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ANALYSIS OF ERGONOMIC LIGHTING IN THE ENGINEERING FACULTY WORKSPACE OF MURIA KUDUS UNIVERSITY

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ABSTRACT

Lighting is an important factor in working comfort. A comfortable workspace must meet good lighting requirements by the lighting standards of a workplace. Visual comfort at work is the result of applying ergonomic aspects to workspace lighting. The purpose of this research is to analyze ergonomically lighting in the workspace of the engineering faculty of Muria Suci University. The method used in this research is descriptive quantitative. Where the data collection of light measurement in the workspace is carried out at the hour (09.00-14.00 WIB). Then the data is processed using surfer software version 10 to determine the distribution of lighting. Testing is done by comparing the standardization table of lighting intensity levels based on SNI 03-6575-2001 standards. Risk data the visual comfort of the lighting at work is analyzed in terms of the level of lighting risk. The results of this study indicate that quantitative exposure risk, all work spaces of the Faculty of Engineering, Muria Kudus University does not eligible SNI 03-6575-2001. Meanwhile, based on the risk of qualitative lighting, administrative workspaces that have a low risk of visual comfort and industrial engineering study program workspaces have a high risk of visual comfort.

INTRODUCTION

The work environment is something that directly and indirectly exists in the workers' environment that can affect themselves in carrying out their activities such as workplace temperature, humidity, workplace ventilation, workplace lighting, workplace layout, workplace cleanliness, and equipment. tools available in the workplace (Isyandi, 2004). One of the factors that affect productivity at work is workplace lighting. If the lighting in the workplace is not bright enough, it will have an impact on the visual comfort of the eyes without being disturbed.

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To get visually comfortable, ergonomic aspects must be applied in the lighting of the workspace. Ergonomics is the science, art, and application of technology to harmonize or balance all the facilities used for activities and rest with all the abilities, abilities, and limitations of humans both physically and mentally so that a better overall quality of life can be achieved. (Tarwaka, 2013)

There are two types of lighting in the workspace, namely natural lighting that comes from nature, such as the sun, hot lava, phosphorus in trees, lightning, fireflies, and the moon which are secondary sources of natural light because the moon only reflects sunlight. (Satwiko, 2015) and lighting embedded by light sources other than natural light, such as lamps. Grandjean (1993) explains that lighting cannot be separated from work comfort, even though it is done in the classroom. Bad light can cause eye fatigue by reducing efficiency, complaints of stiffness in the eye area, and headaches around the eyes, and damage to the eye lenses. Large and light effects of human objects clearly, quickly without causing errors. Insufficient lighting causes the workers' eyes to become fast as they try to open wide. This will result in mental fatigue and can further cause damage (Wignjosoebroto, 2003). Lighting intensity is an aspect of the physical environment that is important for worker safety. The workplace requires sufficient light intensity to function properly and accurately. Good lighting intensity is determined by the nature and type of work where careful work requires a greater light intensity (Suma'mur, 1993). Intensity lighting records workloads will increase work productivity.

Visual comfort is a natural light connection that can help humans receive visual information without being distracted by their visual senses (Manurung, 2012). Visual comfort is one of the results obtained from workspace applications with the ergonomic aspects of flight applications. Therefore, the Indonesian National Standard number 03-6575-2001 concerning procedures for designing special lighting systems in buildings becomes a reference in the application of building lighting. SNI 03-6575-2001 states that the standard of lighting in the workspace is 350 Lux. If the lighting in the workspace meets SNI 03-6575-2001 standards, workers will get visual comfort. With other things, the lighting in the work area has fulfilled ergonomic aspects, for example, direct measurement of light intensity in each production area at PT. Lendis Cipta Media Jayad by using lux meter in the production area gets the highest lighting, which is 236 lux, but it is still not according to the standard set by the Minister of Health, which is 300 lux (Putra and Madyono, 2017). Therefore a lighting design strategy is needed by optimally utilizing natural light. The optimal lighting design includes: optimizing the number of skylights, maintaining visual comfort, and maintaining coolness, and saving energy (Wee et al., 2016)

The workspace as a space that helps in work activities has an important meaning for workers which is a factor that can affect work effectiveness and productivity. One of these factors is workspace lighting. In plain view, the lighting in the engineering faculty of Muria Kudus University is less comfortable to be accepted visually. In other words, less bright. There are 7 workspaces in the Faculty of Engineering, namely mechanical engineering department workspaces, informatics engineering workspaces, information systems department workspaces, electrical engineering department workspaces, industrial engineering department workspaces, departmental workspaces, and administrative workspaces.

