity of lighting according to the condition of the employee. Then the number of lamps needed was calculated as an effort to standardize room lighting so that it can increase employee productivity at work.

RESEARCH METHOD

The method of research used is quantitative research. The quantitative method is a research method based on concrete data, research data in the form of numbers that will be measured using statistics as a calculation test tool, related to the problem being studied to produce a conclusion (Sugiyono, 2018). 5 respondents were given an Eye Fatigue Measurement questionnaire. then the results of the questionnaire from the respondents were tested for validity and reliability with statistical analysis. The lighting measurements were carried out 9 times for 3 days with 4 measurement points using a lux meter. Elaboration of lighting changes is carried out in the morning, afternoon, and evening. this is based on that at the three times of the day, there is a change in the position of natural light from the sun. Ethical approval was obtained because data collection was carried out when the researcher received an MBKM internship scholarship from the government program. The expected hypothesis in this study is whether there is an effect of lighting on workers' eye fatigue. The stages of the research will be described in the form of a flowchart. The sequence of research stages can be seen in Figure 1.

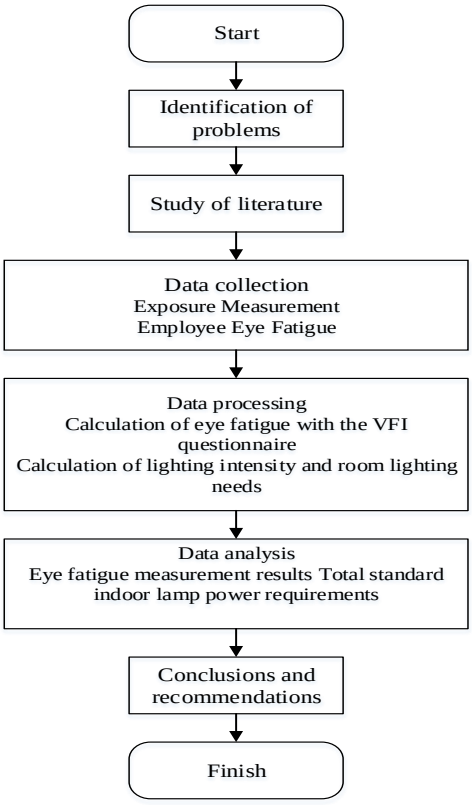

Figure 1. Research Flowchart

RESULTS AND DISCUSSION

1. Lighting Intensity Measurement

Taking the lighting measurement points based on the rules for measuring the intensity of lighting in the workplace SNI 16-7062-2004 with a room area of 56 m2. The measurement point for lighting the production plan and control unit workspace can be seen in Figure 2.

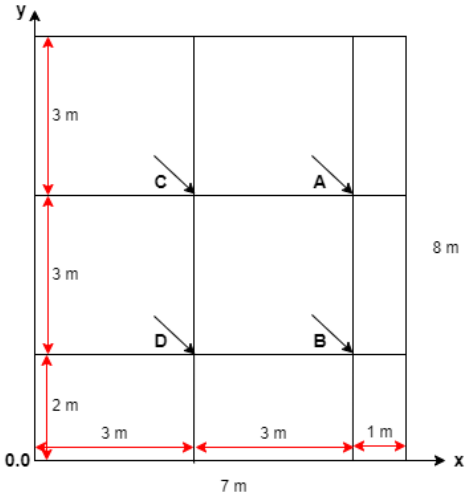

Figure 2. Point of Lighting Measurement

The results of lighting measurements using a lux meter in the production plan and control unit workspace can be seen in table 1.

Table 1. Exposure Measurement Results

No	Multiple Measurement	Measurement results (lux)				Average
		A	B	C	D	
Day 1						
1	Morning (08.00 WIB)	240	138	224	398	250
2	Daylight (12.30 WIB)	266	285	101	565	304.25
3	Evening (15.30 WIB)	220	132	65	337	188.5
Day 2						
1	Morning (08.00 WIB)	270	165	250	405	272.5
2	Daylight (12.30 WIB)	285	330	105	560	320
3	Evening (15.30 WIB)	267	180	87	345	219.75
Day 3						
1	Morning (08.00 WIB)	280	158	253	382	268.25
2	Daylight (12.30 WIB)	287	292	123	573	318.75
3	Evening (15.30 WIB)	239	143	102	355	209.75

Based on table 1, the lighting in the production plan and control unit workspace with 7 lamps with a power of 36 watts, has an average of 250 lux on the 1st day at 08.00, at 12.30 at 304.25 lux, and at 15.30 it is 188.5. On the 2nd day at 08.00 at 272.5 lux, at 12.30 at 320 lux, and 15.30 at 219.75. On the 3rd day at 08.00, it is 268.25 lux, at 12.30 it is 318.75 lux, at 15.30 it is 209.75. Based on SNI, the average lighting standard for office space is 350 lux. So it can be concluded that the lighting in the workspace of the production plan and control unit does not meet the standards or it can be said that the lighting in the workspace of the production plan and control unit is not ergonomic.

