# DESIGN OF MONITORING SOLAR PUBLIC STREET LIGHTING (PJUTS) WITH LORA ESP32 NETWORK BASED ON INTERNET OF THINGS (IOT)

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**Abstract**

One of the most popular renewable energy sources is the usage of solar panels, whichhave even been employed in some places as the primary source of power. Public Street Lighting and issues that frequently arise with Solar Cell Public Street Lighting, particularly during operating hours brought onby damage stored in the battery. Long distances become a concern in and of themselves, thus they must be monitored frequently.As a result, researchers are working to develop a Lo-Ra-based monitoring system for public solar street lights. According to the research, it is possible to track all data sent in real time, includingbattery voltage, LDR (Light Dependent Resistor) values, current data flowing from solar panels, and currentdata being delivered. Since the lights are only bright at night if a human object is identified using a PIR (Passive Infrared Receiver) sensor, the discussion's findings and conclusions can be applied to an energy-saving system. The design of this instrument can make it easier for technicians to check because the maximumdistance over which data can be sent in LoRa between the transmitter and receiver modules is 4 km.

**Keywords:** Solar Public Street Lighting, LoRa, LDR, PIR

## INTRODUCTION

Airport electrical system is everything that concerns the distribution of electricity at an airport from electricity supply such as PLN or Generator to all equipment that requires electricity at the airport. The airport electricity system is different from the PLN electricity system because the PLN electricity system produces voltage stability while the airport electricity produces current stability. This difference is because most of the equipment at the airport requires a constant current supply. (Herndarto, 2018)

Solar energy is an energy source that is unlimited and will never run out of availability and this energy can also be utilized as an alternative energy that will be converted into electrical energy, using solar cells. Solar panels as an alternative source of electrical energy can be utilized by people who need electrical energy. (Purwoto, 2020) Electricity generation can be done in two ways, directly using photovoltaics and indirectly by concentrating solar energy. Photovoltaics directly convert light energy into electricity using the photoelectric effect. Solar energy concentration uses a system of lenses or mirrors combined with a tracking system to focus solar energy to a single point to power a heat engine. Solar cells or photovoltaic cells are devices that convert light energy into electrical energy using the photoelectric effect. It was first made in 1883 by Charles Fritts. (Jatmiko, 2018)

In line with that, today's energy needs are mostly met by energy. sourced from fossil fuels such as petroleum, coal, and natural gas. As time goes by, the current energy sources are decreasing. With conditions like this, the possibility of an energy crisis is inevitable. One alternative that can be applied to this problem is the utilization of sunlight to be used as a power plant where the airport's need for electricity supply from PLN costs a lot. The need for electricity is very, very important to support the needs of human life, especially at airports. PLTS is one of the means to meet the needs of the community for environmentally friendly electricity. With the geographical situation in Indonesia which gets sunlight every year, therefore, an alternative energy source is needed as an effort to help fulfill the energy supply for the airport. A large and renewable source of

energy available to humans is solar thermal energy, specifically electromagnetic energy emitted by the sun.

Based on the above problems, the authors want to utilize alternative energy, namely solar energy for taxiway lights which initially used electrical energy from PLN. therefore the authors raised the title "Modification of the efficiency of saving electrical energy with Prototype solar cells on taxiway lights".

## METHOD

This chapter will discuss observation data which includes the time and place of research, tool design which includes hardware planning (hardware) and the work system of the tool. software (software) and the work system of the tool. Tool design will be discussed in parts accompanied by schematic images.

This chapter will also explain the design and devices that will be used to make Electric Energy Saving Efficiency Modifications with Solar cell Prototype Against Taxiway Lights at Sultan Muhammad Salahudiin Bima Airport.

The current condition has many shortcomings, namely the relatively expensive expenditure in the main power supply, namely PLN on runway lights, especially on Taxiway lights which are not effective and efficient in saving in today's era.

The desired condition is in the use of electrical energy in the taxiway lights which were initially supplied by the main power supply, and if the main power supply dies then the generator running will require a lot of fuel oil, therefore the author wants to change which initially the taxiway lights were backed up by PLN to supply solarcell power.

The research method used in this research is to use research and development tools or Research and Development (R&D).

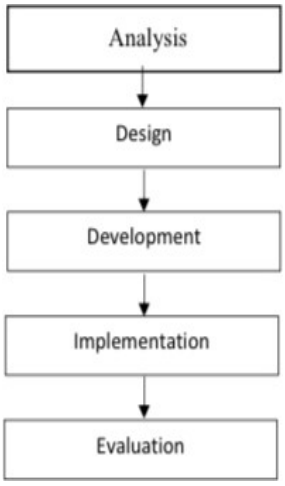


*Figure 1: Research flowchart (William Lee, 2004)*

In Figure 1 As in the flow chart above, thisresearch method is divided into 7 stages, namely:As in the flow chart 3.1 above, this research method is divided into 5 stages, namely:

a. Stage 1: Analysis
   At this stage, research is carried out to analyze related problems that often occur when the cubicle drains.occur when the cubicle flows to the load

b. Stage 2: Design
   Then after knowing the existing problems, the next step is to design the concept of the tool that will be made to solve the problems that occur in the Taxiway.

c. Stage 3: Development After designing the conceptual tool and then realizing thetool design that was previously conceptualized.

d. Stage 4: Implementation.After assembling the tool, the next step is to test whether the tool that has been madecan work as desired or not.

e. Stage 5: Evaluation
   The evaluation stage in the ADDIE model developmentresearch is carried out to provide feedback to users. revisions are made according to the results of theevaluation or the needs that the product has not been ableto fulfill. The ultimate goal of evaluation is to measurethe achievement of development goals. After assemblingthe tool, the next step is to test whether the tool that hasbeen made can work as desired or not.

