



ERGONOMIC DESIGN BASED ON ANTHROPOMETRIC METHODS TO REDUCE ELECTRIC POWER USE: ENERGY SAVING ON ELECTRIC POWER USE

I. Ketut Wijaya*

Lecturer in Electrical Engineering, Udayana University, Bukit Jimbaran, Bali, Indonesia.

Article Received on 21/10/2023

Article Revised on 11/11/2023

Article Accepted on 01/12/2023



*Corresponding Author

I. Ketut Wijaya

Lecturer in Electrical
Engineering, Udayana
University, Bukit Jimbaran,
Bali, Indonesia.

ABSTRACT

Electric power is the dominant means needed by the entire community with all its risks. Electrical power is a basic thing in people's lives to carry out their daily activities. Moreover, people's lives are lives and with development to achieve better conditions, electricity is very necessary to support progress. To achieve this progress cannot be separated from electricity to support its achievement. The longer the electricity condition, the more expensive it will be to use and this requires wise usage procedures. The current condition of electric

power means that entrepreneurs who use electric power must be very careful in their use. For this reason, efforts are needed to reduce the use of electricity so that the business can run well. All kinds of efforts have been made to reduce electricity use which cannot be achieved properly. The use of electric power is a condition related to life, its use must be planned and a design created that can be used in its use.

KEYWORDS: Electrical Power, Business, Ergonomic Design, Anthropometric Methods.

INTRODUCTION

Electricity usage is increasing, which means paying the electricity bill every month is increasing.^[23] Electricity makes us comfortable and using more electricity will increase enthusiasm for work and also make us safe.^[22] Using electricity will make work easier and more comfortable in life.

Electricity is considered a measure of life because the more electricity used, the more life increases. However, for most people, electricity is still considered expensive and they use as little as possible so that the remaining money can be used for other purposes. The simplest method used is to use an automatic device to illuminate the page (photocell) or by lowering the light according to the height of the person standing with their arms raised. If it's a hotel, you need to use a card key so that if the occupants of the room leave, all electricity usage stops (turns off). This situation must be done so that the lights save electricity and monthly bill payments are reduced. The use of electricity should be as simple as possible and the use of lights is increasing over time.^[19,20] Managing electricity usage is very difficult, but you have to use the right methods so that electricity can be used safely and comfortably.^[7] Comfort and safety in using electricity are the main goals, but energy savings must also be prioritized.^[16]

The design must be prioritized using ergonomics as a whole and installation must coincide with the construction of the house where the equipment will be installed.^[8]

Research methods

The method will provide a way to solve existing problems based on how the problem is modeled. Carrying out research by calculating the light intensity, recording the light intensity of each lamp to get the actual intensity.^[11,12] On Timers and electric door locks only the usage time is recorded. What needs to be considered is how to save electricity and make the yard bright.^[17,18]

RESULTS AND DISCUSSION

Results

Table 1: Lamp lights based on on Time and Off time using a Photocell.

No.	Afternoon live lights			Afternoon live lights		
	Light 1	Light 2	Light 3	Light 1	Light 2	Light 3
1	17.52	18.08	18.08	6.00	6.10	6.43
2	18.01	17.08	18.07	6.01	6.41	6.44
3	18.03	17.56	18.07	6.10	6.08	6.12
4	18.07	18.00	18.02	6.02	6.09	6.04
5	18.06	18.05	18.09	5.59	5.59	6.01
6	18.27	17.51	17.55	5.58	5.57	5.55
7	18.04	18.11	18.11	6.31	6.32	6.29
8	18.17	18.10	18.12	6.39	6.42	6.42
9	18.15	18.16	18.19	6.39	6.42	6.42
10	18.20	18.21	18.22	6.38	6.41	6.42

