

Analysis Of Light Intensity In The Library Of Madrasah Aliyah Negeri 2 Kota Palu Using The Android-Based Luxmeter Application

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ARTICLE INFO	ABSTRACT
Volume: 2	Lighting in the Library's reading room at Madrasah Aliyah Negeri 2 Kota Palu is the main concern because the lack of light intensity results in easily tired eyes, damaged eyes, and discomfort when carrying out reading activities. The reading room must have enough light under the standards that have been set. Light intensity measurement analysts use an android-based lux meter application to determine the value of light intensity, and this measurement is carried out to obtain whether the light intensity in the Library reading room has met SNI 6197:2011 standards or has not met the criteria. The android-based Luxmeter used can measure the light intensity in the Library reading room with a room area of 15.84 m x 7.87 m. Data retrieval is done by placing an android-based lux meter in four corners of the reading room. The measurement results with an android-based lux meter are compared with SNI to determine the effectiveness of light intensity in the reading room. The measurement data that has been carried out does not meet the SNI requirements for lighting in the library reading room; the average intensity value at 08.00 is 19.25 Lux, at 12.00 is 103 Lux and at 16.00 is 38.25 Lux.
KEYWORDS	
Light Intensity, Library luxmeter, Android	

1. Introduction

Every time humans carry out activities in different places, all activities will be supported by lighting. Good lighting is needed to help all human activities. Lighting is divided into two, namely natural lighting and artificial lighting. (Fleta, 2021). Sunlight is one example of a natural lighting source (Suwarlan, 2021). At the same time, artificial lighting is all forms of light sourced from a manufactured tool

Excellent lighting in the library is the most important element in making the learning environment effective and comfortable for visitors. Poor light intensity can cause visual discomfort, decrease concentration, inhibit reading ability, and even damage the eyes (Wulandari, 2010). Vice versa, too bright lighting can cause glare and interfere when reading (Yuliana, 2022).

Measuring light intensity using the right meter is an important first step in analyzing and evaluating the library's lighting level. A lux meter is a common measuring tool used to measure light intensity. Luxmeter is a tool used to measure lux, a unit of measurement for light intensity. (Mumpuni et al., 2017).

The development of technology allows Android-based mobile phones to measure light intensity by installing the Smart Luxmeter application. Smart Luxmeter application is an application to measure the light intensity or brightness of a room

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using an Android-based device. This application is useful in various situations, such as adjusting room lighting, measuring light intensity in a certain room, or getting quality lighting in photography.

The Library of MAN 2 Kota Palu has service operating hours Monday to Friday open from 07.00 WITA until 16.30 WITA. In its service, it utilizes the potential of natural and artificial lighting from morning to evening. There is no information about the condition of lighting levels at the Library of MAN 2 Kota Palu. Therefore, a study on the lighting level in the Library of MAN 2 Kota Palu is needed.

Based on the background of the research above, the author is interested in analyzing the Light Intensity in the Library of MAN 2 Kota Palu using the Android-Based Smart Luxmeter Application. This research was conducted to determine the lighting level in the Library of MAN 2 Kota Palu and compliance with SNI 6197:2011.

2. Literature Review

2.1 light intensity

The theory of light intensity relies on understanding light as an electromagnetic wave. In general, the power of light can be explained by two main ideas, namely; According to wave theory, light is an electromagnetic wave that propagates through a medium (such as air, water, or glass) (Swamardika, 2009). This wave has two main components, namely the electric field (E) and the magnetic field (B), which vibrate perpendicular to each other and perpendicular to the direction of light propagation. The light intensity in wave theory is related to the square of the wave amplitude (Roth & Stahl, 2019). That is, the greater the amplitude of the wave, the greater the intensity of the light. The formula for the light intensity (I) relationship with wave amplitude (A) is $I \propto A^2$. Its unit light intensity (W/m²) and unit wave amplitude (meters)(Anissa, 2020).

