The Effect Of Source Voltage Fluctuation on Illumination Decrease In Bandles, Led Lights, and Energy Saving Lights

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Abstract. The fluctuating source voltage causes the distributed voltage not to have a nominal value of 220V and affects the characteristics of the lighting. In this study, observations were made on the change in source voltage of the three types of lighting during peak load times. The purpose of this research is to show that any change in the source voltage (PLN) can affect the lifetime of the light bulb. From the results of research on one of the LED lights, when 0 hours is turned on, the source voltage is at 227.0 volts with 108.4 Lux lamp illumination. When 12 hours are turned on, the source voltage is 225.9 Volts with 103.3 Lux lamp illumination. There was a decrease in source voltage of 1.1 Volt and a decrease in illumination of 5.1 Lux. And when 24 hours the lamp is turned on, the source voltage is at 230 Volt with 97.8 Lux lamp illumination. There was an increase in source voltage of 4.1 Volt and a decrease in illumination of 5.5 Lux. As a result of frequent increases in source voltage, the lamp lifetime will decrease more rapidly.

1. Introduction

Technological developments have made electrical energy a key in meeting the needs of people in Indonesia. However, the energy available is very limited. Therefore we need energy efficiency in all systems that require electrical energy. One of the largest and largest uses of electric energy in Indonesia is lighting, namely the use of various lamps to illuminate housing, hospitals, industries, roads and so on. In line with this need, many types of lamps are manufactured by factories. Lamps Incandescent, Light Emission Diode (LED) and an Energy Saving lights lamp types that are widely used by the public. The need for lighting, people can choose the type of lamp they like according to their needs, because the types of lamps currently circulating have been produced with various brands according to their needs [1].

Their condition where the voltage in the supply fluctuates so will affect the characteristics of the illumination light for the use of electrical energy in Indonesia is divided into two, namely a peak load and time on the outside of peak load. For the time outside, the peak load starts from morning to evening, while for the peak load it takes place at night. During peak loads, more electricity users result in a decrease in voltage. Their condition where the voltage in the supply fluctuates so will affect the characteristics of the illumination light for the use of electrical energy in Indonesia is divided into two,
namely a peak load and time on the outside of peak load. For the time outside, the peak load starts from morning to evening, while for the peak load it takes place at night. During peak loads, more electricity users result in a decrease in voltage [2].

The selection and use of lamps for lighting at home can create a dream house where we live in it to get comfort, peace that we might never get from other people's homes. To create a dream house is not an easy matter of cost, ideas and desires must be combined. In indoor and outdoor lighting elements, the strong aspects of light that affect the resulting lighting, where these aspects play the most dominant role in influencing the quality of the design of a room lighting. The quality of lighting can have a big impact on the lighting in your home [3]. Technological development of energy saving lamp current, produced by small power to obtain a large luminous flux intensity or value of high efficacy, thereby improving energy efficiency [4].

This research was conducted to observe changes in the source voltage of incandescent lamps, LED (Light Emition Diode) and Energy Saving Lamps by measuring voltage, current and illumination and giving an explanation of the nominal voltage of the source so that the lamps can last. From the results of this study, it is hoped that it can help the public in choosing the lamps used for lighting so that the electrical energy used is more efficient.

2. Methodology

The use of sunlight for room lighting provides efficient use of electrical energy for lamps and reduces electricity consumption costs by up to 33 percent. The choice of lamp and the placement of the luminaire greatly affect the quality and quantity of light given to work areas such as desks and blackboards. It is recommended that the luminaire be placed parallel to the window so that the effectiveness of light distribution from the lamp is higher, and the work area near the window can be supported by natural light. Redesigning/repairing and maintaining lighting installations greatly influences the optimization of the lighting system in the long run [5]. A study comparing two lighting technologies based on Compact Fluorescent (CFL) luminaires and Light Emitting Diode (LED) for general lighting in offices concluded that LED luminaires allow significantly reduced environmental impact (reduction in greenhouse gas emissions by 41e 50% of demand. cumulative energy), mainly due to the high energy efficiency at the stage of use [6].