2. Data on Planning and Control Characteristics of Employee Production Units

This research has obtained two characteristics of employees consisting of:

a. Age

The percentage of employees based on age can be seen in Table 2

Table 2. Age Percentage

No	Name	Age	%
1	Sera Yunarizal	26-35	20
2	Zaenal Arifin	26-35	20
3	Hasan	≥ 46	20
4	Sulistyono	≥ 46	20
5	Sunaryo	≥ 46	20
		Total	100

Based on the table above, it can be seen that there are 3 employees aged ≥ 46 years with a percentage of 60%, and 2 employees aged 26-35 years with a percentage of 40%.

b. Work Period

The percentage of employees based on work period can be seen in Table 3

Table 3. Work Period Percentage

Work Period (year)	N	%
≥ 6 year	5	100
Total	5	100

Table 3 above can be seen that the length of service of all employees ≥ 6 years with a total of 5 employees, then the percentage is 100%

3. Eye Fatigue Measurement

Measurement of eye fatigue using VFI measurement. The following is the processing of questionnaire data:

a. Weighting

The weighting is obtained from the value of each questionnaire answer. The weighting values can be seen in table 4.

Table 4. VFI weighting

No. Question	Weighting					Amount
	Worker 1	Worker 2	Worker 3	Worker 4	Worker 5	
Question 1	2	2	3	4	3	14
Question 2	1	3	2	3	4	13
Question 3	1	3	3	3	3	13
Question 4	1	2	2	3	3	11
Question 5	1	2	2	3	3	11
Question 6	2	2	3	3	3	13
Question 7	1	2	2	3	2	10
Question 8	1	1	2	3	2	9
Question 9	1	2	1	4	3	11
Question 10	2	2	3	3	3	13
Question 11	1	2	2	4	3	12
Question 12	3	3	3	4	4	17
Question 13	1	3	2	3	3	12
Question 14	3	3	3	4	4	17
Question 15	1	3	3	3	3	13
Question 16	2	4	3	4	4	17
Question 17	2	4	3	4	4	17
Question 18	1	2	4	4	3	14
Question 19	2	2	3	3	3	13
Question 20	1	1	2	3	3	10
Question 21	1	1	2	3	2	9
Question 22	2	2	3	3	3	13
Total	33	51	56	74	68	282

b. Score Category

The score is obtained from the division of the total score of each respondent and the maximum score of 22 questions. If the value obtained is 0.4, then the employee experiences eye fatigue and if < 0.4, then the employee does not experience eye fatigue. The following is the calculation of worker score 1. The overall results can be seen in table 5.

Worker Score 1

$$VFI = \frac{Total\ of\ answers\ for\ each\ operator}{Total\ of\ higher\ coefficient\ of\ occurrence\ for\ each\ ailment}$$

$$VFI = \frac{33}{88} = 0.38$$

Table 5. VFI Calculation Results

Worker	VFI	Category
1	0.38	No Eye Fatigue
2	0.58	Experiencing Eye Fatigue
3	0.64	Experiencing Eye Fatigue
4	0.84	Experiencing Eye Fatigue
5	0.77	Experiencing Eye Fatigue

Based on the results of the interpretation of the VFI score in table 5, it can be concluded that there are 4 employees experiencing eye fatigue.

4. Calculation of Lamp Needs

The number of lamp needs is obtained from the lumen value divided by the lumen of the lamp used. The wattage of the lamp used in the room at this time is 36 watts because it is equal to 2700 lumens and if it is divided by the area of the room, which is 56 m2, it produces a value of 48.21 lux. The selected lamp color temperature is white/daylight (> 5300K) because if the illumination level is high, comfortable lighting can be created. Here is the calculation of the need for lamps:

36 *watt* = 2700 lumen

$$\emptyset = \text{Lux SNI} \times \text{Room Size}$$
$$\emptyset = 350 \times 56 = 19600$$
$$\text{N} = \frac{\emptyset}{\text{Lumens of lamp used}}$$
$$\text{N} = \frac{19600}{2700}$$
$$\text{N} = 7.26 \approx 8 \text{ lamp}$$

5. Discussion

Room lighting measurements show that the lighting in the production planning and control unit workspace is not by SNI No. 03-6197-2000 with an average value < 350 lux. One of the effects of substandard lighting is eye fatigue employees (Purnosidi, 2021). The results of distributing eye fatigue questionnaires using VTI showed that 4 out of 5 employees experienced eye fatigue. So it takes 8 lamps with a power of 36 watts, and a white/daytime color temperature to meet the standard.

The results of this research are also in line with the results of research conducted by Purwanti in 2013, which showed the lighting value in the control room production PT. XYZ is not up to KEPMENKES RI No. 1405/MENKES/SK/IX/02. Correlation calculation results show a low relationship between illumination and luminance against eye fatigue. This matter lighting was one of the factors that cause fatigue eye.

CONCLUSION

Based on the results of research that has been done in the production planning room, and the control unit . It can be concluded from PT Semen Gresik Rembang that from the results of measuring the intensity of the lighting, it is found that the lighting in the work space is less than 350 lux. Even though based on SNI No. 03-6197-2000, workspace lighting is 350 lux.

Then based on measurements of employee eye fatigue using the Visual Fatigue Index (VFI) questionnaire, there were 4 employees experienced eye fatigue out of a total of 5 employees.

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