Based on this background, the purpose of research in the workspace of the Faculty of Engineering, Muria Kudus University is to determine ergonomic lighting applications in workspaces that can increase work productivity. The results of research on 15 companies showed that the use of light intensity by the type of work gave an increase in work results between 4 ± 35% (Sanders and McCormick, 1987). Otherwise, poorly designed lighting will result in visual impairment or fatigue during work.

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RESEARCH METHOD

The method used in this research is descriptive quantitative. Where the research is placed as a key instrument, data collection techniques are carried out by combining and analyzing inductive data (Sugiono, 2010). Furthermore, the results of these studies generally describe a result that is not used to make broad conclusions (Sugiyono, 2005). The research stages can be seen in the following flow chart Figure 1.

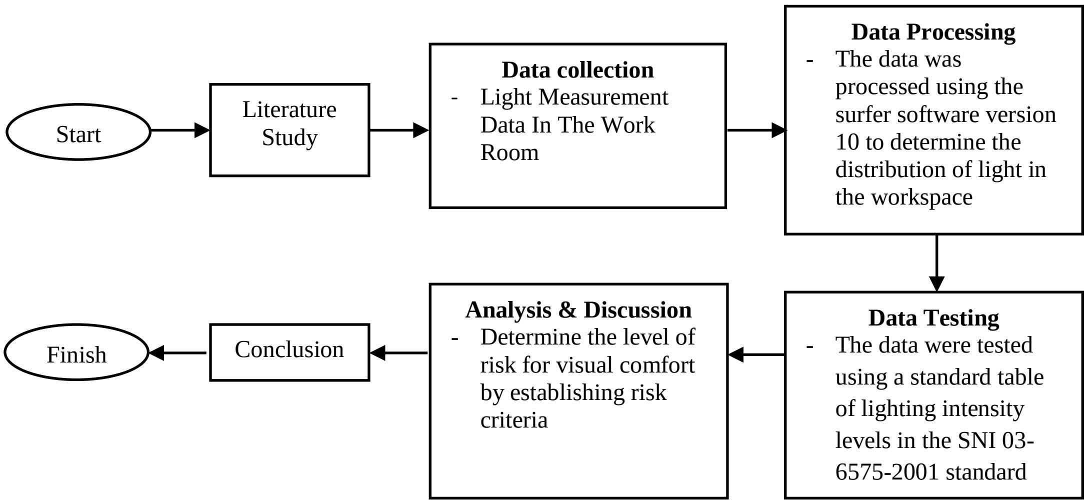

Figure 1. Research Flowchart

RESULTS AND DISCUSSION

The collection of data on light measurement in the workspace is carried out at (10.00-14.00 WIB) considering that SNI 16-7062-2004 requires an area of the workspace. From a total of 7 (seven) workspaces in the Faculty of Engineering, Muria Kudus University, each workspace has an area of 73.87 m^2, except for the workspace for the mechanical engineering study program which has a workspace of 84.88 m^2, so determining the point of measuring light intensity uses the horizontal intersection of the length and width of the pile. a station with a distance of 3 meters. The point of measuring light intensity in the workspace can be seen in Figure 2 and Figure 3.