Currently, light-emitting diode (LED) technology is increasingly being used, however, how it affects the environment has not yet been studied. Based on the study [7] using the LCA (life cycle assessments) method of LED downlight luminaires using data from the luminaire manufacturer, laboratory measurements, industry experts and literature assisted by SimaPro LCA software. The LCA functional unit is one luminaire used for 50,000 hours. In addition, the sensitivity to the environmental impact on life was studied by assessing the LED downlight Luminaire for 36,000 hours and 15,000 hours as the energy source used to calculate the environmental impact. Research on "Evaluating the Use of Led Lights as a Replacement for Conventional Lamps" was carried out by measuring the power of LED lamps and Energy Saving Lamps for 1 month using an ampere meter from the Kyoritsu brand. Obtained the value of electrical power in the room lights as follows: For 5watt LED lights 1,687.5 kwh per month and Energy Saving lamps 8 watts 2,400 kwh per month [8].

So, LED lamp has a good luminance as the luminance of the LED lights is done gradually, decrease the luminance of the LED lights are also not as drastic as the light Soft Light. And after measuring, it was found that the rated power of the 5 Watt Soft Light lamp was 2.5 watt and the 5 Watt LED lamp was 1.4 watts [2]. The replacement of a classic light bulb with a modern LED source takes into account not only quantitative parameters but also the quality of the radiation emitted. The replacement of a classic light bulb with a modern LED source takes into account not only quantitative parameters but also the quality of the radiation emitted [9]. In [10], stated that a 600 W LED can replace a 1000 W HPS. One of the factors that affect the lumen/watt value of an LED is the binning value the LED has, the greater the binning value, the worse the quality. Using LED components that have a better binning value will change the result of the light emitted. Make a similar
circuit with the right number of LEDs and taking into account the distribution and distribution of lighting [3].

Life cycle assessment comparing the environmental impact of two common street lighting technologies: high pressure sodium (HPS) luminaires and light-emitting diodes (LEDs). The environmental impacts of manufacture, use and end-of-life of luminaires are studied with particular attention to their functions. The life time ratio between HPS and LED is also very significant, causing most of the environmental impact: 96% in HPS and 87% in LED luminaires over 30 years of operation, while manufacturing accounts for 4% and 13%, and end of life less than 1%, each [11]. In a per luminaire or per lumen hour ratio, LED luminaires cause an average 26% or 17% lower environmental impact than HPS luminaires. In addition, the development of LED technology will reduce its environmental impact and make it happen clearly favorable for the environment: with the estimated development of luminous efficacy by 2020, the environmental impact file of LED luminaires per kilometer of road illuminated is estimated to be 41% lower compared to HPS technology [12] [13].

Subsequent research uses Energy Saving Lamps with a power of between 18 watts and 20 watts. Based on the measurement results, it turns out that in general the performance of guaranteed energy saving lamps is better than non-guaranteed energy saving lights. By considering the specification data of each energy saving lamps, it can be seen that the price of energy saving lights is comparable with good measurement results, regardless of whether or not the energy saving lights are guaranteed, energy saving lights with better measurement results are more expensive [14].

The power factor of the SL type energy saving lamp can be obtained by changing the source voltage by lowering the voltage from 220 V to 150 V every 1 hour. Then the voltage is increased to 240 V. Each time the voltage drops, the power factor increases by 50-63% and when the voltage reaches 240 V, the power factor decreases by 40-52%. In addition to the power factor when the voltage is 220 V, with the name plate power of 5 watts, the results of the Philips lamp brand decreased 57% to 54%, Visalux fell 47% to 46%, Visicom increased 51- 54%, Panasonic increased 49-54%, decreased energy 48% to 44%, Shinyoku up 40- 45%, Hannochs up 38-42%. 14 watt name plate power from Panasonic brand Power factor up 53-55%, Philips up 51-53%, Visalux down 51% to 50%, Visicom up 48-49%, Energy up 46-47%. Hannochs up 45-46%, Shinyoku fell 44% to 42%[15]. The average use of the initial filament current in electronic Tube lamps is lower than that of the Tube lamps with inductor ballasts, namely 147.1 mA with 247.2 mA. While the average flow stationary electronic fluorescent lamp 21.69 mA and the fluorescent lamp with ballast inductor 180 mA. This shows that the service life of Tube lamps with electronic ballasts can generally be longer than Tube lamps with ballast inductors [16].