Quantum theory explains light as discrete particles called photons (Sutarno et al., 2017). Each photon carries energy proportional to the frequency of light. The formula that relates the intensity of light (I) to the number of photons (N) and energy per photon (E) is $I = N \times E$. In quantum theory, light intensity is related to frequency (f) or wavelength (λ) through the photon energy formula: (Visible Spectroscopy, 2014)

$$E = h \times f = \frac{hc}{\lambda}$$

h = Planck's constant with values 6.626×10^{-34} Joule seconds

c = speed of light in vacuum 3×10^8 m/sec

2.2 Light intensity in the library

Light intensity in the library reading room can affect comfort and room functionality and even cause eye damage if the lack of light intensity occurs for a long time. Proper brightness is very important for visitors reading in the library (Kurniasih & Saputra, 2019).

Here are some of the benefits of good lighting in the library; Increase the comfort and productivity of readers, reduce eyestrain, improve focus and concentration, create a calm and peaceful atmosphere, and Increase the attractiveness of the library. (Andarini & Listianti, 2017).

2.3 Lux meter

Lux meter is a device measuring light intensity or illumination in a certain environment (Jailani et al., 2017). This tool is commonly called an illuminometer. This tool is used to measure how bright a place or room is with a unit of light known as "lux"(Akbar et al., 2017). One lux equals the light intensity of one lumen evenly distributed over one square meter. Lux meters have a light sensor that is very sensitive to light entering the appliance. These sensors can be photodiodes, phototransistors, or other light sensors that can convert light into measurable electrical signals.

The development of technology allows Android phones to measure light intensity. The trick, install an Android phone with the smart Luxmeter application (Putri & Sudarti, 2022). This app is useful in various situations, such as when adjusting the lighting of a room, measuring the intensity of light in a certain area, or ensuring the quality of lighting.

2.4 Eye sensitivity to light waves

The eye's sensitivity to light waves relates to the ability of the human eye to detect light in a wide range of wavelengths covering the visible light spectrum. Humans can see the color and intensity of light within a certain range of wavelengths, called the visible light spectrum.

The visible light spectrum covers a wavelength range of about 400 to 700 nanometers (nm). Wavelengths shorter than 400 nm are ultraviolet light, which the human eye cannot see, while wavelengths longer than 700 nm are infrared rays, which also cannot be seen by the human eye (Rianti, 2013).

2.5 Light Distribution

In detail the distribution of light can be seen in the following table 1:

Table 1. Types of Light Distribution (Parera et al., 2018)

Light Distribution	Informations
Immediately	90% - 100% downward rays and 0% - 10% upward rays
Semi Direct	60% - 90% downward rays and 0% - 40% upward rays
Indirect	90% - 100% upward rays and 0% - 10% downward rays
Semi Indirect	60% - 90% upward rays and 0% - 40% downward rays
Blend Directly	Indirect lighting with evenly translucent armature/luminaire

The distribution of light or the spread of light in a room is known in several terms, including direct, indirect, semi-direct, semi-indirect, and diffuse lighting (Kartika & Elsiانا, 2021). The light distribution is determined by the lighting direction and the effect of the lamp holder (armature/luminaire) lamp. The level of lighting and power density of SNI 6197:2011 room functions can be seen in table 2 below;

Table 2. Lighting level and power density to room function SNI 6197:2011(SNI 6197, 2011)

Number	Room Functions	SNI 6197:2011	
		Luminous level (lux)	Power density (w/m2)
1	Office workspace	350	12
2	Classroom	350	15
3	School laboratory	500	13
4	Library	350	11
5	Operating room	1000	10
6	Middle-industry jobs	500	15
7	Hotel lobby	200	12

3. Methodology

3.1 Research Design

This study used a quantitative approach to collect and analyze data on light intensity in libraries. The research design used was a field study with four-angle light-intensity data collection in the library of Madrasah Aliyah Negeri 2 Kota Palu.

3.2 Tools and Materials

- a) Luxmeter: Used to calibrate the smart lux meter application, Android mobile installed with the smart lux meter application: Used to measure light intensity in lux units
- b) Library floor plan: Used to mark the light intensity measurement room in the library.
- c) Note-taking tools: Notebooks and computers for recording measurement data.

3.3 Measurement Procedure

- a) Identify measurement locations: Determine reading areas or rooms in the library.
- b) Android-based lux meter preparation: Ensure the lux meter is properly calibrated.
- c) Measurement of light intensity: Using an Android-based lux meter, measure the light intensity in the reading room at four predetermined points at 08.00 WITA, 12.00 WITA, and 16.00 WITA. Place the android-based lux meter in the right position and stabilize it before recording the indicated value.