11	18.19	18.20	18.20	6.35	6.36	6.33
12	18.21	18.23	18.23	6.03	6.12	6.10
13	18.06	18.05	18.06	6.05	6.04	6.04
14	18.27	17.51	17.55	6.10	6.09	6.07
15	18.12	18.12	18.24	6.12	6.11	6.12
16	18.17	18.10	18.12	6.13	6.12	6.13
17	18.15	18.16	18.19	6.27	6.26	6.30
18	18.20	18.21	18.22	6.27	6.29	6.34
19	18.19	18.20	18.28	6.32	6.33	6.34
20	18.21	18.23	18.23	6.27	6.29	6.29
21	18.31	18.33	18.34	6.25	6.27	6.28
22	18.35	18.37	18.37	6.36	6.37	6.38
23	18.33	18.34	18.35	6.31	6.35	6.35
24	18.26	18.27	18.27	6.21	6.25	6.27
25	18.25	18.26	18.27	6.30	6.26	6.31
26	18.27	18.30	18.29	6.27	6.26	6.31
27	18.23	18.26	18.27	6.24	6.23	6.20
28	18.19	18.18	18.19	6.18	6.17	6.15
29	18.19	18.18	18.19	6.15	6.16	6.17
30	18.14	18.18	18.18	6.15	6.17	6.18
31	18.07	18.09	18.11	6.15	6.16	6.16
32	18.13	18.14	18.15	6.20	6.22	6.22
33	18.20	18.02	18.02	6.30	6.30	6.32
34	18.04	18.08	18.09	6.30	6.31	6.32
Average	18,15	18,08	18,15	6,18	6,20	6,23

Table 2: Lights on based on on Time and Off time without using a Photocell.

No.	Lights on in the evening			Lights off in the morning		
	Light 1	Light 2	Light 3	Light 1	Light 2	Light 3
1	18.20	18.20	18.20	7.00	7.00	7.00
2	18.50	18.50	18.50	6.30	6.30	6.30
3	18.20	18.20	18.20	7.00	7.00	7.00
4	18.50	18.50	18.50	7.30	7.30	7.30
5	18.20	18.20	18.20	7.00	7.00	7.00
6	18.50	18.50	18.50	7.30	7.30	7.30
7	18.20	18.20	18.20	8.00	8.00	8.00
8	18.50	18.50	18.50	7.40	7.40	7.40
9	18.20	18.20	18.20	7.00	7.00	7.00
10	18.50	18.50	18.50	7.05	7.05	7.05
11	18.20	18.20	18.20	7.30	7.30	7.30
12	18.50	18.50	18.50	7.00	7.00	7.00
13	18.20	18.20	18.20	7.30	7.30	7.30
14	18.50	18.50	18.50	8.00	8.00	8.00
15	18.20	18.20	18.20	7.40	7.40	7.40
16	18.50	18.50	18.50	7.00	7.00	7.00
17	18.20	18.20	18.20	8.05	8.05	8.05
18	18.50	18.50	18.50	7.40	7.40	7.40
19	18.20	18.20	18.20	8.15	8.15	8.15

20	18.50	18.50	18.50	8.00	8.00	8.00
21	18.20	18.20	18.20	7.15	7.15	7.15
22	18.50	18.50	18.50	7.30	7.30	7.30
23	18.20	18.20	18.20	8.00	8.00	8.00
24	18.50	18.50	18.50	7.40	7.40	7.40
25	18.20	18.20	18.20	7.00	7.00	7.00
26	18.50	18.50	18.50	7.05	7.05	7.05
27	18.20	18.20	18.20	7.30	7.30	7.30
28	18.50	18.50	18.50	7.00	7.00	7.00
29	18.20	18.20	18.20	7.30	7.30	7.30
30	18.50	18.50	18.50	8.00	8.00	8.00
31	18.20	18.20	18.20	7.40	7.40	7.40
32	18.50	18.50	18.50	7.00	7.00	7.00
33	18.20	18.20	18.20	8.05	8.05	8.05
34	18.50	18.50	18.50	7.40	7.40	7.40
Average	18.35	18.35	18.35	7.36	7.36	7.36

Table 3: Differences in light flame Before and After using Photocell.

Average with Photocell	18.15	18.08	18.15	6.18	6.2	6.23
Average without Photocell	18.35	18.35	18.35	7.36	7.36	7.36
Difference	0.2	0.27	0.2	1.18	1.16	1.13
Final Difference				0.98	0.89	0.93

Table 4: Lights turn On and Off using a TIMER.