Ballast output power and lamp dimming can be adjusted by adjusting the working frequency. The highest output power occurs at a frequency of 25, 5 kHz of 13.2 W. Dimming can be done in the range of 13.2 W at a frequency of 25.5 kHz up to 7.3 W at 33.3 kHz. Based on the test results, the average efficiency value is 91 , 8%; The lowest efficiency value is 82.1% when the frequency is 33.3 kHz and the highest efficiency value is 96.1% when the frequency is 31.3 kHz. From the results of the power test at the resonant frequency and current harmonics, the ballast has a power factor of 0.430 and a Total Harmonic Distorsion of 240.08% [17].

The average illumination level of the production floor is far below the standard of the Minister of Health Decree No. 1405 of 2002. Data on the level of illumination with defective products passing inspection have a strong enough relationship. This shows that the lower the level of illumination, the higher the number of defective products that pass the inspection so that it is necessary to increase the level of illumination in order to reduce the number of defective products that pass inspection at the numbering workstation. Thus it is proposed to replace the lamps with energy-saving lamps by increasing the number of lamps from the actual lamp condition and the distance between the lamps is regulated according to the spacing criteria rule [18]. The potential research for saving electrical energy from electrical energy conservation measures, namely savings by using 18 watt tube LED.
lamps and 9 watt LED bulb and compliance with SNI 03-6575-2001 standards and the resulting savings for lighting systems of 19.69 kwh / day or 590.7 kwh / month [19].

Fluorescent lamps use more electricity than what is written on the tube. In addition, fluorescent lamps use an electric current greater than energy saving lamps. Energy-efficient lamps use less electricity at both power and current, so they are truly energy efficient [20]. Energy consumption research in the use phase is the dominant effect for three lights, although the lamp CFL 15 W and 12.5 W LED lamps perform better than an incandescent bulb of 60 W. In other words, the electrical energy consumption per unit of light output higher resulting in a much higher environmental impact. The LED lamp has the lowest energy input per unit of light output and is the most environmentally friendly of the three lamps. Considering the high contribution of electricity consumption for the three lamps, it is clear that as technology develops for the manufacture of light-emitting devices, there is a need to focus on energy production by utilizing environmentally friendly and renewable technologies [21].

Furthermore, research on measurements for 5 pieces of electronic ballast Tube Lamp lamps. In general, it can be concluded that the intensity of the light produced is proportional to the input power and voltage. The working frequency is inversely proportional to the power consumption absorbed by the load. Tube Lamp (TL) with electronic ballast can stay lit even if the input voltage drops to 100 volts from normal voltage 220 volts [22]. Power factor electronic ballast samples tested were in the range of 0, 51 to 0.98. The harmonic voltage distortion that occurs ranges from 0.53% to 1.23% which still meets the standards, while the harmonic current distortion ranges from 15.17% to 153.8% where based on the standard, it should be below 15%. While the losses in the electronic ballast samples tested ranged from 2.3 watts to 6.5 watts with an efficiency of 77% to 91% [23].

As for research on one of the factors that affect the lumen/watt value of a LED is the binning value of the LED, the greater the binning value, the worse the quality. From the experimental results, it was found that the lumen/watt value for LEDs with types, both imported and local, after being aged for 4000 hours and tested for light strength, decreased by an average of 8.15%. The use of an LED component that has a better binning value will change the result of the light emitted [4]. Research that discusses the intensity of lighting in the lecture hall of the Physics Building, University of Jember, found that the average lighting strength in lecture halls A and B did not meet the standards set by SNI, namely 250 lux. Meanwhile, the measurement results and the calculation of reflectance values in the two lecture halls for walls, floors and ceilings have met the SNI recommendation standards with values ranging from 0.5 to 0.8 [24]. A house with type 36 consisting of 2 bedrooms, 1 living room, 1 family room, 1 bathroom and terrace, each with 1 light point, a total of 6 light points. Of all the rooms / light points installed, the total power required is 768 Joules per 12 hours and the energy used for 1 month is 23.04 kwh. The rate or cost of all lamps used for 1 month is Rp. 13,939.2 [25].