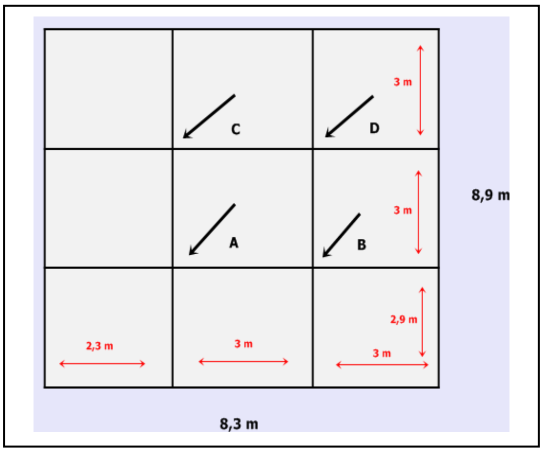

Figure 2. The Workspace Areas Of Departments In The Engineering Faculty

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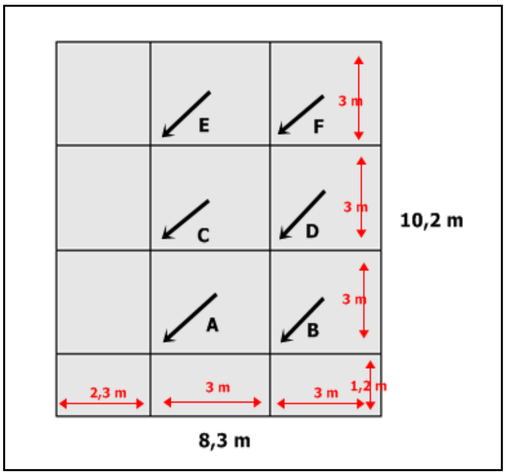

Figure 3. The Workspace area of mechanical engineering department

The results of measuring workspace lighting at the Faculty of Engineering, Muria Kudus University can be seen in Table 1.

Table 1. Workspace lighting measurement results

Department Workspace	**Measurement Average at 10.00-14.00 WIB (Lux)**
Mechanical engineering	277,11
Informatics engineering	251,25
Information system	223,58
Electrical	224,91
Industrial engineering	308,50
Dean	228,33
Administrative	134,91

Based on table 1, it can be concluded that there is high average lighting in the Industrial Engineering study program workspace of 240.67 lux. And the average lighting below is in the 97.33 lux administration workspace. Meanwhile, the workspace for the Industrial Engineering study program is 308.50 lux. And the lowest average lighting is in the administrative workspace of 134.91 lux.

The results of the measurement of work space lighting are then processed using surfer 20 software to determine the distribution of lighting in the workspace. The first step in knowing the distribution of lightning is determining the coordinate points of each workspace. There are 3 coordinate points on the x, y, and z axes. the x-axis shows the horizontal point or length of the workspace, the y-axis shows the vertical point the width of the workspace, and the z-point coordinate shows the intensity of bright light at that point. After determining the point (x, y, z), the distribution of lightning is known as shown in figure 4.

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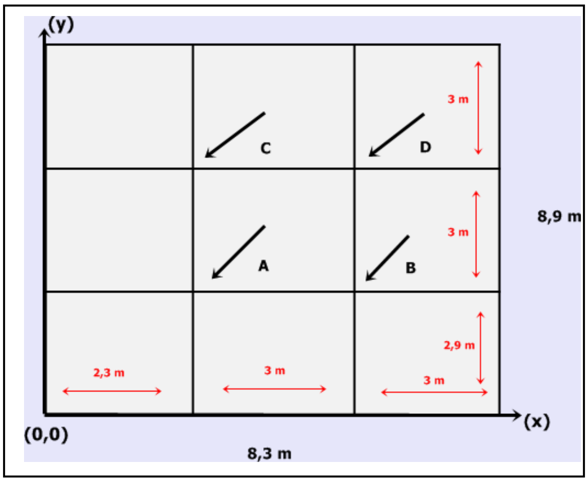

Figure 4. The coordinate point of the department's workspace area at departments in the Engineering Faculty

Table 2. Workspace coordinate points

Department Workspace	Measurement Coordinate Point at (10.00-14.00 WIB)											
	A			B			C			D		
	X	Y	Z	X	Y	Z	X	Y	Z	X	Y	Z
Informatics engineering	2	3,2	217	4	1,4	179,7	6,7	3,2	378	6,7	5,8	230,3
Information system	2	3,2	250,3	4	1,4	210	6,7	3,2	201,7	6,7	5,8	232,3
Electrical	2	3,2	190,7	4	1,4	181,7	6,7	3,2	291	6,7	5,8	236,3
Industrial engineering	2	3,2	252,3	4	1,4	287	6,7	3,2	359,7	6,7	5,8	335
Dean	2	3,2	340,7	4	1,4	309,7	6,7	3,2	75,3	6,7	5,8	187,7
Administrative	2	3,2	120	4	1,4	135,3	6,7	3,2	139,7	6,7	5,8	144,7