No.	The lights come on in the afternoon			The lights go out in the morning		
	Light 1	Light 2	Light 3	Light 1	Light 2	Light 3
1	18.00	18.00	18.00	6.00	6.00	6.00
2	18.00	18.00	18.00	6.00	6.00	6.00
3	18.00	18.00	18.00	6.00	6.00	6.00
4	18.00	18.00	18.00	6.00	6.00	6.00
5	18.00	18.00	18.00	6.00	6.00	6.00
6	18.00	18.00	18.00	6.00	6.00	6.00
7	18.00	18.00	18.00	6.00	6.00	6.00
8	18.00	18.00	18.00	6.00	6.00	6.00
9	18.00	18.00	18.00	6.00	6.00	6.00
10	18.00	18.00	18.00	6.00	6.00	6.00
11	18.00	18.00	18.00	6.00	6.00	6.00
12	18.00	18.00	18.00	6.00	6.00	6.00
13	18.00	18.00	18.00	6.00	6.00	6.00
14	18.00	18.00	18.00	6.00	6.00	6.00
15	18.00	18.00	18.00	6.00	6.00	6.00
16	18.00	18.00	18.00	6.00	6.00	6.00
17	18.00	18.00	18.00	6.00	6.00	6.00
18	18.00	18.00	18.00	6.00	6.00	6.00
19	18.00	18.00	18.00	6.00	6.00	6.00
20	18.00	18.00	18.00	6.00	6.00	6.00

21	18.00	18.00	18.00	6.00	6.00	6.00
22	18.00	18.00	18.00	6.00	6.00	6.00
23	18.00	18.00	18.00	6.00	6.00	6.00
24	18.00	18.00	18.00	6.00	6.00	6.00
25	18.00	18.00	18.00	6.00	6.00	6.00
26	18.00	18.00	18.00	6.00	6.00	6.00
27	18.00	18.00	18.00	6.00	6.00	6.00
28	18.00	18.00	18.00	6.00	6.00	6.00
29	18.00	18.00	18.00	6.00	6.00	6.00
30	18.00	18.00	18.00	6.00	6.00	6.00
31	18.00	18.00	18.00	6.00	6.00	6.00
32	18.00	18.00	18.00	6.00	6.00	6.00
33	18.00	18.00	18.00	6.00	6.00	6.00
34	18.00	18.00	18.00	6.00	6.00	6.00
Average	18.00	18.00	18.00	6.00	6.00	6.00

Table 5: Lights turn On and Off using without a TIMER.

No.	Lights on in the evening			Lights off in the morning		
	Light 1	Light 2	Light 3	Light 1	Light 2	Light 3
1	17.00	17.00	17.00	7.00	7.00	7.00
2	17.00	17.00	17.00	6.30	6.30	6.30
3	18.30	18.30	18.30	7.00	7.00	7.00
4	17.35	17.35	17.35	7.30	7.30	7.30
5	18.20	18.20	18.20	7.00	7.00	7.00
6	18.50	18.50	18.50	7.30	7.30	7.30
7	18.20	18.20	18.20	8.00	8.00	8.00
8	17.00	17.00	17.00	7.40	7.40	7.40
9	18.30	18.30	18.30	7.00	7.00	7.00
10	17.35	17.35	17.35	7.15	7.15	7.15
11	18.20	18.20	18.20	7.30	7.30	7.30
12	18.50	18.50	18.50	7.00	7.00	7.00
13	18.50	18.20	18.20	7.30	7.30	7.30
14	18.50	18.20	18.20	8.00	8.00	8.00
15	18.50	18.50	18.50	7.40	7.40	7.40
16	18.20	18.20	18.20	7.00	7.00	7.00
17	17.00	17.00	17.00	8.05	8.05	8.05
18	18.30	18.30	18.30	7.40	7.40	7.40
19	17.35	17.35	17.35	8.15	8.15	8.15
20	18.30	18.30	18.30	8.00	8.00	8.00
21	18.30	18.30	18.30	7.30	7.30	7.30
22	18.21	18.21	18.21	8.00	8.00	8.00
23	18.30	18.30	18.30	7.40	7.40	7.40
24	18.20	18.20	18.20	7.00	7.00	7.00
25	17.00	17.00	17.00	8.05	8.05	8.05
26	18.30	18.30	18.30	7.40	7.40	7.40
27	17.35	17.35	17.35	8.15	8.15	8.15
28	18.30	18.30	18.30	8.00	8.00	8.00
29	18.30	18.30	18.30	7.30	7.30	7.30

30	18.21	18.21	18.21	8.00	8.00	8.00
31	18.30	18.30	18.30	7.00	7.00	7.00
32	17.35	17.35	17.35	8.05	8.05	8.05
33	18.30	18.30	18.30	7.40	7.40	7.40
34	18.30	18.30	18.30	8.15	8.15	8.15
Average	17.96	17.96	17.96	7.48	7.48	7.48

Table 6: Difference between using a Timer and Not using a TIMER.