The use of electrical energy from lamps needed by apartment buildings per year is LED lamps of 508.47 MWh, which is less than the energy of CFL lamps of 681.48 MWh and TL lamps of 682.9 MWh. In terms of financing electricity bill payments, LED lamps can save 25.54% compared to the use of TL lamps [26]. The measurement results of the two groups of Energy Saving Lamps (ESL) show that 64% of ESL do not meet the requirements of CISPR 15 while the remaining 36% meet the requirements of CISPR 15. In group 1 (price ≤ IDR 10,000, -) all ESL (100%) do not meet the requirements of the conduction emission test, the mains terminal disturbance voltage. In group 2 (price> IDR 10,000), there are 5 (five) that meet the requirements and there are 2 (two) ESL that do not meet the requirements in CISPR 15[27]. From the research that has been done, it can be concluded that light is transmitted (62.6 lux) across a flat plane and is absorbed by color by 59%. This color absorption can be a guideline for recommending the use of the number and power of lights in a room [28]. The consumption of electric power for lighting in the Telkom Divre VII building using 36 Watt TL lamps and 20 Watt Essentials is 32,775 KWh / month while for the use 18 Watt LED Tube and 9 Watt essential LED is 8,984 KWh/month so that the efficiency is high. generated by using LED lamps amounted to 27.41%. The monthly electricity bill using 36 Watt TL lamps and 20 Watt essential is
Rp. 38,173,216, whereas for the use of 18 Watt LED Tube lamps and 9 Watt essential LED lamps is Rp. 10,440,728, so that 365.6% more efficient [29].

2.1 Definition of Light
Light is one part of various types of electromagnetic waves that emit into space. These waves have a certain frequency and length, the values of which can be distinguished from other light energies in the electromagnetic spectrum. The source of light that is used by humans as lighting today is sunlight and electrical energy. The concept of light is in principle a form of electromagnetic waves. Refers to the concept of waves using the following formula:

\[ \lambda = \frac{\nu}{f} \]  

Where:
\( \lambda \) = Wavelength (m)
\( \nu \) = Speed of light propagation (km/s)
\( f \) = Frequency of light waves (Hz)

2.2 Light Flux
Light flux, commonly known as lumen, is the amount of light emitted from the light source. The symbol of light flux is expressed in F and the unit is lumen (lm). One lumen is the light flux emitted at 1 steradian from a 1 Cd light source on the spherical surface with the number of radii (R) = 1m. If a light flux is related to electric power, then 1 watt of light which is 555 m\( \mu \) in wavelength equals 683 lm. So with \( \lambda = 555 \text{ m}\( \mu \), then 1 watt of light = 683 lm. The formula for calculating the light flux among others as follows:

\[ \phi = P \times K \]  

Where:
\( \phi \) = Light Flux (lm)
\( P \) = Lamp Power (Watt)
\( K \) = Light Efficacy (lm/Watt)

2.3 Steradian
Radian is a point in the middle of a circle between two radii of a circle, where the radius (R) is equal to the distance of the two ends of the radii arc. To calculate the circumference of a circle is \( 2\pi R \), so 1 radian = \( \frac{360^\circ}{2\pi} = 57.30 \). Whereas steradian is an angle that is at the center of the ball from the radius to the outer boundary of the sphere as big as the square of the radius. It is known that the surface area of the sphere is \( 4\pi R^2 \), so around the sphere there are \( 4\pi \) angles of the room, each 1 steradian. For the Steradian number an angle is denoted by the symbol \( \omega \).

2.4 Design System
This research was conducted at the Electrical Engineering Laboratory of Muhammadiyah University of North Sumatra. The research method used is by measuring voltage, frequency, current, and luminance for each lamp brand, including incandescent lamps, LED lamps and energy saving lamps. In addition, measurements were made on the area of the room. The measurement process uses a digital multimeter measuring instrument Kyoritsu model 1009, and a lightmeter Krisbow KW06-288. Figure 1 shows the design of the test series that will be carried out.
3. Results and Discussion

3.1 Analysis of the Effect of Change (Fluctuation) in Source Voltage on Decrease in Incandescent Illumination

Table 1. Source Voltage Fluctuation

| Hour | Source Voltage Fluctuation (V) |
|------|-------------------------------|
| 0    | 227.0                         |
| 12   | 225.9                         |
| 24   | 230.0                         |
| 36   | 228.0                         |
| 48   | 227.0                         |
| 60   | 226.3                         |

Table 1 shows the voltage fluctuation that occurred in the incandescent lamp from 0 Hour at 227 V to 226.3 V at 60 Hour.