Table 2 above shows the coordinate point (0,0) as a reference for determining the x-axis and y-axis points. The value of the coordinate point (x) is obtained based on the horizontal length of the plane A to the X-axis. The value of the coordinate point (Y) is obtained based on the vertical width of the plane A to the Y-axis. While the z coordinate point value is obtained from the average light intensity obtained from the measurement results at 10.00-14.00 WIB.

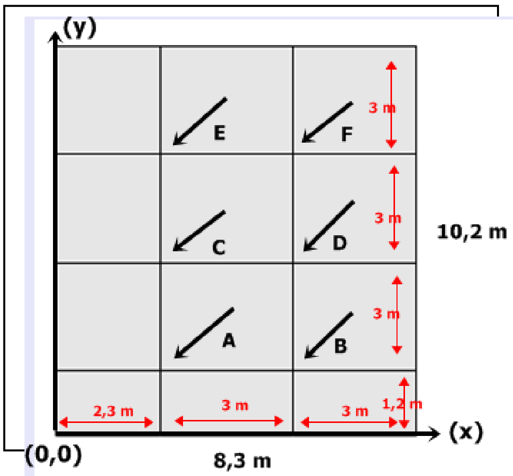

Figure 5. The coordinate point of the department's workspace area at Mechanical Engineering Department.

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Table 3. Workspace coordinate points of Mechanical Engineering Department

Measurement Coordinate Point at (10.00-14.00 WIB)	Axel	Mechanical Engineering Department
A	X	2
	Y	3,2
	Z	231
B	X	4
	Y	1,4
	Z	260,7
C	X	6,7
	Y	3,2
	Z	254,7
D	X	6,7
	Y	5,8
	Z	331
E	X	6,7
	Y	7,5
	Z	404,3
F	X	4
	Y	9,6
	Z	181

Table 3 above shows the coordinate point (0,0) as a reference for determining the x-axis and y-axis points. The value of the coordinate point (x) is obtained based on the horizontal length of the plane A to the X-axis. The value of the coordinate point (y) is obtained based on the vertical width of the plane A to the Y-axis. While the z coordinate point value is obtained from the average light intensity obtained from the measurement results at 10.00-14.00 WIB in the work room of the mechanical engineering department.

After the X, Y, and Z coordinate points are obtained, the lighting distribution in the engineering faculty workspace can be seen as follows

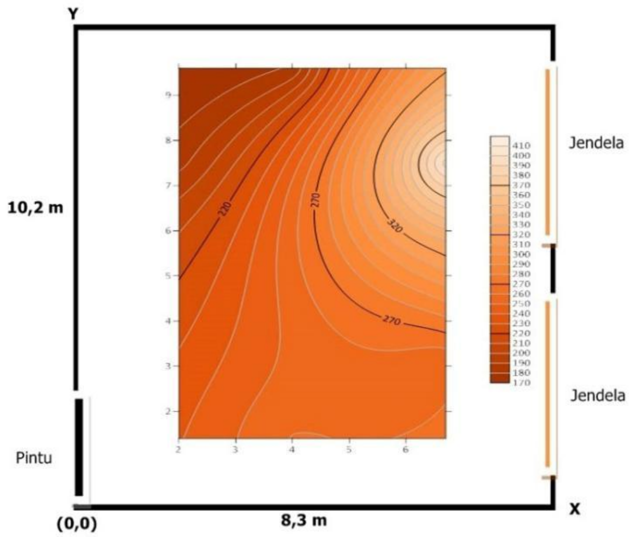

Figure 6. Lighting distribution for the Mechanical Engineering Department workspace