With Timer	18	18	18	6	6	6
No Timer	17.96	17.96	17.96	7.48	7.48	7.48
Difference	0.04	0.04	0.04	-1.48	-1.48	-1.48
Final Difference				-1.52	-1.52	-1.52

Table 7: Save electricity by using an ELECTRIC CARD KEY.

No.	Enter the room using the Electric Card Key			Exit the room using the electric card key		
	1	2	3	1	2	3
1	13	14	13	6.30	6	6
2	13	13	13	6	6	6
3	14	13	13	6	6	6
4	15	14	14	6	7	7
5	14	13	14	7	7	.7
6	14	14	15	7	6.30	6.30
7	13	15	13	6.30	6.30	6,30
8	14	15	13	6.30	6	6
9	15	14	14	6	6	6
10	13	14	13	6	6	6
11	14	13	14	6	7	7
12	15	14	15	7	7	7
13	14	15	15	7	6.30	6.30
14	14	13	14	6.30	6	6
15	13	14	14	6	7	7
16	14	15	13	7	7	7
17	15	14	14	7	7	6.30
18	14	14	15	6.30	6.30	6
19	14	13	13	6	6.30	7
20	13	13	14	6	6	7
21	14	14	15	7	6	7
22	15	15	14	7	6	6.30
23	15	14	13	6.30	7	6.30
24	14	14	13	6.30	7	6
25	14	13	14	6	6.30	6
26	13	14	15	6	6	6
27	14	15	14	6	5	7
28	15	14	14	7	5.3	6
29	13	15	13	7	5	6
30	14	14	13	6	6	6
Average	17.96	13.97	13.80	6.40	6.27	6.39

Table 8: Electrical data With and Without electric card key in the room.

No.	Before Using the Electric Card Lock			After Using Electric Card Lock		
	Room 1 (jam)	Room 2 (jam)	Room 3 (jam)	Room 1 (jam)	Room 2 (jam)	Room 3 (jam)
1	12	12	12	7	7	8
2	12	10	12	6	7	9
3	11	12	10	8	8	10
4	12	12	12	7	7	8
5	12	10	12	7	7	9
6	11	12	10	7	7	10
7	12	12	12	7	7	8
8	10	12	12	6	8	9
9	12	9	9	8	7	7
10	12	12	12	7	7	8
11	12	12	12	7	7	7
12	12	9	12	7	7	8
13	12	12	9	7	7	9
14	12	12	12	7	7	10
15	12	12	12	8	8	8
16	12	10	12	7	7	9
17	12	12	10	7	7	10
18	11	12	12	7	7	8
19	12	12	12	8	7	9
20	12	12	12	7	8	7
21	12	12	9	7	7	9
22	12	12	12	8	7	10
23	12	9	12	7	10	8
24	12	12	8	7	10	9
25	10	12	12	8	9	10
26	12	12	11	7	8	8
27	12	10	12	7	10	9
28	10	12	9	8	9	10
29	12	12	10	7	8	6
30	12	12	12	6	9	7
Average	11.70	11.43	11.17	7.13	7.70	8.57

Table 7: Before and After Using Electronic Card Keys.

No.	Before Using the Electric Card Lock			After Using Electric Card Lock		
	Room 1 (jam)	Room 2 (jam)	Room 3 (jam)	Room 1 (jam)	Room 2 (jam)	Room 3 (jam)
Average	11.70	11.43	11.17	7.13	7.70	8.57
	Final Difference			4.57	3.73	2.60