Table 2. Difference of Source Voltage Fluctuation

| Difference of Source Voltage Fluctuation (V) |
|---------------------------------------------|
| Hour (0 - 12) | Hour (12 - 24) | Hour (24 - 36) | Hour (36 - 48) | Hour (48 - 60) |
| 1.1           | 4.1            | 2              | 1              | 0.7            |

It is shown in table 2 that there is a difference between (0-12) hours of 1.1 V, (12-24) hours of 4.1 V, (24-36) hours of 2 V, (36-48) hours of 1 V and (48-60) hours of 0.7 V in the incandescent lamp test sample.

Table 3. Decreased incandescent illumination

| No. | Light Type | Power (W) | Decreased Illumination (Lux) |
|-----|------------|-----------|------------------------------|
|     |            |           | Hour 0 | Hour 12 | Hour 24 | Hour 36 | Hour 48 | Hour 60 |
|     |            |           |        |         |         |         |         |         |
Table 3 shows a decrease in the illumination of each incandescent bulb with the Philips, Chiyoda and Tigerhead brands in the same power of 40 W from 0 hours to 60 hours of use.

Table 4. Difference in reduction of incandescent lamp illumination

| No. | Light Type       | Brand     | Power (W) | Difference in Illumination Decrease (Lux) |
|-----|-----------------|-----------|-----------|------------------------------------------|
|     |                 |           |           | Hour (0-12) | Hour (12-24) | Hour (24-36) | Hour (36-48) | Hour (48-60) |
| 1   | Incandescent    | Philips   | 40        | 3          | 3.4         | 3.2          | 3.1          | 3           |
| 2   | Incandescent    | Chiyoda   | 40        | 3.5        | 3.9         | 3.7          | 3.6          | 3.5         |
| 3   | Incandescent    | Tigerhead | 40        | 3.3        | 3.7         | 3.5          | 3.4          | 3           |

Table 4 shows the difference in the decrease in illumination in each test sample for every 12 hours of use.

The data contained in Figure 2 which shows the difference between the voltage fluctuation and the difference in the decrease in incandescent lamp illumination. In the difference between the first 12 hours, namely between 0 hours to 12 hours, the difference in voltage fluctuation is 1.1 V, while the difference in decreasing incandescent lamp illumination of each brand is; Philips 3 Lux, Tigerhead 3.3 Lux and Chiyoda 3.5 Lux. In the difference between the second 12 hours, namely between 12 hours to 24 hours, the difference in voltage fluctuation is 4.1 V, while the difference in decreasing incandescent lamp illumination of each brand is; Philips 3.4 Lux, Tigerhead 3.7 Lux and Chiyoda 3.9 Lux.
In the difference between the third 12 hours, namely between 24 hours to 36 hours, the difference in voltage fluctuation is 2 V, while the difference in decreasing incandescent lamp illumination for each brand is; Philips 3.2 Lux, Tigerhead 3.5 Lux and Chiyoda 3.7 Lux. In the difference between the fourth 12 hours which is between 36 hours to 48 hours, the difference in voltage fluctuation is 1 V, while the difference in decreasing incandescent lamp illumination for each brand is; Philips 3.1 Lux, Tigerhead 3.4 Lux and Chiyoda 3.6 Lux. In the fifth time difference of 12 hours, namely between 48 hours to 60 hours, the difference in voltage fluctuation is 0.7 V, while the difference in decreasing incandescent lamp illumination of each brand is; Philips 3 Lux, Tigerhead 3.3 Lux and Chiyoda 3.5 Lux. Judging from the respective movements, the difference in decreasing illumination follows the difference in voltage fluctuation, if the difference in voltage fluctuation increases, the difference in decreasing illumination will also increase.