- d) Data recording: Screenshot and record the light intensity values obtained from the Android-based lux meter for each measurement point.

3.4 Data Analysis

- a) Data processing: Data generated from light intensity measurements into an appropriate format.
- b) Statistical analysis: Use appropriate statistical methods to analyze light intensity measurement data. Compare measurement results with lighting standards according to SNI 6197:2011.
- c) Interpretation of results: Evaluate the results of the analysis and interpret the measurement data to understand the lighting conditions in the library of Madrasah Aliyah Negeri 2 Kota Palu.
- d) Recommendation: Based on the analysis results, provide appropriate recommendations to improve the lighting quality in the library of Madrasah Aliyah Negeri 2 Kota Palu.

4. Results and Discussion

4.1 Data Collected

Madrasah Aliyah Negeri 2 Kota Palu is located at Jalan M.H. Thamrin No. 41 Palu, East Besusu Village, East Palu District, Kota Palu, Central Sulawesi Province. Madrasah Aliyah Negeri 2 Kota Palu has several infrastructure facilities, including a library with an area of 20 m x 10 m.



Figure 1.a. Floor Plan of MAN 2 Kota Palu

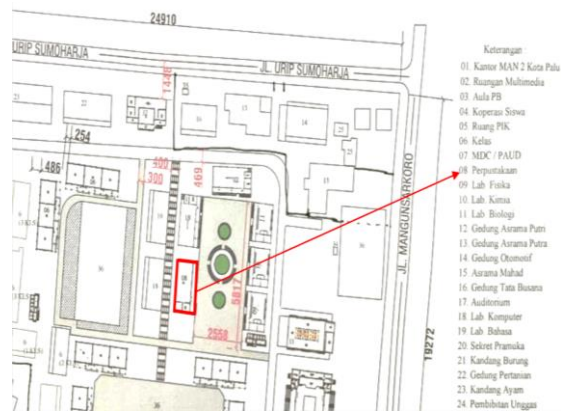


Figure 1.b. Floor Plan of MAN 2 Library in Kota Palu

The reading room at MAN 2 Kota Palu consists of one floor with an area of 15.84 m x 7.87 m. The condition of the library's reading room of Madrasah Aliyah Negeri 2 Kota Palu generally experiences a lack of light, even when the lights in the library are turned on. Although the window openings in the room are wide enough, the lighting of the room is still assisted by artificial lighting, namely, using lights.



Figure 2. Lighting Conditions of the Library's reading room at MAN 2 Kota Palu

4.2 Lighting Analysis in the Reading Room

Picture of one of the measurement results in four corners of the room at 08.00 WITA, 12.00 WITA, and 16.00 WITA using an android-based lux meter can be seen in the following picture:

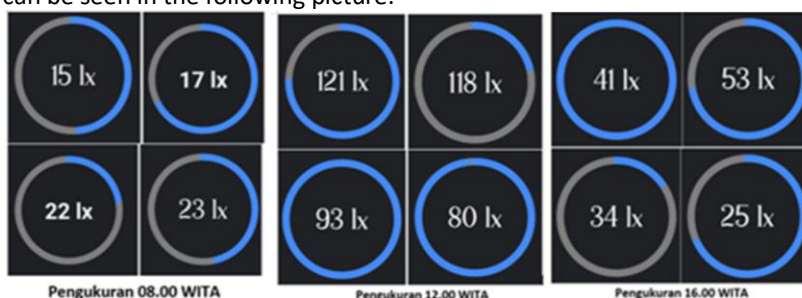


Figure 3. Measurement Results of four corners of the reading room

This measurement is carried out to determine the light intensity in the library reading room has or has not met SNI 6197:2011 standards. Android-based Lux meter is used to measure the intensity of light produced from the study room that has been prepared. The results of light intensity measurements in the four corners of the library reading room can be seen in Table 3.