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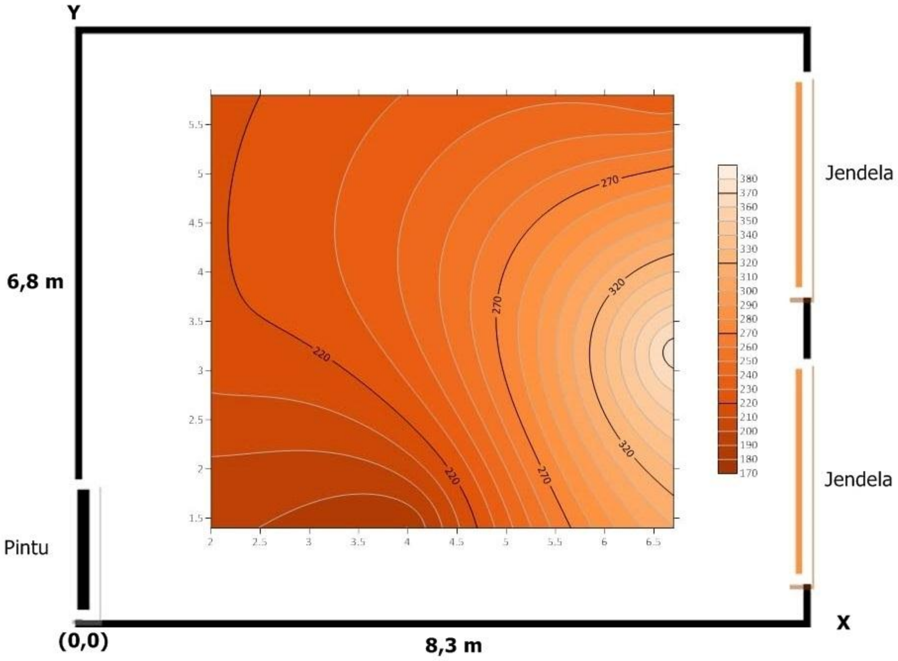

Figure 7. Lighting distribution for the Informatics Engineering Department workspace