It is shown that in the time difference of 12 hours to 24 hours, the difference in voltage fluctuation increases from 1.1 V to 4.1 V, the difference in the decrease in lamp illumination also increases. Philips which increased from 3 to 3.4 Lux, Kawachid from 3.3 Lux to 3.7 Lux and Chiyoda from 3.5 Lux to 3.9 Lux. Likewise, at a time difference of 24 hours to 36 hours, the voltage fluctuation drops from 4.1 V to 2 V, the difference in the decrease in illumination is also down. Philips which dropped from 3.4 to 3.2 Lux, Tigerhead from 3.7 Lux to 3.5 Lux and Chiyoda from 3.7 Lux to 3.7 Lux.

### 3.2 Analysis of the Effect of Changes (Fluctuations) in Source Voltage on Decreasing Energy Saving Lamp Illuminations

| Table 5. Source Voltage Fluctuation |
|-----------------------------------|
| Source Voltage Fluctuation (V)    |
| Hour 0   | Hour 12  | Hour 24  | Hour 36  | Hour 48  | Hour 60  |
| 227.0    | 225.9    | 230.0    | 228.0    | 227.0    | 226.3    |

Table 5 shows the voltage fluctuation that occurred in the Energy Saving Lamp (ESL) from 0 Hour at 227 V to 226.3 V at 60 Hour.

| Table 6. Difference of source voltage fluctuation |
|-----------------------------------------------|
| Difference of source voltage fluctuation (V) |
| Hour (0 - 12) | Hour (12 - 24) | Hour (24 - 36) | Hour (36-48) | Hour (48 - 60) |
| 1.1           | 4.1            | 2              | 1            | 0.7            |

It is shown in table 6 that there is a difference between (0-12) hours of 1.1 V, (12-24) hours of 4.1 V, (24-36) hours of 2 V, (36-48) hours of 1 V and (48-60) hours of 0.7 V in the Energy Saving Lamp test sample.

| Table 7. Decrease in Energy Saving Lamp (ESL) illumination |
|---------------------------------------------------------|
| No. | Light | Type | Brand | Power (W) | Decreased illumination (Lux) |
|-----|-------|------|-------|-----------|-----------------------------|
| 1   | ESL   | Philips | 11 | 54.2 | 51.5 | 48.3 | 45.3 | 42.4 | 39.6 |
| 2   | ESL   | Hanochs | 11 | 58.9 | 55.2 | 51.1 | 47.2 | 43.4 | 39.7 |
| 3   | ESL   | Kawachi | 11 | 57.1 | 54.1 | 50.7 | 47.5 | 44.4 | 41.4 |

Table 7 shows a decrease in the illumination of each energy saving lamp with the Philips, Hanochs and Kawachi brands in the same power of 40 W from 0 hours to 60 hours of use.
Table 8. Difference in reduction of Energy Saving Lamp (ESL) illumination

| No. | Light Type | Brand     | Power (W) | Difference in illumination decrease (Lux) |
|-----|------------|-----------|-----------|------------------------------------------|
|     |            |           | Hour (0-12) | Hour (12-24) | Hour (24-36) | Hour (36-48) | Hour (48-60) |
| 1   | ESL        | Philips   | 11         | 2.7          | 3.2          | 3           | 2.9          | 2.8          |
| 2   | ESL        | Hanochs   | 11         | 3.7          | 4.1          | 3.9         | 3.8          | 3.7          |
| 3   | ESL        | Kawachi   | 11         | 3           | 3.4          | 3.2         | 3.1          | 3           |

Table 8 shows the difference in the decrease in illumination in each test sample for every 12 hours of use.

![Graph comparison of the difference of voltage fluctuation (V) to the difference of the decrease in illuminance (lux) of energy-saving lamps](image)

Figure 3. Comparison graph of difference of voltage fluctuation (V) to difference of illumination drop (lux) energy saving lamp in time (Hours)