DISCUSSION

Yard lights use photocell

Installation of photocell

a. In yard lights

SELCON functions to ensure that the lights turn on and off at specified times so that they can turn on properly at night. The Photocell function can be ensured to reduce excessive use of lamps.^[14,15] Photocell is a tool that can be used as a tool that will be attached to a lamp so that the lamp can turn on and off automatically. Photocell works automatically based on the strength of sunlight that shines throughout the day.^[21] Sunlight is needed to make the pieces of the two metals in the Photocell which have different densities become exposed to heat so that they stretch and do not connect the two types of metal so that electric current does not flow through the metal and the electric current is not distributed and the light goes out.^[13]

In the afternoon towards evening the sunlight began to weaken so that the two metals began to approach each other until they finally touched and the lights began to come on. In the morning the sun's rays began to appear and shine so that the two metals began to stretch and the lights went out. This process always repeats itself in the morning and evening so that Photocell can function according to its design and benefits.^[9,10]

Using a Photocell can be seen to save close to 1 hour per day per lamp so it can be said that this tool is suitable for use as a tool to save energy.^[3] From the research used, three lamps in saving one lamp can save almost 1 hour as seen in Table 3. With the composition of lamps 1, 2, 3, the time obtained in lighting for one day is 0.98, 0.89, 0, 93 hours. Thus, it is very feasible to use Photocell because it is proven that the results obtained are shown in Table 3 and it is feasible to use it.

b. Page lighting without using photocell

If the lights do not use Photocell, the owner must be careful and skillful in turning the light switch on and off so that the lights don't stay on all day. The main function of a light switch is to turn on and turn off the electric current source. If the source of electric current is cut off with a device called a switch, the electric current cannot be cut off automatically. The power of the switch also has certain limitations, for this reason the switch must be adjusted to the size of the lamp installed. The switch must not be installed with lights that exceed the power of the switch.^[6] If it is installed with excessive power, it can cause a short circuit and cause heat to occur in the switch and cause the tire to burn.

Use of dimer

a. Terrace lights use TIMER

TIMER is a tool used as a time limiter in order to limit the desired time. The dimer functions automatically.^[4] A time limiter is needed to reduce the time used by a working tool so that it does not exceed the specified working capacity.^[2] The lights on the terrace use a time limiter (TIMER) to limit the operation of the lights so that they do not exceed the working time. Time limiters are installed on terrace lights as a control in the use of electric current which is increasingly expensive.^[1]

By using DIMER, this tool means it is very useful because the results of its use are very successful in producing values that are suitable for use, such as: 1 hour 52 minutes for TIMER 1, 1 hour 52 minutes for TIMER 2 and 1 hour 52 minutes for TIMER 3. Installation of the TIMER tool will make humans forget the disease humans have, namely forgetfulness.

b. Terrace lights do not use TIMER

Electricity can be used in good condition and is very easy to use, but it will be dangerous if you use it incorrectly. Cables are a means of channeling electric current so that electricity can be utilized properly. The cable must be of good quality with standards that meet the size or diameter appropriate to the equipment to be installed. DIMER must also be in accordance with the capability requirements of the TIMER itself with the limitations of the TIMER's capabilities. So TIMER must be used within limits and to limit the running time of the lamp. For this reason, the timer is used as a means to limit the running time of the lights and if you don't use a timer, you can be sure that the lights will stay on longer and make electricity use longer and make you pay more electricity bills at the end of the month.

Use of electric door lock

a. Rooms use electric card locks

The function of the card door lock is to regulate the on and off power and cut off electricity for the entire room. Cutting off the electric current must be done and disconnection is carried out on all electric currents in the room. If a guest leaves the room for certain purposes, the card will be removed from where it was placed. After the card is removed from the key very slowly, the electric current will be cut off and the disconnection of the electric current will be done automatically.^[5]

The use of card keys can be used to save energy in hotels or other businesses because there is evidence that the use of card keys can indeed be relied on to save energy in a business or other use. Very good energy. Energy savings reach 4 hours 57 minutes in room 1, for room 2 the savings reach 3 hours 73 minutes (4 hours 13 minutes) and for room 3 the savings reach 2 hours 60 minutes) or 3 hours.

b. The room does not use an ELECTRIC CARD LOCK

The electric card lock actually has a working principle that is almost the same as the working principle of other safety devices used for other automatic electrical breakers. Other disconnecting devices are also expected to work according to expectations so that they can work to cut off electrical currents according to the limits of the device itself. Humans have abilities and limitations and often forget things that must be done, such as the daily work of turning off the electric circuit breaker to reduce the burden of electricity payments. To not forget to turn off, especially turning off the electric current, use a power breaker with automatic capabilities. For example, in rooms that are rented, automatic devices such as electric card locks are used so that those who occupy them leave, automatically all facilities that use electricity are turned off.