Table 3. Measurement Results in Every Corner of the reading room Light Intensity

No	Point/Corner of Room	Average Light Intensity (lux)		
		08.00 WITA	12.00 WITA	16.00 WITA
1	First	15	121	41
2	Second	17	118	53
3	Third	22	93	34
4	Fourth	23	80	25

The measurement results with an android-based lux meter are compared with SNI to determine the effectiveness of light intensity in the library reading room. The measurement data that has been carried out has not met SNI standards for lighting in the library reading room; the average intensity value at 08.00 is 19.25 Lux, at 12.00 is 103 Lux, and at 16.00 is 38.25 Lux. Comparison of Android-based Luxmeter measurement results with SNI 6197:2011 Recommendation Standard in Table 4.

Table 4. Comparison Table of Measurement Results with SNI 6197:2011 Recommendation Standard

Corner of the Room	Lux Difference			Standard	Information
	08.00 WITA	12.00 WITA	16.00 WITA		
First	-335	-229	-309	350	Not yet compliant
Second	-333	-232	-297	350	Not yet compliant
Third	-328	-257	-316	350	Not yet compliant
Fourth	-327	-270	-325	350	Not yet compliant

Light intensity is very important in the library reading room because many things will happen when the quality of light intensity in the library reading room does not meet the standards set. Inadequate lighting quality adversely affects the function of vision and the environment around the library reading room, as well as psychological aspects, which can be fatigue in the eyes, discomfort, lack of vigilance to the heaviest influence of the eyes being damaged. In this study, the light intensity measured was by natural and artificial lighting conditions in the library reading room, which was 15.84 m x 7.87 m. Light intensity measurement is calculated using the Android-based Lux Meter Application measuring instrument. Measurements were taken at 08.00 WITA, 12.00 WITA and 16.00. The difference in sunlight intensity at 12.00 WITA is greater when compared to 08.00 WITA and 16.00 WITA, so it can cause discrepancies in the light intensity. The table of measurement results in each corner of the library reading room has not met SNI Standard 6197: 2011.

In Table 4 about the comparison of measurement results with SNI 6197:2011 recommendation standards, the results of even distribution of the average lighting measurement divided by the recommended value are obtained using the formula:

$$\text{Equalization Analysis} = \frac{\text{Average Measurement}}{\text{Recommended intensity}}$$

It can be seen in Table 5. After analyzing the distribution of light, it turns out that the distribution of light in the library reading room has not been evenly distributed due to several factors, namely, the light source is not in the middle of the library reading room and the distance of the light source entering through the window to the midpoint of the uneven light distribution area,

this also causes a decrease in the strength of the lighting in the room, therefore the distribution of light in each corner is different.

Table 5. Lighting Equalization Analysis

Area	Average / Minimum			Information
	08.00 WITA	12.00 WITA	16.00 WITA	
First corner of the room	0,04	0,35	0,12	Not evenly distributed yet
Second corner of the room	0,05	0,34	0,15	Not evenly distributed yet
Third corner of the room	0,06	0,27	0,10	Not evenly distributed yet
Corner of the room Quarter	0,07	0,23	0,07	Not evenly distributed yet
Average	0,06	0,29	0,11	Not evenly distributed yet

4.4 Evaluation of Lighting Conditions in the Library

Based on the results of this study, several steps to improve the quality of lighting in the Library of MAN 2 Kota Palu:

- 1) Add more lighting on collection shelves to increase visibility and make it easier for users to find books.
- 2) Use brighter desk lamps or add additional light sources to ensure optimal reading conditions for users.
- 3) Pay attention to the room's layout and windows to maximize the use of natural light. Ensuring that blinds or curtains do not block light optimally.
- 4) Perform regular maintenance on lighting systems to ensure lights function properly and repair broken or dimmed lights.

5. Conclusion

Light intensity measurement in the Library's reading room at Madrasah Aliyah Negeri 2 Kota Palu can be done using an Android-based lux meter application. The results of measuring light intensity in four corners of the study room in a row showed the average value of intensity at 08.00 WITA is 19.25 Lux, at 12.00 WITA is 103 Lux, and at 16.00 WITA is 38.25 Lux. According to SNI 6197:2011 standard, these results have not been met because of the large light intensity in the study room, which is 350 Lux. The results of the analysis of light distribution in the Library's reading room at Madrasah Aliyah Negeri 2 Kota Palu, on average, were 0.06, 0.29, and 0.11. From the measurement data, it is still not evenly distributed according to the SNI 6197:2011 standard that has been determined.

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