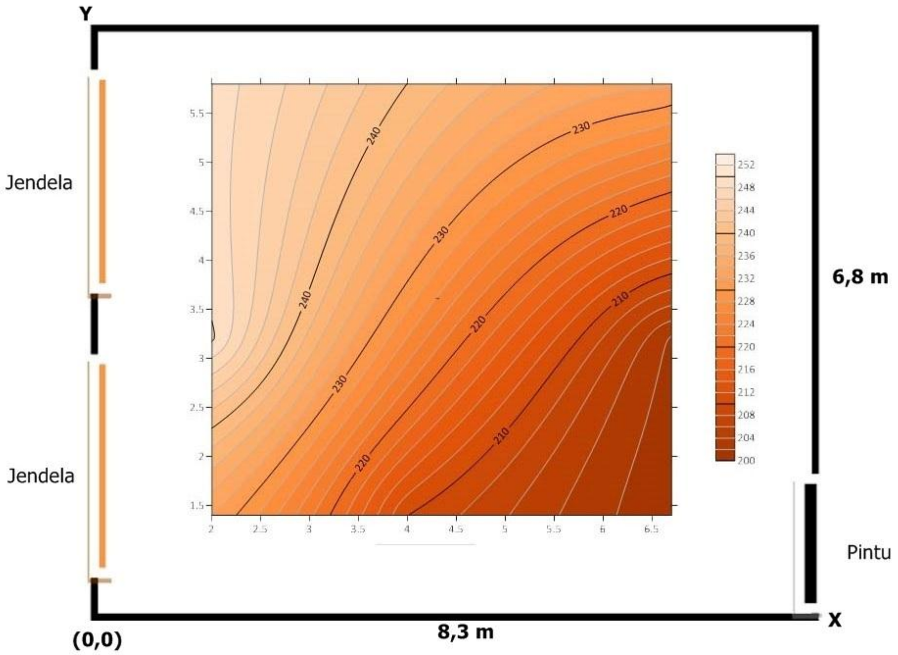

Figure 8. Lighting distribution for the Information System Department workspace

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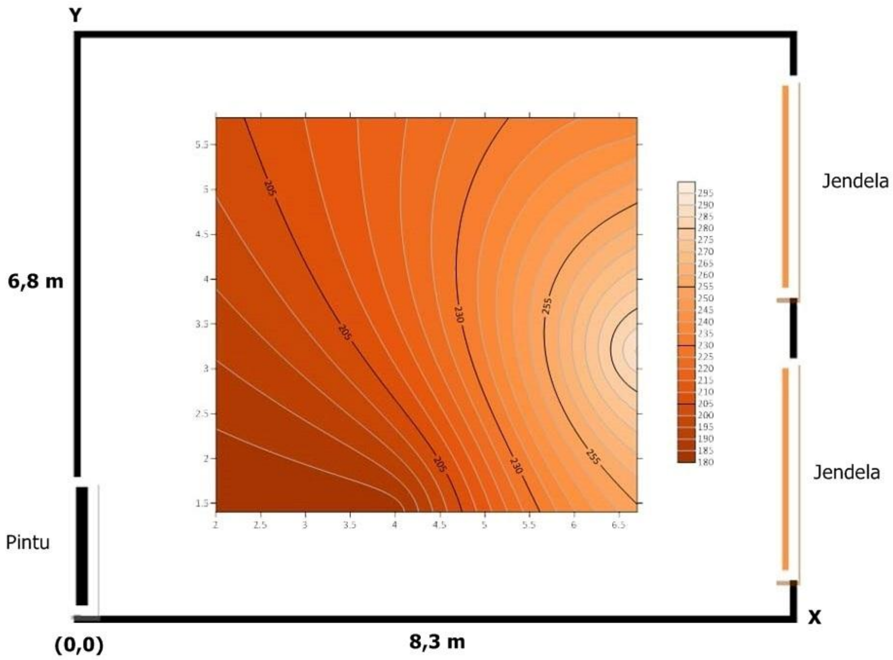

Figure 9. Lighting distribution for the Electrical Department workspace

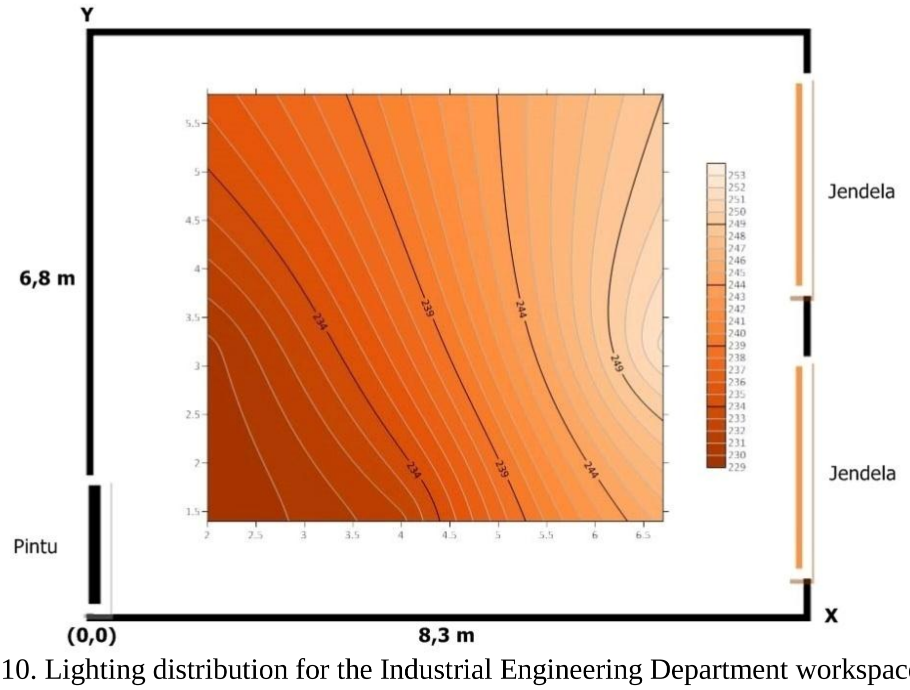

Figure 10. Lighting distribution for the Industrial Engineering Department workspace