The data contained Figure 3 which shows the difference between the voltage fluctuation and the decrease in the illumination of energy-saving lamps. In the difference between the first 12 hours, namely between 0 hours to 12 hours, the difference in voltage fluctuation is 1.1 V, while the difference in decreasing incandescent lamp illumination of each brand is; Philips 2.7 Lux, Kawachi 3 Lux and Hanochs 3.7 Lux. In the difference between the second 12 hours, namely between 12 hours to 24 hours, the difference in voltage fluctuation is 4.1 V, while the difference in decreasing incandescent lamp illumination for each brand is; Philips 3.2 Lux, Kawachi 3.4 Lux and Hanochs 4.1 Lux. In the difference between the third 12 hours, namely between 24 hours to 36 hours, the difference in voltage fluctuation is 2 V, while the difference in decreasing incandescent lamp illumination for each brand is; Philips 3 Lux, Kawachi 3.2 Lux and Hanochs 3.9 Lux. In the difference between the fourth 12 hours which is between 36 hours to 48 hours, the difference in voltage fluctuation is 1 V, while the difference in decreasing incandescent lamp illumination for each brand is; Philips 2.9 Lux, Kawachi 3.1 Lux and Hanochs 3.8 Lux. In the fifth time difference of 12 hours, namely between 48 hours to 60 hours, the difference in voltage fluctuation is 0.7 V, while the difference in decreasing incandescent lamp illumination of each brand is; Philips 2.8 Lux, Kawachi 3 Lux and Hanochs 3.7 Lux. Judging from the respective movements, the difference in decreasing illumination follows the difference in voltage fluctuation, if the difference in voltage fluctuation increases, the difference in decreasing
illumination will also increase. It is shown that in the time difference of 12 hours to 24 hours, the difference in voltage fluctuation increases from 1.1 V to 4.1 V, the difference in the decrease in lamp illumination also increases. Philips which increased from 2.7 to 3.2 Lux, Kawachi from 3 Lux to 3.4 Lux and Hanochs from 3.7 Lux to 4.1 Lux. Likewise, at a time difference of 24 hours to 36 hours, the voltage fluctuation drops from 4.1 V to 2 V, the difference in the decrease in illumination is also down. Philips which dropped from 3.2 to 3 Lux, Kawachi from 3.4 Lux to 3.2 Lux and Hanochs from 4.1 Lux to 3.9 Lux.

3.3 Analysis of the Effect of Change (Fluctuation) in Source Voltage on Decrease in Light Emission Diode (LED) Illumination

**Table 9.** Source Voltage Fluctuation

| Source Voltage Fluctuation (V) |
|-------------------------------|
| Hour 0 | Hour 12 | Hour 24 | Hour 36 | Hour 48 | Hour 60 |
| 227.0 | 225.9 | 230.0 | 228.0 | 227.0 | 226.3 |

Table 9 shows the voltage fluctuation that occurred in the Light Emission Diode (LED) from 0 Hour at 227 V to 226.3 V at 60 Hour.

**Table 10.** Difference of source voltage fluctuation

| Difference of source voltage fluctuation (V) |
|---------------------------------------------|
| Hour (0 - 12) | Hour (12 - 24) | Hour (24 - 36) | Hour (36-48) | Hour (48 - 60) |
| 1.1 | 4.1 | 2 | 1 | 0.7 |

It is shown in table 10 that there is a difference between (0-12) hours of 1.1 V, (12-24) hours of 4.1 V, (24-36) hours of 2 V, (36-48) hours of 1 V and (48-60) hours of 0.7 V in the Light Emission Diode (LED) test sample.

**Table 11.** Decrease in Light Emission Diode (LED) illumination

| No. | Light Type | Brand | Power (W) | Decreased Illumination (Lux) |
|-----|------------|-------|-----------|-----------------------------|
|     |            |       | Hour 0    | Hour 12 | Hour 24 | Hour 36 | Hour 48 | Hour 60 |
| 1   | LED        | Philips | 7         | 151.5   | 148.1   | 144.3   | 140.7   | 137.2   | 133.8   |
| 2   | LED        | Hanochs | 7         | 146.6   | 143.4   | 139.8   | 136.4   | 133.1   | 129.9   |
| 3   | LED        | Kawachi | 7         | 108.4   | 103.3   | 97.8    | 92.5    | 87.3    | 82.2    |

Table 7 shows a decrease in the illumination of each Light Emission Diode (LED) with the Philips, Hanochs and Kawachi brands in the same power of 40 W from 0 hours to 60 hours of use.