Acknowledgments

Thank you to LPPM Udayana University for financial assistance so that this research can be carried out and thank you to all journals that have provided support and all journals are used as reference lists.

CONCLUSION

The conclusions that can be drawn are

The use of the three circuit breakers is so that in use they can function to save electricity as desired and can help in turning on and off the electric current by itself and can reduce electricity usage. Circuit breaker operation. This is almost the same as other circuit breakers, only the way it works is automatically.

REFERENCES

1. Andreas, Ricky. Analysis of Lighting Quality and Operational Costs Lighting StreetLight Type and Led On Toll Road Spondol-Krapyak, 2015.
2. Asnal Effendi dan, Asep Suryana, Evaluation of Streetlight Lighting System In Sungai Bahar District. Journal of Electrical Engineering ITP, 2013; 2: 2.

3. Badung District Government, Road Lighting Planning, 2018.
4. Basic Theory of Public Street Lighting and Electrical Energy Measurement volumes 1. Uni North Sumatra versions.
5. Christian D., Lestari P. Lighting Technique and Lighting Layout. Artolite Grasindo. Basic Theory of Public Street Lighting and Electrical Energy Measurement Uni versus North Sumatra, 1991; 1.
6. Dinas Cipta Karya Kabupaten Jember. Existing condition of street lighting. Jember, 2013.
7. Direktorat Jenderal Bina Marga, Specification Lamp Street Lighting in the Urban, (Jakarta). National Standardization Body, SNI 7391 Lighting Information on Urban Roads, Jakarta: BSN, 1991; 2008.
8. Direktorat Bina Marga, 1991. Lighting Street Light Specifications No. 12/S/BNKT/1991
9. Eni Satria, Comparative Planning Technically and Economically In Electric Lighting System For Conventional Public Road And Solar Cell, 2018.
10. Harten P. Van, Strong Flow Installation, Bandung: Bina Cipta, 1981; 2.
11. I Ketut Wijaya, Ergonomic Redesign of Computer Laboratory To Improve Performance And Efficiency Power Electrics In Electrical Engineering Computer Laboratory At Udayana University, 2011.
12. I Ketut Wijaya, Word Effects of Temperature, the Lighting, Workload, Noise Against Eye Fatigue, General Fatigue and Stress Affect Learning Outcomes the Student Computer Users, Journal, 2012.
13. Kadir, Abdul Distribution and Utilization of Electric Power. Jakarta: University of Indonesia (UI-Press), 2000.
14. Mayretta, Santa. Evaluation of Street Lighting (Road Case Study W.R Supratman Bandung, West Java). Essay. Yogyakarta: Civil Engineering, Atma Jaya University Yogyakarta, 2014.
15. Planning Prabu, 2009. System and Standards. Lighting of Space, Accessed, 2017; 27.
16. Santa Mayretta, Evaluation of Street Lighting. Thesis, 2014.
17. Badung District Government, Road Lighting Planning SNI 7391, (2008). Specification of Street Lighting in Urban Area, 2018.
18. Regulation of the Minister of Energy and Mineral Resources No. 30 tahun 2012. About Electricity Tariff Provided By Company Persero (Persero) Pt Perusahaan Listrik Negara. PUIL, 2011; SNI 040225-2011.
19. Roza Indra Yeni, Application of Katherine Kolcaba's Comfort Theory In Children In Fulfilling Oxygenation Needs In The Nursing Room, 2017.

20. SNI 7391: Specification of street lighting Electricity utilization technique, 2008; 1.
21. Sri Pringatun, Karnoto, M. Toni Prasetyo, Comparative Analysis of Toll Road Lighting. Media Elektrik, 2011; 4: 1.
22. Wibawa, Unggul, Management of Industry-II, Malang: Department of Electrical Engineering Universitas Brawijaya, 2004.
23. Wikipedia, The regional security complex theory is a regional security theory presented by Barry Buzan dan Ole Waever dalam buku *Regions and Powers: The Structure of International Security*, 2017; 2003.