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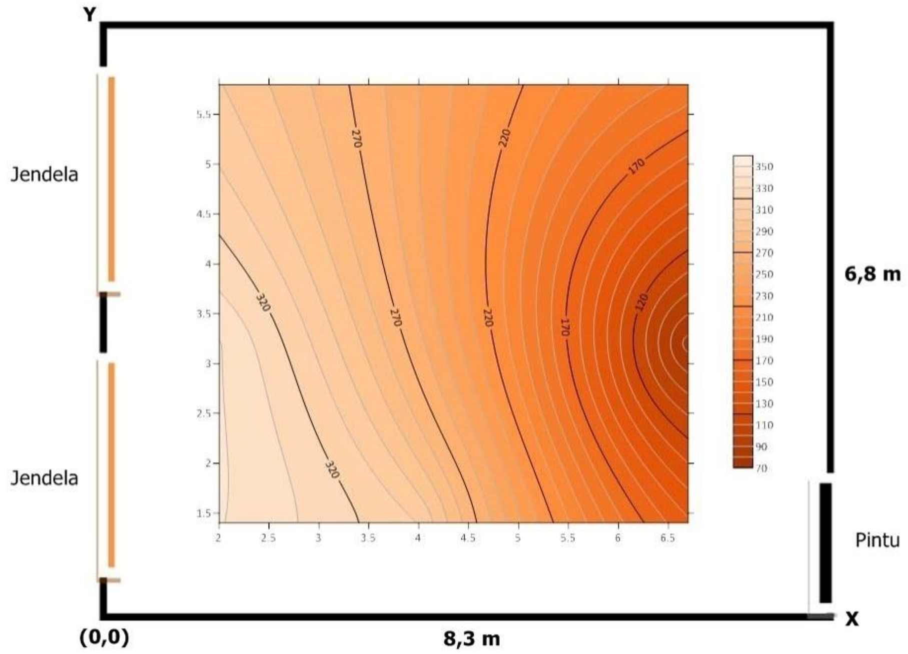

Figure 11. Lighting distribution for The Dean office workspace

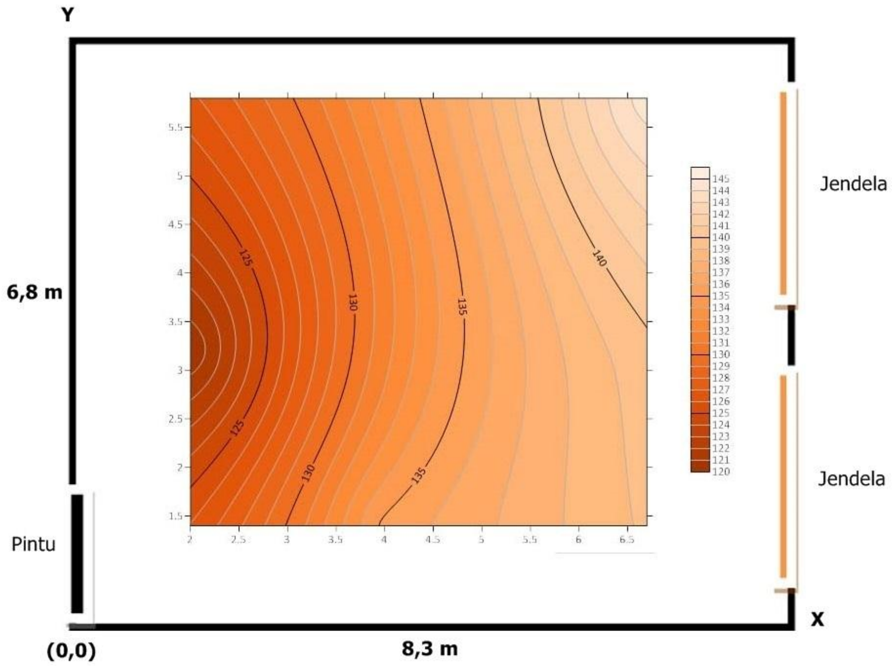

Figure 12. Lighting distribution for the Administrative workspace

Figure 6 to 12 show the distribution of lighting in the engineering faculty workspace. The distribution of lighting in the engineering faculty workspace is an illustration of lighting that enters or fills the workspace. From the distribution of lighting, it can be seen that the distribution of workspace lighting is brighter in the part that is close to the window.