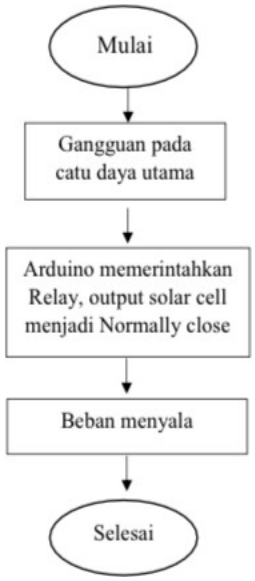


Diagram of how the tool works

In Figure 2. diagram of how the tool works utilizes solar energy to convert electricity supply from PLN into solar energy through solar cells in order to reduce conventional electrical energy and is not environmentally friendly.

In this planning, the supply of taxiway lights starts with PLN, and at the airport or in the Airfirld lightning system facility does not deny the failure of PLN (blinking) and takes about 5-15 seconds quoted by Annex 14 that the time interval for the death of the main power supply with the operation of the backup power supply is a maximum of 15 seconds, to process data from the main power supply the author uses a Microcontroller or Arduino in order to process data from the main power supply.commands the relay to change the solar cell output from Normally Open to Normally Close and the load will turn on.

Hardware Components

Solar cell or solar panel
The solar panel used is a 120 wp monocrystalline solar panel that can help contribute to the environment / emit greenhouse gas emissions because it does not go through the fossil fuel / fuel oil process. The use of solar cells utilizes an abundant as well as free energy source by converting sunlight into electrical energy. The sunlight received in indonesia which is abundant can utilize renewable energy sources and fear of running out such as using coal fuel, fuel oil derived from fossils so as not to cause pollution.(solarpanelsurya.net)

Specifications of 120 wp poly Solar Panel:

a) Maximum power (Pmax) 120w
b) Voltage at Pmax (Vmp) 19.2V
c) Current at Pmax (Imp) 6.25A
d) Open-circuit voltage (Voc) 24.8V
e) Short-circuit current (isc) 6.65A
f) Maximum system voltage 1000V DC
g) Power tolerance + 3%


Battery
Batteries in PLTS components that function to store electrical energy generated by solar panels during the day, to be used at night and during cloudy weather. Batteries used in PLTS experience a cyclical process of charging and discharging, depending on the presence or absence of sunlight.

Solar Charger Controller

Solar charger control functions to adjust the electric current that enters the battery, so that the battery does not experience overcharge or excess charging which results in the battery being quickly damaged.
electricity into the battery, so that the battery does not experience overcharge or excess charging which results in the battery being quickly damaged. That way, the battery is always in full condition, but without having to overcharge. Avoiding Over Discharge batteries or batteries in a weak state. That is, if the battery is in a weak condition or the voltage drops too low, the SCC will stop the flow to the load. This is important, because

LED lights
LED or Light Emitting Diode is a lamp that uses diodes to produce light. This diode functions as an electric current conductor and when given a voltage, the diode will emit light. LED lights are usually used for interior lighting because they have several advantages compared to other types of lights.

Relay
Relay is an electrically operated switch and is an Electromechanical component consisting of 2 main parts namely Electromagnet (Coil) and Mechanical (a set of Switch / Switch Contacts).
Relay uses the Electromagnetic Principle to move the Switch Contact so that with a small electric current (low power) it can deliver higher voltage electricity. (Imadudin, 2020)

Arduino
Arduino Uno is an ATmega328 microcontroller, on this microcontroller board has 14 inputs and outputs (6 output ports for PWM), has 6 input ports as analog, a 16 MHz ceramic crystal resonator port, a port for USB connection, a port for adapter sockets, ICSP header pins, and a reset button if the battery is in a very low voltage

| **Spesifikasi** | **Keterangan** |
|---|---|
| Mikrokontroller | ATmega328 |
| *Operating Voltage* | 5V |
| *Input Voltage (recommended)* | 7-12V |
| *Input Voltage (limits)* | 6-12V |
| *Digital I/O Pins* | 14 (of which 6 provide PWM Output) |
| *Analog Input pins* | 6 |
| DC Current per I/O Pins | 40 mA |
| DC Current for 3.3V Pin | 50 mA |
| SRAM | 2KB (ATmega 328) |
| EEPROM | 1KB (ATmega328) |
| *Clock Speed* | 16MHz |

condition, the battery will be quickly damaged.