**Table 12.** Difference in reduction of Light Emission Diode (LED) illumination

| No. | Light Type | Brand | Power (W) | Difference in illumination decrease (Lux) |
|-----|------------|-------|-----------|-------------------------------------------|
|     |            |       | Hour 0    | Hour 12 | Hour 24 | Hour 36 | Hour 48 |
| 1   | LED        | Philips | 7         | 3.4     | 3.8     | 3.6     | 3.5     | 3.4     |
| 2   | LED        | Hanochs | 7         | 3.2     | 3.6     | 3.4     | 3.3     | 3.2     |
| 3   | LED        | Kawachi | 7         | 5.1     | 5.5     | 5.3     | 5.2     | 5.1     |
Table 12 shows the difference in the decrease in illumination in each test sample for every 12 hours of use.

The data contained Figure 4 which shows the difference between the difference in voltage fluctuation and the difference in the decrease in LED illumination. In the difference between the first 12 hours, namely between 0 hours to 12 hours, the difference in voltage fluctuation is 1.1 V, while the difference in decreasing incandescent lamp illumination of each brand is: Hanochs 3.2 Lux, Philips 3.4 Lux and Kawachi 5.1 Lux. In the difference between the second 12 hours, namely between 12 hours to 24 hours, the difference in voltage fluctuation is 4.1 V, while the difference in decreasing incandescent lamp illumination for each brand is; Hanochs 3.6 Lux, Philips 3.8 Lux and Kawachi 5.5 Lux. In the difference between the third 12 hours, namely between 24 hours to 36 hours, the difference in voltage fluctuation is 2 V, while the difference in decreasing incandescent lamp illumination for each brand is; Hanochs 3.4 Lux, Philips 3.6 Lux and Kawachi 5.3 Lux. In the difference between the fourth 12 hours which is between 36 hours to 48 hours, the difference in voltage fluctuation is 1 V, while the difference in decreasing incandescent lamp illumination for each brand is; Hanochs 3.3 Lux, Philips 3.5 Lux and Kawachi 5.2 Lux. In the fifth time difference of 12 hours, namely between 48 hours to 60 hours, the difference in voltage fluctuation is 0.7 V, while the difference in decreasing incandescent lamp illumination for each brand is; Hanochs 3.2 Lux, Philips 3.4 Lux and Kawachi 5.1 Lux. Judging from the respective changes, the difference in the decrease in illumination follows the change in the difference in voltage fluctuation, if the difference in voltage fluctuation increases, the difference in decreasing illumination will also increase. It is shown that in the time difference of 12 hours to 24 hours, the difference in voltage fluctuation increases from 1.1 V to 4.1 V, the difference in the decrease in lamp illumination also increases. Hanochs which increased from 3.2 to 3.6 Lux, Philips from 3.4 Lux to 3.8 Lux and Kawachi from 5.1 Lux to 5.5 Lux. Likewise, at a time difference of 24 hours to 36 hours, the voltage fluctuation drops from 4.1 V to 2 V, the difference in the decrease in illumination is also also down. Hanochs which decreased from 3.6 to 3.4 Lux, Philips from 3.8 Lux to 3.6 Lux and Kawachi from 5.5 Lux to 5.3 Lux.

![Figure 4. Comparison graph of difference of voltage fluctuation (V) to difference of illumination drop (Lux) of led lamps in time (Hours)](image-url)
4. Conclusion
Based on the results of the research that has been done, it is concluded:
1. The size and the small value of the decrease in illumination, will affect the life of a lamp. A lamp with a large decrease in illumination rate, the faster its life will be reduced. While the lamp with a reduced rate of illumination is small, the life of her longer.
2. The value of the lamp's illumination capacity and lumens can affect the life of the lamp. A lamp with a large value of illumination and lumen capacity has a longer lifetime than a lamp with a small value of illumination and lumen capacity.
3. A change in source voltage (PLN) in the form of an increase or decrease in voltage affects the life of the lamp. Example of a Kawachi LED lamp. When 0 hour is turned on, the source voltage is at 227.0 Volt with 108.4 Lux lamp illumination. When the lamp is turned on for 12 hours, the source voltage is at 225.9 volts with 103.3 Lux lamp illumination. There was a decrease in source voltage of 1.1 Volt and a decrease in illumination of 5.1 Lux. And when the lamp is turned on 24 hours, the source voltage is at 230 Volt with 97.8 Lux lamp illumination. There was an increase in source voltage of 4.1 Volt and a decrease in illumination of 5.5 Lux. With frequent increases in source voltage, the lamp life will decrease faster than the decrease in source voltage, which will reduce the lamp's life span.

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