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The results of lighting measurements in the workspace of the Faculty of Engineering, Muria Kudus University can be tested by comparing the lighting standards according to SNI 03-6575-2001 of 350 lux. The following table 4 shows the results of the comparison test of the workspace lighting of the engineering faculty of Muria Kudus University

Table 4. A Comparative test of workspace lighting at the Faculty Of Engineering, Muria Kudus University against SNI 03-6575-2001

Department Workspace	Average light level (Lux)	SNI 03-6575-2001 (Lux)	Result
Mechanical engineering	277,11	350	not eligible
Informatics engineering	251,25	350	not eligible
Information system	223,58	350	not eligible
Electrical	224,92	350	not eligible
Industrial engineering	308,50	350	not eligible
Dean	228,33	350	not eligible
Administrative	134,92	350	not eligible

The risk criteria will be a reference for the risk owner or the risk owner unit (UPR) in determining the level of possible livelihood and its impact on the risks that occur. Establishing criteria is essential for analyzing and evaluating the significance faced by the organization and for supporting the decision-making process (https://irmapa.org). Lighting Risk Level will affect visual comfort. Good visual comfort will increase work productivity. This is by research conducted by Michele De Carli, Valeria De Giuli, and Roberto Zecchin in 2008 with the title Review of visual comfort in office buildings and the influence of sunlight on productivity with the conclusion that if daylight is the main source of lighting, there are major increases in productivity, performance, and overall well-being

The level of lighting risk is the level of risk faced by workers to the light they receive at work. To determine the level of risk of exposure, the risk criteria are first determined. The risk criteria used in this study are quantitative (lighting level) and qualitative (comfort level). The risk criteria can be seen in Table 5.

Table 5. Lighting level risk criteria

Level	Quantitative Criteria (Lux)	Qualitative Criteria
Low	<150	Visually Uncomfortable
Medium	151-300	Less Comfortable Visually
High	>301	Visually Comfortable

Based on table 5, it can be seen that the level of lighting risk in each workspace of the Faculty of Engineering, Muria Kudus University is as shown in table 6.

Table 6. Level of risk of exposure against comfort in measurement

Department Workspace	Average light level (lux)	Risk level		
		Low	Medium	High
Mechanical Engineering	277,11		√	
Informatics Engineering	251,25		√	
Information System	223,58		√	
Electrical	224,92		√	
Industrial Engineering	308,50			√
Dean	228,33		√	
Administrative	134,92	√		

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Table 5 above shows that there are 3 levels of lighting risk to visual comfort, namely low, medium and high. for low risk level means the lighting intensity in the workspace with a value of less than 150 lux. for a moderate risk level means the lighting intensity in the workspace with a value between 151-300 lux. And for the high risk level means the lighting intensity in the workspace with a value of more than 301 lux.

The seven work spaces in the engineering faculty of Muria Suci University, there is a workspace that have a low risk levels for visual comfort, namely administrative workspaces, there are 5 work spaces that have a moderate risk level for comfort visual, namely the Dean workspace, Mechanical Engineering Department, Informatics Engineering Department, Information System Department, Electrical Department, and there is a workspace that has a high level of risk to visual comfort, namely the work space for an industrial engineering department.

The implication of this research result shows that the lighting in the workspace of the engineering faculty of Muria Kudus University is below the SNI, namely 350 lux. so that lighting in the workspace can provide discomfort at work.

CONCLUSIONS

Visual comfort receiving lighting by SNI 03-6575-2001 will provide comfort in working. comfort is one of the goals of implementing ergonomic aspects (Wignjosoebroto, 2003). The lighting in the workspace of the Muria Kudus University engineering faculty from the research results shows that it is below the value of 350 lux which means it is not by SNI 03-6575-2001. so it is necessary to make immediate changes to the lighting of the workspace. To create visual comfort which results in increased productivity.

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