## RESULTS AND DISCUSSION

In the results of the analysis of the initial conditions of the runway lights, especially the Taxiway at Muhammad Salahuddin Airport in Bima, there are 30 Taxiway lights with each lamp 45 watts with a total load of 1350 watts, with this the author makes a protoype of modifying the efficiency of saving electrical energy on Taxiway lights by using 120wp solar panels with a 90 watt load, to meet the needs of the airport if installing 120wp solar panels requires 12 solar panels to meet the total load requirements of the bima airport taxiway lights, The results of this tool research data have been tested by the author, the results obtained from testing each component of this tool whether it can run as desired or not and the measurement results of each component of this tool are taken as data for this study. Solar Panel Analysis Results Solar panel testing aims to determine the condition of solar panels can work properly or not. Testing of solar panels is done repeatedly to ensure that these solar panels are ready to be used in the design of the tool, when testing solar panels depends on the sunlight absorbed by solar panels, testing is carried out from 07.00 to 17.00, this test is carried out when the weather is sunny so that the table below is the result of the test.

In this development stage, it can be seen the comparative analysis of the efficiency of saving electrical energy using solar panels and PLN.

f. It is known that the Taxiway light load at Bima airport is 1350 watts if using PLN costs how much per month? Lamp Power = 1350 watts
   Lamp usage / day = 12 hours / day Power consumption
   / day = 1350W x 12 hours / day = 16,200W
   Power consumption/month = 16,200W x 30 days
   = 486,000 = 486kW
   Cost per month = 486kW x Rp 1,595
   = Rp 775,170/month

g. Solar panel efficiency
   ηmax = max power SP / indicent radiation flux X A x100% = 120 / 0.804 x 100% = 14.92%
   Output Power (PG)
   = 1.94 m2 x 3.88 kWh/m2/day x 12 pieces x 14.92%
   = 13.47 kWh/day x 30 days
   = 404.1 kWh/month
   Calculation of Export (energy from Solar Panel)
   = Solar Panel Energy x Solar Panel Tariff 1 kWh x 65%
   = 404.1 kWh/month x Rp 1,595.00 x 65%
   = IDR 418,950/month

h. Comparison of the cost of using PLN sources with PLTS for 3 years (according to battery lifetime)? Price of 1 12v 2Ah battery = Rp 222,000 x 12 batteries
   = Rp.2,664,000 (for 3 years of use)
   PLN source costs per 5 years = Rp 775,170 x 12 x 3
   = 27,906,120
   So it can be seen that the load using PLTS is more efficient than the load that is sourced from PLN.

Return of Investment PLTS
ROI = Capital: PLN cost/month
= Rp 2,664,000 : Rp 775,170
=34 months = 2 years and 10 months Monthly Cost Efficiency (Savings)
= PLN tariff (per month)- Import cost PLN Tariff (per month) x 100%
= Rp 775,170.00- Rp 418,950.00
Rp 775,170.00 x 100%
= 46 %

### Evaluation Results

At this stage is a process to see whether the product made is successful, in accordance with initial expectations or not this stage is the last step taken by researchers based on the ADDIE development system design model.

The data at the evaluation stage comes from two types of subjects, the first is expert valiadation conducted by lecturers, airport electrical employees or cadet respondents. Opinions and suggestions from testing this prototype will later implement directly in the field.

From the validation of electrical experts, which can come from lecturers who have tested the prototype. The results of the validator that this cubicle control and monitoring tool has gone through an evaluation from a validator named Mr. Dr. Prasetyo Iswahyudi, ST, MM, he has an electrical science background. He is an expert in the field of electricity explaining that the tool works and functions properly so that it can be tested for the legal requirements for graduation at the Surabaya Aviation Polytechnic.

Advantages and disadvantages of tools

From the analysis of the final project tool that the author designed with the title "Modification of the efficiency of saving electrical energy with a solar cell prototype for taxiway lights at Muhammad Salahuddin Airport, Bima" has advantages and disadvantages including:

Advantages of the tool:

1. This tool can be used without being connected to PLN.
2. This tool utilizes via blynk application for monitoring loads that are backed up by solar cells and PLN
3. This tool is environmentally friendly, PLTS does not require a generator like other power plants so there is no noise generated.generator like other power plants so there is no noise generated. In addition, there is no waste or pollution resulting from the use of PLTS.

4. This tool can be located flexibly, PLTS can be built anywhere without regard to the topographical conditions of the environment to be occupied.

Weaknesses of the device:

1. The price of installation / manufacture at the airport is relatively expensive because price for each component is relatively expensive. The more expensive the power you want to generate, the more components needed resulting in more costs required.
2. The efficiency of solar power plants is highly dependent on weather conditions. Cloudy weather reduces the ability of solar power plants to operate.

## Conclusion

1. PLTS planning at Muhammad Salahuddin Bima Airport is a back-up system for Taxiway lights whilereducing the use of conventional electricity.
2. The PLTS design that is prepared is the main and supporting PLTS components, these components must be tested first to determine the feasibility of thefunction of the

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